

Inga Bethmann, M. Sc.

Three Essays on the Economic Effects of Tax Policy

Dissertation
for obtaining the degree of Doctor of Business and Economics
(Doctor rerum politicarum - Dr. rer. pol.)

at WHU – Otto Beisheim School of Management

30.08.2017

First Supervisor: Prof. Dr. Martin Jacob

Second Supervisor: Prof. Dr. Martin Glaum

Acknowledgements

I am obliged to many people who have supported me on this long road.

First, I would like to express my gratitude to my supervisor Prof. Dr. Martin Jacob. I would like to thank for his valuable advice on the selection of research areas, his methodological support, and his valuable insights into the academic world. Moreover, I would like to thank for his patience with me and for all the time and effort he has put into the success of my work.

Moreover, I would like to thank my second advisor Prof. Dr. Martin Glaum for his support and valuable practical insights for my research projects and the time to review this manuscript.

Another important person that I would like to thank is Prof. Dr. Maximilian Müller. He has been a very helpful co-author and discussion partner who always had an open door. His dedication and enthusiasm for research have motivated me during the dissertation process.

Moreover I would like to thank Prof. Dr. Michael Devereux for inviting me to the Centre for Business Taxation at the Said Business School in Oxford, U.K. in 2016. The research visit gave me valuable insights into a different academic environment and broadened my horizon.

Finally, I would like to thank Prof. Dr. Robert Risse who has given me lots of practical insights and who was very engaged in helping me getting proprietary data.

None of this would have been possible without the support from my family who helped me to stay dedicated to this intensive project. My special thanks go to my boyfriend Eike who supported me along the road and who suffered with me through phases of frustration.

Moreover, I would like to thank my friends for being there when I needed their support. Finally, I would like to thank my colleagues at the department for several coffee breaks, discussions, and small favors.

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List of Abbreviations

ACE	Allowance for Corporate Equity
CBIT	Comprehensive Business Income Tax
E.g.	Exempli gratia (for example)
Et al.	Et alii (and others)
E.U.	European Union
FOC	First Order Condition
HMRC	Her Majesty's Royal Customs
i.e.	Id est (that is to say)
IFRS	International Financial Reporting Standard(s)
Max	Maximum
Min	Minimum
MNE	Multinational Enterprise
N	Number
NACE	Nomenclature of Economic Activities
OECD	Organisation for Economic Co-operation and Development
P.	Page
SIC	Standard industrial classification
SD	Standard deviation
U.K.	United Kingdom
U.S.	United States (of America)

1 Introduction

Tax policy plays a major role in the current political debate. Over the last decades, we have seen a global race to the bottom on corporate taxation as well as several large tax reforms such as the American Jobs Creation Act in 2004, which allowed a tax holiday for foreign profits repatriated to the United States. Currently we observe the discussion on the introduction of the destination based cash flow tax in the U.S. and a change in the taxation regime for foreign income of multinational firms. One of the major objectives of these reforms is the stimulus of corporate investments because corporate investments are expected to foster economic growth and employment as already suggested by Keynes (1936) and Domar (1946). The underlying assumption is that taxes play a significant role in corporate decision-making.

Given that taxes reduce firms' after-tax cash flows and thereby affect the cost of capital, it is reasonable to assume that changes in tax policy affect corporate decision-making such as investments. A large stream of literature provides theoretical and empirical evidence on the effect of corporate tax rates on investment decisions (e.g., Summers 1981, Cummins, Hassett, and Hubbard 1994, Cummins, Hassett, and Hubbard 1996, Chirinko, Fazzari, and Meyer 1999), on the effect of payout taxes on investments (e.g., Faulkender and Petersen 2012, Becker, Jacob, and Jacob 2013, Alstadsæter, Jacob, and Michaely 2015), and on the effect of corporates taxes on leverage or employment (e.g., Heider and Ljungqvist 2014, Ljungqvist and Smolyansky 2014, Fuest, Peichl, and Siegloch 2016).

This dissertation contributes to the literature with three studies that examine economic consequences of tax policy comprising theories from accounting, finance, and economics. It thereby answers the call for papers on the “real-effects” of tax policy in Hanlon and Heitzman (2010). In particular, three different features of tax policy are examined in this thesis. The first one being statutory tax rates: a change in the tax rate affects current and future after-tax cash flows of profitable firms as long as they are not able to fully avoid the tax burden in the current

and in future periods. Therefore, one would expect that tax rates affect, *inter alia*, a firm's investment decision. The main contribution of this thesis lies in the analysis of cross-sectional variation in the investment response to tax rate changes.

The second feature are tax loss offset provisions: while prior literature mainly focuses on the incorporation of loss offset possibilities in investment decisions prior to an actual loss (e.g., Domar and Musgrave 1944, Stiglitz 1969, Dreßler and Overesch 2013, Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017), this thesis focuses on the investment response of loss firms. If a firm offsets its current loss with previous profits, it will receive tax refunds that are available for investments. Assuming that external financing costs exceed internal costs of financing (financial constraints), one would expect that at least part of the tax refund is used for investments. A major contribution of this dissertation lies in the discussion of the desirability of the investment response to more lenient loss offset possibilities.

Finally, this thesis examines the role of repatriation taxes on foreign source income: if the marginal investment is financed with new equity ("old view") changes in repatriation taxes will affect the costs of capital and thereby affect investment decisions of multinational firms. This thesis mainly focuses on how the reduction of repatriation taxes, following a regime change in the taxation of foreign source income, maps into capital location decisions and finally the competitive position of multinational firms in foreign markets.

This dissertation does not only contribute to the academic literature on the relation between taxation and investments. The main contribution lies in a more detailed analysis of the average investment response to taxation. It examines cross-sectional variation in the investment response that informs policy makers about major beneficiaries of their tax reforms and could speak towards the desirability of investment responses. The dissertation further informs the discussion on the desirability of the investment response in the case of more lenient loss offset possibilities by studying potential distortions in the competitive selection of firms and aggregate

output and productivity implications. Finally, this thesis gives first insights into the impact of repatriation taxes on foreign source income on the competitiveness of multinational firms and on the potential impact on market dynamics in foreign countries.

The thesis comprises five chapters: an introduction, three empirical research papers, and an overall summary and conclusion. Each research paper is to be seen as an independent and individually complete study. The autonomous structure of each chapter allows the reader to read each of the three studies separately. While the second chapter includes a single authored study that uses the first person singular, chapter three is co-authored with Prof. Dr. Martin Jacob, and Prof. Dr. Maximilian A. Müller, and chapter four is co-authored with Dr. Martin Simmler. The latter two chapters, therefore, use the first person plural.

The second chapter of this thesis focuses on the negative relation between statutory tax rates and corporate investments and provides evidence for cross-sectional variation in a firm's tax rate elasticity of capital. The study exploits staggered variation in local business tax rates across German municipalities. This setting helps to study investment responses in a very homogeneous institutional and economic environment and thereby helps to overcome omitted variable problems stemming from different legal and economic developments of treatment and control firms due to the geographic proximity and economic similarity of municipalities. The approach follows a growing stream of literature that uses variation in tax rates set at lower administrative levels to study firm responses, such as Ljungqvist and Smolyanski (2014), Heider and Ljungqvist (2015), and Giroud and Rauh (2016) who use variation in U.S. state taxes.

The results suggest an average long-run capital decline of up to 0.97% after a 1% increase in the tax rate. In line with prior literature that suggests higher investment-cash flow sensitivities of firms with financing constraints (e.g., Fazzari, Hubbard, and Petersen 1988, Faulkender and Petersen 2012) tax rate elasticities are up to half times larger for financially constrained firms

than for unconstrained firms. Moreover, capital responses are about half times larger for firms with fewer tax avoidance possibilities. This is in line with e.g., Schreiber and Overesch (2010) and Dobbins and Jacob (2016). Finally, this study speaks towards the role of market power (i.e., tax incidence) in the relation between taxes and investments, as suggested by Dyreng et al. (2017) who examine the trade-off between tax avoidance and shifting the tax incidence to either consumers or employees. The results are in line with the notion of a weaker relation between taxes and capital for firms with higher market power. These firms are less likely to bear the economic burden of the tax because they shift the tax incidence to their employees or customers. However, the latter analysis is limited to very indirect measures for tax incidence.

This study greatly benefits from comments and suggestions by Antonio De Vito, Michael Devereux, Martin Jacob, Maximilian A. Müller, Wayne Landsman, Silke Rüniger (discussant), David Samuel (discussant), Philip Schnorpfeil, seminar participants at WHU – Otto Beisheim School of Management, and seminar participants of the 3rd Doctoral Research Seminar at WU, Vienna and 40th European Accounting Association meeting.

The third chapter examines investment responses to tax loss offset provisions using variation in loss carryback provisions in the E.U. and variation in a firm's profitability status over time. While tax regimes usually treat losses and profits asymmetrically because profits are immediately taxed but losses are not immediately refunded, loss carryback regimes mitigate the asymmetry by granting tax refunds to loss firms.

The study finds that these tax refunds increase loss firms' investment. While a third of the refund is invested, the remaining two thirds are held as cash or returned to shareholders. The implications of an investment response of loss firms are, however, more ambiguous than for the average profitable firm. While the investment response could be explained by loosening of loss firms' financing frictions, it is unclear whether that is desirable. On the one hand, it is plausible that loss firms face efficient financing frictions because capital markets ration funds

to distressed and inefficient firms that are prone to overinvest in risky projects with negative net present value (NPV). On the other hand, loss carrybacks could loosen financing frictions induced by capital market inefficiencies (e.g., adverse credit supply shocks). This study examines these countervailing effects—the risk of supporting “losers” versus relaxing inefficient financing frictions—of loss carrybacks. Exploiting heterogeneity in the investment response to tax refunds helps to disentangle whether less restrictive refunds help loss firms to overcome underinvestment problems or lead to overinvestment. The analysis reveals that the investment response is driven primarily by firms with financial distress and low productivity, i.e., businesses that are prone to engage in risky overinvestment.

Consistent with the risk of misallocation, the study finds that tax refunds resulting from loss carrybacks distort the negative relation between productivity and exits. The delayed exit of low-productivity loss firms receiving tax refunds indicates potential distortion of the competitive selection of firms. This distortion also negatively affects aggregate output and productivity.

This study complements literature on the ex ante benefits of carrybacks such as increased risk taking (Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017) by providing empirical evidence on the potential costs—the risk of misallocation—of granting loss carrybacks. Prior literature provides mixed evidence on the ability of carrybacks to stimulate loss firms’ investment (Dobridge 2015) and is silent on the desirability of this effect.

This paper has benefited from comments and suggestions by Anna Alexander, Yakov Amihud, Kathleen Andries, Phil Berger, Kay Blaufus, Matthias Breuer, Martin Glaum, Michelle Hanlon, Jeff Hoopes, Wojciech Kopczuk, Dominika Langenmayr, Christian Leuz, Michael Overesch, Daniel Saavedra (discussant), Richard Sansing, Harm Schütt, Joel Slemrod, Kjetil Telle, Eric Zwick, and seminar and conference participants at WHU – Otto Beisheim School of Management, 19th UNC Tax Symposium, the Accounting Section Meeting of the Verein für Socialpolitik, the Annual Meeting of the EAA, the EAA Doctoral Colloquium, and

the IIPF Doctoral School on Tax Systems. Moreover, it has benefited from the help of local experts from Ernst & Young and KPMG in obtaining information on institutional tax details.

The fourth chapter informs the ongoing political and academic discussion about the optimal taxation of foreign source income of multinational firms. The two competing systems in place are the territorial and the worldwide tax regime. A territorial tax regime excludes foreign source income from repatriation taxes at the parent level. Under a worldwide tax regime, foreign corporate profits are taxed at the national rate of the parent but a credit is given for foreign taxes paid. While most countries in the world apply a territorial tax system, the U.S. are the most prominent country with a worldwide tax regime.

This study examines whether a worldwide corporate income tax regime impairs the competitive position of subsidiaries of multinational groups in foreign markets relative to a territorial regime. Multinationals from worldwide tax regimes face a competitive disadvantage vis-à-vis other market participants in countries with a lower tax rate than the parent company because they face a higher tax burden. In high-tax countries multinationals from worldwide tax regimes face a competitive disadvantage vis-à-vis multinationals from a territorial tax system that benefit from the tax differential between high and low-tax countries, e.g., by locating production in low-tax countries. Changing from a worldwide to a territorial tax system leads to cost savings and thereby to an increase in output of multinationals.

Based on a Cournot model with two firm types and endogenous entry, output of each competitor and so the number of competitors decreases in response to these cost savings. The study tests the model predictions by exploiting the U.K. tax regime change from worldwide to territorial in 2009. First, using firm-level panel data, results suggest an increase in output of U.K. subsidiaries in foreign markets after the reform. Further, in line with the relocation process driving the results, evidence suggests that capital expenses decrease in high-tax countries. Second, industry-level panel data reveal that net entry rates decline in industries with a high

ratio of U.K. multinationals after the reform suggesting that the increased competitiveness of U.K. multinationals leads to a decline in expected profits in the respective industries. This decline prevents new firms from entering.

The findings contribute to the literature on the effect of the taxation of foreign earnings on firm behavior. Previous literature shows that the change from worldwide to territorial taxation fosters repatriation of foreign earnings and reduces overinvestment (Arena and Kutner 2015, Egger et al. 2015), and leads to an increase in investments in low-tax countries (Feld et al. 2016, Liu 2017). Moreover, the study contributes to the literature that investigates the impact of taxation on industry dynamics, i.e., the competitive position of firms within a market (Brekke et al. 2017). The relation between market dynamics and repatriation taxes on foreign source income could inform policy makers in the U.S. who frequently discuss the change from a worldwide to a territorial taxation system.¹

This study has greatly benefited from helpful comments and suggestions by Richard Collier, Michael Devereux, Fabio Gaertner (discussant), Luzi Hail, Martin Jacob, Michael Smart, Johannes Voget, and Brown Bag participants at the Oxford Centre for Business Taxation, and WHU – Otto Beisheim School of Management as well as seminar participants of the 7th Conference on Current Research in Taxation, Vienna.

¹ See e.g., the Urban-Brookings Tax Policy Center: “Is a territorial tax system viable for the United States?”, March 28, 2017, available at <http://www.urban.org/sites/default/files/publication/89241/2001204-is-a-territorial-tax-system-viable-for-the-united-states.pdf>, last accessed August 25, 2017.

2 Heterogeneity in Tax Rate Elasticities of Capital: Evidence from Local Business Tax Reforms²

2.1 Introduction

Policy makers are interested in stimulating corporate investments to foster economic growth and employment (e.g., Keynes 1936, de Long and Summers 1991). Tax cuts are usually seen as useful tools to spur capital investments. The U.S. President's Framework for Business Taxation in April 2016 states that a reduction in the U.S. federal rate from 35 % to 28% would "help encourage greater investment".³ This is in line with Donald Trump's view that "lower tax rates will provide a tremendous stimulus for the economy",⁴ or the view of the British Chancellor, George Osborne, in July 2015 who claims that the staggered tax cut from 28% to 20% in 2015 "increased much needed investment".⁵

While there is large theoretical and empirical evidence for a negative relation between taxes and capital investments, there is no consensus estimate on the size of the tax rate elasticity of capital and scarce evidence exists for cross-sectional differences in the relation between taxes and capital expenditures. This is mostly due to previous research design choices. For example, studies that combine tax rate and tax base elements using the cost of capital or q-approach to study tax elasticities of capital (e.g. Jorgenson 1963, Hall and Jorgenson 1967, Summers 1981, Cummins, Hassett, and Hubbard 1994, Cummins, Hassett, and Hubbard 1996, Chirinko, Fazzari, and Meyer 1999, Dwenger 2014) do not provide estimates for the pure tax rate effect.

² This chapter is based on Bethmann (2017), Heterogeneity in Tax Rate Elasticities of Capital: Evidence from Local Business Tax Reforms, FAccT Center Working Paper Nr. 24/2017. The paper has been presented at the 3rd Doctoral Research Seminar at WU, Vienna and the 40th European Accounting Association meeting in Valencia.

³ See The President's Framework for Business Tax Reform: An Update, April 2016, available at: <https://www.treasury.gov/resource-center/tax-policy/Documents/The-Presidents-Framework-for-Business-Tax-Reform-An-Update-04-04-2016.pdf>, last accessed August 25, 2017.

⁴ See Trump: Tax Reform That Will Make America Great Again, available at <https://assets.donaldjtrump.com/trump-tax-reform.pdf>, last accessed August 25, 2017.

⁵ George Osborne, Chancellor of the Exchequer, July 2015, available at: <https://www.gov.uk/government/speeches/chancellor-george-osbornes-summer-budget-2015-speech>, last accessed August 25, 2017.

2 Heterogeneity in Tax Rate Elasticities of Capital: Evidence from Local Business Tax Reforms

Most tax reforms do not allow to disentangle tax base and tax rate effects because tax rate changes are usually accompanied by a change in the tax base. Analyzing changes in local business tax rates set at municipality level allows me to isolate the tax rate effect because regulations for the computation of the tax base are set at federal level. Moreover, the usage of firm-level data enables me to control for cross-sectional differences in capital responses to tax rate changes, which could lead to more precise estimates compared to studies on aggregate investment effects using macro data (e.g., Auerbach 1983, Djankov et al. 2010). This approach follows a growing stream of literature that uses variation in tax rates set at lower administrative levels to analyze firm responses, such as Ljungqvist and Smolyanski (2014), Heider and Ljungqvist (2015), and Giroud and Rauh (2016) who use variation in U.S. state taxes.

Identifying heterogeneity in capital responses to tax rate changes helps policy makers (i) to identify which firms are affected most by a change in tax policy and (ii) to understand potential behavioral responses of those showing lower investment sensitivities in order to adjust tax policy accordingly. In addition, providing evidence on heterogeneity in firms' investment responses may also help to explain the wide range of estimates for user cost elasticities of capital that mostly range between -1 and 0.⁶

This study contributes to existing literature by examining heterogeneity in capital responses to tax rate changes with respect to three characteristics. First, I provide evidence that financially constrained firms show capital elasticities that are about half times larger than those of unconstrained firms. Given that taxes affect a firm's after-tax cash flow, this finding is in line with the notion of higher investment-cash flow sensitivities of financially constrained firms (see e.g., Fazzari, Hubbard, and Petersen 1988, Rauh 2006, Faulkender and Petersen 2012).

⁶ For user cost elasticities see e.g., Jorgenson (1963), Hall and Jorgenson (1967), Chirinko, Fazzari, and Meyer (1999), Cummins, Hassett, and Hubbard (1994), Cummins, Hassett, and Hubbard (1996). For a discussion and overview see Dwenger (2014).

Second, I argue that tax avoidance possibilities mitigate the effect of tax rate changes on capital expenditures because changes in statutory rates translate into smaller changes in effective tax rates if firms engage in tax avoidance. This is in line with findings in Schreiber and Overesch (2010) who show that the tax sensitivity of investments of multinationals decreases with rising R&D intensity, i.e., profit shifting possibilities. Moreover Simmler (2015) and Dobbins and Jacob (2016) find stronger investment responses of domestic group firms relative to multinational groups to a large business tax reform in 2008 in Germany. In line with this notion, the results suggests that single-jurisdictional firms without profit shifting possibilities show about half times larger capital elasticities than firms which belong to a multi-jurisdictional group. Compared to prior studies which relied on corporate tax rate changes accompanied by changes in the tax base to identify the tax effect, my setting allows cleaner estimates of the pure tax rate effect as the computation of the tax base is not affected by local tax reforms.

Lastly, my study contributes to the literature on tax incidence (e.g., Harberger 1962, Krzyzaniak and Musgrave 1963, Dye 1998, Vasquez-Ruiz 2012, Arulampalam, Devereux, and Maffini 2012, Fuest, Peichl, and Siegloch 2016, Dyreng et al. 2017). As pointed out by Dyreng et al. (2017), the ability to shift the tax burden to stakeholders via price increases or wage reductions could impact the relation between taxes and investment or financing decisions.⁷ This study is the first to test this notion empirically. My findings suggest that firms show lower capital elasticities if they are better able to shift the tax incidence to their stakeholders. I find lower capital elasticities for highly profitable firms that are expected to have a higher market power, which is in line with the notion that these firms shift the tax burden to either their consumers or employees. Moreover, I find evidence that firms with a higher power vis-à-vis their employees show lower tax rate elasticities of capital, which could be explained with a shift

⁷ See Dyreng et al. (2017) p. 7.

of the tax burden to their employees. One limitation of my analysis is, however, that I do not observe output prices or individual wages directly. This makes the analysis imperfect because it can only rely on indirect proxies to measure the extent to which firms transfer the additional tax burden to their stakeholders. While the results are consistent across the two different proxies for a firm's possibility to shift the tax incidence, the results need, nevertheless, to be interpreted with caution.

For the identification of the tax rate effect, my research design exploits staggered variation in local business taxes in Germany. While local business tax rates are set at municipality level, regulations for the computation of the tax base are set at federal level. The setting allows me to disentangle tax rate and tax base effects and to study investment responses in a very homogeneous institutional and economic environment.⁸ Cross-country studies (e.g., Cummins, Hassett, and Hubbard 1996) usually have difficulties to comply with the common trends assumption due to different economic and legal conditions and different tax base definitions. Failure to control for these omitted variables could lead to biased coefficient estimates for the tax rate effect if these factors change over the observation period and if they affect capital expenditures. For example, if changes in economic conditions induce a change in tax policy, estimations for the tax rate effect will as well reflect investment changes that are due to the different economic environment. In my setting, instead, treatment and control group face the same legal and economic environment, which allows cleaner estimates of the tax rate elasticity of capital.

I compare changes in capital stock of firms, which face a change in the local business tax rate, to the change in capital stock of firms operating in a different municipality but the same

⁸ Other studies have exploited this setting to examine e.g., the tax rate setting process (Buettner 2006, Baskaran 2014, Foremny and Riedel 2014), behavioral responses to a formula apportionment regime (Riedel 2010, Buettner, Riedel, and Runkel 2011), location decisions of multinational firms (Becker, Egger, and Merlo 2012), or the tax incidence on wages (Fuest, Peichl, and Sieglöcher 2016).

county (*Kreis*). That is, the inclusion of county–year fixed effects removes all regional and year specific observable and unobservable factors that determine a firm’s capital stock, which makes the approach similar to a spatial discontinuity design.⁹ Limiting the counterfactuals to firms from the same county mitigates potential endogeneity concerns of tax policy. If the change in tax policy follows or anticipates changes in economic conditions, I assume that control firms face the same change in economic conditions due to their geographical proximity. Moreover, an additional test using leads and lags of the explanatory variable supports the assumption that potential endogeneity of tax policy does not bias my results because there are no differences between treatment and control firms prior to the announcement of the tax reform. I further control for a large variety of observable firm characteristics that vary over time and that influence the level of capital stock. I additionally include firm fixed effects that control for unobservable time invariant firm characteristics (e.g. industry, ownership structure, manager characteristics) that could influence the level of capital stock.

Financial as well as ownership information is provided by Amadeus. My sample includes 26,894 listed and (mostly) private firms from 3,897 different municipalities between 2005 and 2014. Private firms show more heterogeneity than public firms with respect to financial constraints because they are more prone to information asymmetries (Hale and Santos 2009, Saunders and Steffen 2011, Behr, Norden, and Noth 2013).¹⁰ This characteristic is useful when analyzing the role of financing constraints in the relation between taxes and capital expenditures. In addition, private firms are usually smaller than public firms, which facilitates the analysis of capital responses of stand-alone firms and small group firms that operate in only one taxing jurisdiction. Moreover, it is important to understand the behavior of private firms

⁹ For the application of a spatial discontinuity design in the context of local taxes see e.g., Ljungqvist and Smolyansky (2014).

¹⁰ Moreover, prior literature (e.g., Brown and Petersen 2009, Chen and Chen 2012) shows a decline (or disappearance) in investment-cash flow sensitivities (i.e., financing constraints) for public firms that could be caused by e.g., the rising importance of equity markets.

because they represent a substantial part of the overall firm population that employs about two-thirds of all workers in the European Union.

The results suggest that a one percentage point increase in the statutory tax rate leads to a decrease in capital (fixed assets) by up to 0.97% in the long-run. The inclusion of different firm-level control variables such as wage expense, sales, sales growth, age, EBIT, cash holdings, and liabilities slightly decreases the effect. I find that capital responses are persistent in later years and do not incur prior to the tax reform. To corroborate the validity of the approach, I show weaker responses of firms for which I expect lower elasticities of capital, i.e., loss firms. Since loss firms are not subject to tax in the year of the loss and in following periods in which loss carryforwards shield their profits from taxation, I do not expect their investment decisions to depend on the tax rate. In line with this argument, I find a weaker relation between taxes and capital for loss firms.

I further exploit cross-sectional variation in the size of the effect depending on the level of financial constraints. Since tax rate increases reduce after-tax cash flows, I expect firms to change their investment behavior in response to a change in tax policy. Following prior literature that shows higher investment-cash flow sensitivities of financially constrained firms (e.g., Fazzari, Hubbard, and Petersen 1988, Rauh 2006, and Faulkender and Petersen 2012), I expect that a firm's responsiveness to tax rate changes increases with the wedge between internal and external financing costs (i.e. financing constraints). I use size and age to determine a firm's degree of financial constraint assuming that young and small firm are more likely to be financially constrained (see e.g., Hadlock and Pierce 2010). While I find a negative relation between tax rate changes and capital for both, financially constrained, and unconstrained firms, the results suggest that financially constrained firms decrease investments more than unconstrained firms when facing a change in corporate tax rates.

In addition to that this study provides evidence on the difference in the investment response between single-jurisdictional and multi-jurisdictional firms. In line with e.g., Schreiber and Overesch (2010), Simmler (2015), and Dobbins and Jacob (2016), I expect firms operating in multiple municipalities to show lower tax rate elasticities of capital because they have better tax avoidance possibilities.¹¹ Multi-jurisdictional firms can exploit differences either in local business tax rates within Germany or in corporate tax rates across countries.¹² In this regard, I find a stronger relation between taxes and capital within the sample of single-jurisdictional firms. The results suggest that the effect of taxes on capital is about half times larger for single-jurisdictional than for multi-jurisdictional firms in the long run. Given that single-jurisdictional firms are not able to relocate investments to other jurisdictions, estimates for the tax rate elasticities of single-jurisdictional firms represent estimates for the change in the scale of a firm's investments after a tax rate change.

Moreover, I examine the role of tax incidence in the relation between taxes and capital as suggested by Dyreng et al. (2017) who examine the relation between tax avoidance and tax incidence, that is, the tax avoidance of firms with high market power. If firms do not bear the economic burden of a tax increase, they are less likely to adjust their capital in response to tax changes. Firms that face a less elastic consumer demand will face lower declines in demand after an increase in consumer prices. These firms are thus more likely to increase their prices after a tax increase to compensate for the additional costs. Following e.g., Lerner (1934), Kubick et al. (2015), Jacob, Michaely, and Müller (2016), and Dyreng et al. (2017), I expect firms with high profit margins to have more market power, which suggests that they face a less

¹¹ For empirical evidence on profit shifting of multinational firms see e.g., Dischinger and Riedel 2011, Dharmapala and Riedel 2013.

¹² Formula apportionment mitigates profit shifting possibilities within Germany because profits are allocated to each affiliate according to its payroll share. However, this applies only if the group firms form a fiscal unity for local business tax purposes. Moreover, prior literature provides evidence that firms engage in tax avoidance under formula apportionment by manipulating payroll expenses (Riedel 2010, Eichfelder, Hechtner, and Hundsdoerfer 2015).

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elastic demand. In addition, Fuest, Peichl, and Siegloch (2016) show that firms with high profit margins transfer more of the additional tax burden to their employees via a cut in wages.¹³ The results suggest that firms with a better ability to shift the tax incidence to their stakeholders (firms with high profit margins) show about 25% lower tax rate elasticities of capital.

Fuest, Peichl, and Siegloch (2016) suggest that the ability to shift the tax incidence on employees depends on the labor supply elasticity, i.e. the mobility of employees. They show that blue collar workers experience larger wage cuts relative to white collar workers because the latter are expected to be more mobile. In line with the notion that these firms will show lower investment responses to a change in tax policy, the results indicate that firms with a higher share of blue collar workers (lower average wages) show lower capital responses.

This study contributes to the large body of literature on the investment effect of tax policy (e.g., Jorgenson 1963, Hall and Jorgenson 1967, Summers 1981, Cummins, Hassett, and Hubbard 1994, 1996, Chirinko, Fazzari, and Meyer 1999, and Auerbach 2002) by shedding light on the heterogeneity in capital elasticities to changes in the tax policy with a setting that allows the analysis of corporate capital responses in a homogenous institutional and economic environment. The findings help policy makers to identify firms that are most affected by corporate tax rate changes. My findings suggest stronger capital responses of financially constrained firms, which is line with the notion that financially constrained firms show higher investment-cash flow sensitivities. This contributes to existing studies on investment-cash flow sensitivities in general (e.g., Fazzari, Hubbard, and Petersen 1988, Kaplan and Zingales 1997, and Faulkender and Petersen 2012) and more specifically on the role of financial constraints in private firms (Behr, Norden, and Noth 2013, Erel, Jang, and Weisbach 2015, and Farre-Mensa and Ljungqvist 2016). Moreover, single-jurisdictional firms show higher tax rate elasticities of

¹³ This follows the reasoning of fair wage models in which wages are a function of a firms after-tax profits. Given that more profitable firms will face a larger decline in after-tax profits in absolute values, wage adjustments are likely to be stronger.

capital, presumably because they have higher effective tax rates than multi-jurisdictional firms due to fewer tax avoidance possibilities, which is in line with findings of e.g., Schreiber and Overesch (2010), Simmler (2015), and Dobbins and Jacob (2016). Moreover, firms that are not able to transfer the additional tax burden to one of their stakeholders show a stronger relation between taxes and capital. With this finding, I contribute to the large literature on tax incidence (see e.g., Harberger 1962, Krzyzaniak and Musgrave 1963, Dye 1998M, Vasquez-Ruiz 2012, Arulampalam, Devereux, and Maffini 2012, Fuest, Peichl, and Siegloch 2016) by providing evidence for the mitigating effect of tax incidence on the relation between taxes and investments as suggested by Dyreng et al. (2017).

The remainder of the paper is structured as follows: Section 2.2 develops the hypotheses, section 2.3 describes the institutional background of local business taxes in Germany and the dataset used. In section 2.4, I explain the estimation strategy and section 2.5 presents the results. Section 2.6 provides a conclusion.

2.2 Hypothesis Development

While prior studies show that taxes have an adverse effect on a firm's capital stock, this study exploits heterogeneity of firms' investment responses to changes in tax policy.

There are two channels that explain the negative relation between tax rates and investments. First, taxes reduce expected after-tax cash flows of investment projects and thereby reduce the set of positive NPV projects available to a firm. Put differently, tax rates increase required rates of return before taxes of corporate investment projects because shareholders would otherwise prefer to undertake investments outside the firm when facing an increase in corporate taxes and vice versa (e.g., Dobbins and Jacob 2016, Asker, Farre-Mensa, and Ljungqvist 2015).¹⁴ Second, firms reduce capital expenditures in response to tax rate changes due the detrimental effect on

¹⁴ In Appendix A, I derive the relation between taxes, required rates of return, and the optimal level of capital stock more formally.

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contemporaneous after-tax cash flows, i.e., a firm's cash that is available for investments. This assumes imperfect capital markets, i.e., a wedge between costs of internal and external financing that could be due to e.g., agency costs or information asymmetries. If external financing cost exceed the cost of internal financing, freeing up additional cash by lowering tax rates will allow the firm to undertake investment projects that were not beneficial when financed with external capital. Consequently, tax rate increases will limit the amount of cash that is available for investments and thereby reduce investment activity of financially constrained firms.

Therefore, I assume that financing constraints increase tax rate elasticities of capital because they lead to higher investment-cash flow sensitivities (e.g., Fazzari, Hubbard, and Petersen 1988, Rauh 2006, Faulkender and Petersen 2012).¹⁵

H1: Financially constrained firms show higher tax rate elasticities of capital.

Previous literature finds that financially constrained firms engage in more tax avoidance than their unconstrained peers (see e.g. Law and Mills 2015, Edwards, Schwab, and Shevlin 2016). Thus, it is possible that financially constrained firms show lower tax elasticities of capital as changes in the statutory tax rate do not affect their effective tax rates as much as effective tax rates of unconstrained firms. This would lead to no or a smaller decline in a firm's set of positive NPV projects or to a smaller decline in after-tax cash flows that are available for investments. Therefore, the effect of financing constraints on a firm's investment response to tax rate changes is an empirical question.

I expect that tax avoidance possibilities mitigate the effect of taxes on investments. If firms engage in tax avoidance they have lower effective tax rates. This will translate into smaller

¹⁵ There is another stream of literature questioning stronger investment-cash flow sensitivities of financially constrained firms due to e.g., precautionary saving motives (see e.g., Kaplan and Zingales 1997). For a discussion see Fazzari, Hubbard, and Petersen (2000) and Kaplan and Zingales (2000).

effects of a change in tax policy on after-tax cash flows and required rates of return before taxes. Therefore, these firms should show lower tax rate elasticities of capital. Multi-jurisdictional firms are expected to engage in more tax avoidance than firms that operate in only one location because they have better tax planning possibilities, including e.g., profit shifting to lower tax jurisdictions.¹⁶ Therefore, I expect lower tax elasticities of capital of multi-jurisdictional firms relative to single-jurisdictional firms (see also Simmler 2015, Dobbins and Jacob 2016).

H2: Firms with better tax avoidance possibilities show lower tax rate elasticities of capital.

On the other hand, multi-jurisdictional firms have the option to relocate capital to lower tax jurisdictions in case of a change in tax policy.¹⁷ This would translate into higher tax elasticities of capital of multi-jurisdictional firms. However, I assume that firms prefer to shift profits instead of relocating their production capacities as long as the cost associated with tax avoidance (higher uncertainty, reputational costs, agency costs, see e.g., Gallemore, Maydew, and Thornock 2014, Desai and Dharmapala 2009) do not exceed the cost for relocation.

Several studies examine the extent to which the corporate tax burden does not fall on the firm but is transferred to other stakeholders, such as employees, or consumers via decreases in wages or increases in prices (see e.g., Harberger 1962, Krzyzaniak and Musgrave 1963, Dye 1998, Vasquez-Ruiz 2012, Arulampalam, Devereux, and Maffini 2012, Fuest, Peichl, and Siegloch 2016). Dyreng et al. (2017), who examine the effect of tax incidence on tax avoidance, point out a potential mitigating effect of tax incidence on the responsiveness of investment or financing decisions to a change in tax policy. This study tests this proposition empirically. In particular, I examine whether firms that bear only a small fraction of the tax burden show lower tax rate elasticities of capital.

¹⁶ For empirical evidence on profit shifting of multinational firms see e.g., Dischinger and Riedel 2011, Dharmapala and Riedel 2013). Empirical evidence on lower effective tax rates of multinationals can be found in e.g., Dyreng and Lindsey (2009) and Dyreng, Hanlon, and Maydew, (2010)

¹⁷ Grubert and Slemrod (1998) show that the income shifting advantage is the predominant reason for capital investments of U.S. firms in Puerto Rico.

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Price adjustments in response to a tax rate change assume that profit taxes are seen as costs of production.¹⁸ This would lead to a shift in the supply curve and therefore to an increase in prices and a decline in demand. The degree of the price increase and the decline in demand (i.e., the effect on profits) depends on the elasticity of demand. Assuming an inelastic consumer demand, the shift in the supply curve will lead to a larger price increase and to a smaller decline in demand relative to a shift in case of a more elastic consumer demand. Put differently, a price increase leads to a higher tax incidence on consumers if the firm faces an inelastic demand. Thus, a tax rate change will have a smaller effect on a firm's after-tax profits if it faces an inelastic consumer demand. If a firm's cash flows are less affected by a tax change, I would expect lower investment responses to a change in tax policy.¹⁹

I provide analytical evidence for the role of demand elasticity in the relation between taxes and the optimal level of capital in Appendix A.1. Results suggest that the effect of taxes on the marginal product of capital are stronger in case of a more elastic demand. This implies increasing tax rate elasticities of capital with increasing elasticity of demand.

Wage adjustments in response to a change in tax policy follow e.g., the reasoning of the fair wage model that assumes wages to be a function of inter alia a firm's profits (see e.g., Akerlof and Yellen 1990). Therefore, shocks to profits such as an increase in tax liabilities will lead to adjustments in wages.²⁰ The degree to which firms are able to adjust their wages in response to

¹⁸ However, price increases in response to tax rate increases appear to contradict the traditional theory of price setting. First, in a perfectly competitive market, firms have zero profits and thus their production function cannot be affected by profit taxes. For a monopolist the profit maximizing price will not be affected by a change in profit taxes because price adjustments will lead to lower profits before taxation (otherwise, he would not have maximized his profits before the change). However, the application of the profit maximizing approach has been questioned due to a lack of information on the marginal revenue function in reality where firms seem to maintain a target ratio of profits to sales (for a survey see e.g., Hall and Hitch 1939). In that case, price adjustments in response to a change in after-tax profits are possible (see also Goode 1945). Another reason for prices below the profit-maximizing optimum is that firms refrain from price increases because they are afraid that the price increase is not followed (see e.g., Goode 1945, Gordon 1967). Increases in tax rates could be understood as industry-wide signals that induces all firms to increase their prices (see Gordon 1967).

¹⁹ This is in line with e.g., Gordon (1967), p. 731.

²⁰ For an extensive discussion of the different models that explain wage adjustments in response to tax rate changes see e.g., Fuest, Peichl, and Sieglöck (2016).

a tax rate increase depends on the labor supply elasticity, i.e., on the degree to which labor supply declines if wages are cut. In case of a less elastic labor supply, a cut in wages lead to a smaller decline in labor supply than in case of a more elastic labor supply. Thus, there is a smaller decline in the firm's surplus and a larger incidence on employees.

H3: Tax elasticities of capital are lower for firms that shift the tax incidence to their consumers or employees.

2.3 Institutional Background and Data

2.3.1 Institutional Background: Local Business Taxes in Germany

In Germany, the corporate tax burden for corporations comprises of a corporate income tax and a solidarity surcharge (5.5% of corporate income tax burden) that are levied at the federal level and a local business tax that is levied at municipality level. The legal framework for the computation of the taxable base for local business tax is set at the federal level and follows the computation of the taxable income for corporate income tax purposes. Some additions and deductions apply such as a limited deductibility of financing costs.²¹ The local business rate is computed as the product of a basic federal rate (*Steuermesszahl*) that is set at the federal level and a multiplier (*Hebesatz*) that is set by the council of each municipality during the budgeting process in the last three months of the previous period (see Fuest, Peichl, and Siegloch 2016). Multipliers range between 200% (legal minimum since 2004) and 530%, with an average of 400% in my sample, which leads to local business tax rates between 7% and 19.7%.

The German Business Tax Reform Act of 2008 reduced the corporate income tax from 25% to 15% as well as the federal rate for local business tax from 5% to 3.5%. Moreover, it repealed the deductibility of local business tax from its own base and from corporate income tax. An

²¹ See Paragraph 8 and 9 of the Local Business Tax Act (GewStG).

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example for the computation of the local business tax as well as the overall corporate tax rate before and after the reform is provided in Appendix A.3.

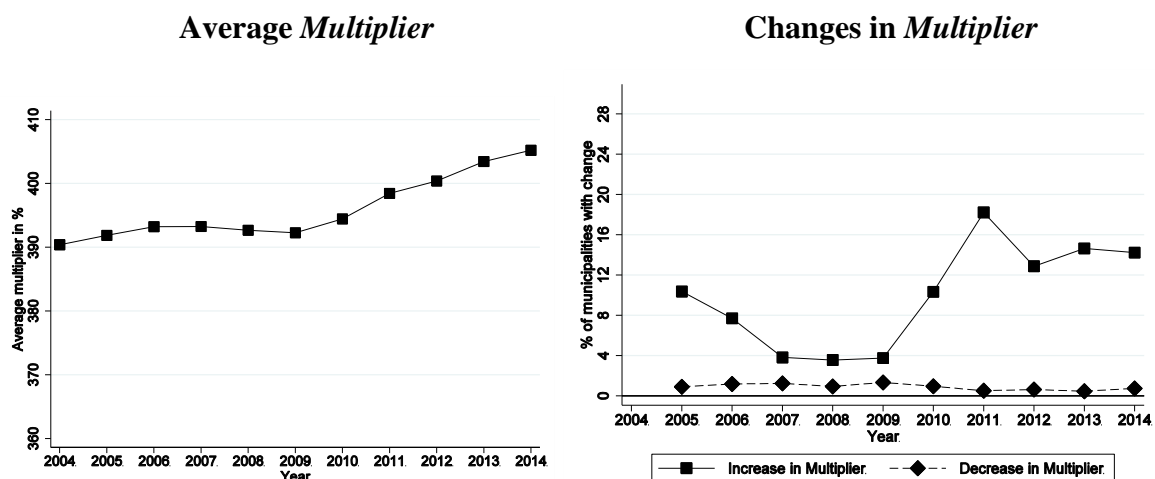
On average about 30 municipalities, Germany's smallest administrative unit, make up one of the 295 counties (*Kreise*), which represents the next larger administrative unit. Municipalities with more than 100,000 inhabitants (about 1% of all municipalities) usually make up their own county. The highest regional jurisdictions are the 16 federal states (*Bundesländer*).

2.3.2 Tax Rate Data

I exploit variation in local business tax rates across municipalities and over time. Figure 2.1 and Figure 2.2 provide an overview of the averages and changes in multipliers over time and across municipalities. Figure 2.1 indicates that there is an increase in local business tax multipliers after 2009. While most of the changes represent tax rate increases, about 4% of all changes represent a cut in the multiplier.²²

Figure 2.1: Local Business Tax Multiplier over Time

This figure plots the average local business tax multiplier for all firms of the sample and the number of changes in the multiplier from 2005–2014 for all municipalities used in the analysis.



²² Tax competition with respect to local business tax rates is less strong due to fiscal equalization scheme that compensates municipalities for losses in tax revenues. See e.g., Buettner (2006).

Figure 2.2: Local Business Tax Multipliers across Municipalities

The maps shows the average multiplier and the average change in multipliers of each municipality that is part of the sample from 2005–2014.

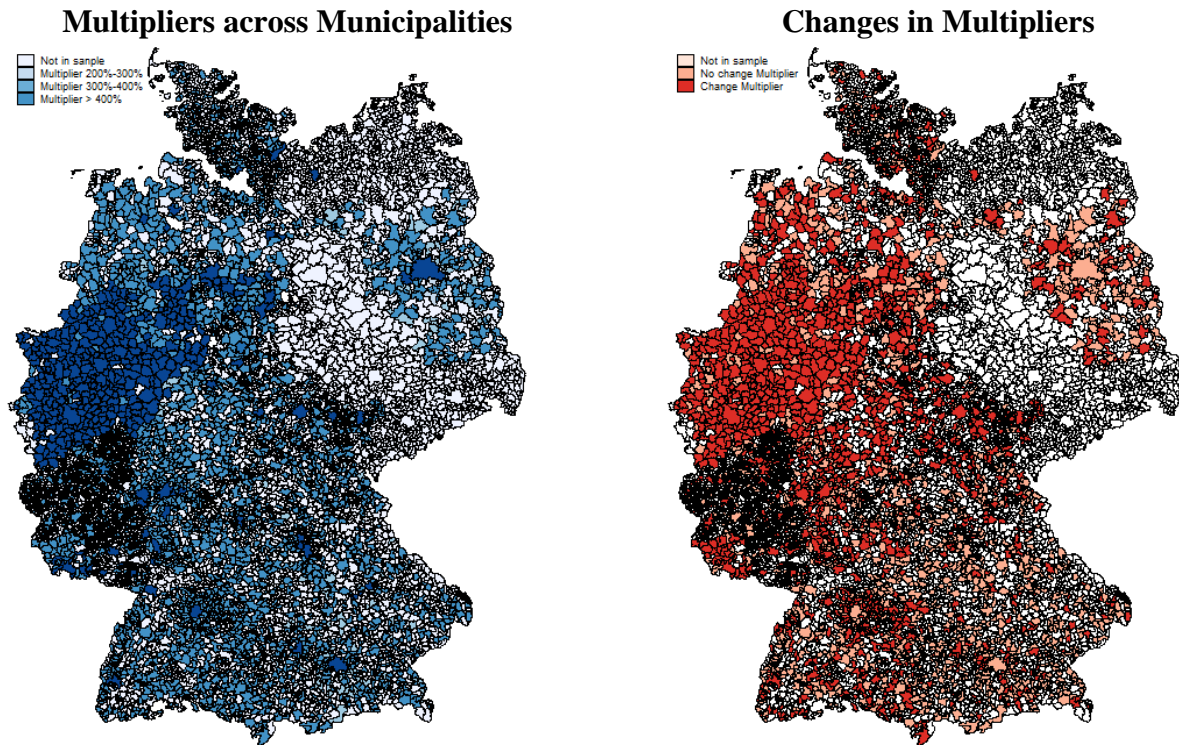


Figure 2.2 indicates that municipalities in Western Germany, especially in North Rhine-Westphalia levy the highest local business tax rates and that we observe more tax rate changes in this region.²³ A detailed overview of the number of observations and tax changes per state is given in Table 2.1.

While the frequency of tax rate changes is high (37% of the firms in the sample experience at least once a change in the multiplier), the size of the tax rate changes is rather small. The average increase in the multiplier amounts to 20 percentage points, which translates into an increase in the overall corporate tax rate of 0.7 percentage points for periods after 2007. This is equal to 2.4% of the average corporate income tax rate for that period. The average reduction in the local business tax multiplier amounts to 18 percentage points.

²³ The relatively high local business tax rates in North Rhine-Westphalia are due to the fiscal equalization scheme that compensates municipalities for losses in tax revenues. The minimum multiplier that a municipality has to levy in order to receive compensation for a loss in tax revenue is the highest in North Rhine-Westphalia. For details see e.g., Buettner (2006).

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Table 2.1: Changes per State

This table presents the number of observations and tax changes per state during the sample period.

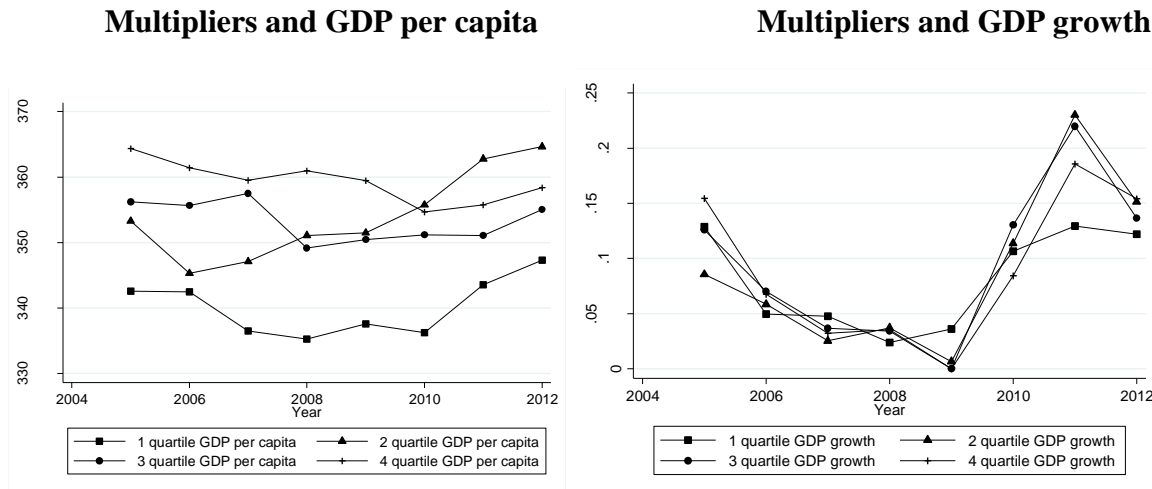
State	Change in Multiplier	% of increases	Total
Baden-Württemberg	970	96.6%	12,970
Bayern	696	54.5%	15,674
Berlin	0	-	4,792
Brandenburg	246	94.7%	2,584
Bremen	58	100.0%	910
Hamburg	0	-	3,800
Hessen	1,192	67.4%	11,344
Mecklenburg-Vorpommern	257	94.9%	1,820
Niedersachsen	1,260	98.3%	10,527
Nordrhein-Westfalen	5,643	86.7%	30,706
Rheinland-Pfalz	460	92.0%	3,994
Saarland	317	81.7%	1,867
Sachsen	261	82.4%	2,226
Sachsen-Anhalt	111	39.6%	446
Schleswig-Holstein	499	97.6%	3,618
Thüringen	949	92.8%	4,114
Total	12,919	85.3%	111,392

In general, local business tax rates are higher in urban regions with high economic development such as Frankfurt (460% in 2014), Hamburg (470% in 2014) or Munich (490% in 2014). This relation can also be observed in the data. Counties in the lowest quartile of GDP per capita also levy the lowest multipliers on average (see first graph in Figure 2.3).

However, changes in economic conditions are not correlated with changes in local business tax rates. The second graph of Figure 2.3 suggests that the number of increases in local business tax multipliers is independent of local GDP growth (measured at county level).

Figure 2.3: Local Economic Environment and Tax Rates

This Figure plots the average local business tax multiplier in each quartile of the GDP per capita (measured at the county level) and the average multiplier relative to the average GDP growth per county.



While I observe slightly more increases in local business taxes for the lowest quartile of GDP growth regions in 2009 and slightly less increases in 2011, the overall number of increases between the different quartiles of GDP growth follow a common trend over the observations period. This is in line with prior literature on German local business tax, which suggests that tax rates are usually not changed in response to local business cycle shocks (see e.g. Fuest, Peichl, and Siegloch 2016).²⁴ Foremny and Riedel (2014) provide evidence that local business tax rates vary with changes in the political environment, such as the election cycle. Moreover, changes in the fiscal equalization scheme, which is set at the state level, and which requires municipalities to levy a minimum multiplier in order to receive compensation for a loss in tax revenues, could induce changes in multipliers (see e.g., Buettner 2006). This reduces concerns that tax policy changes are accompanied by structural changes in the economy, which could lead to biased parameter estimates for the tax rate effect because estimates would also reflect firm responses to the change in the economic conditions (e.g. higher investments in response to an increase in investment opportunities). I will further address these concerns in my empirical model by limiting counterfactuals to firm-years from the same county and year.

²⁴ In particular, they show that neither unemployment nor GDP or fiscal surplus change prior to changes in local business tax rates.

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Throughout the study I will use changes in the overall statutory corporate tax rate (sum of corporate income tax, solidarity surcharge and local business tax) to identify capital responses to tax rate changes. This provides cleaner estimates for the tax rate elasticity of capital than using changes in local business tax multipliers that have different effects on the overall corporate tax rate before and after 2008. Changes in the overall statutory tax rate are all induced by changes in local tax rates. Moreover the overall statutory tax rate declined in 2008 due to the corporate tax reform that reduced both, the federal corporate income tax rate as well as the basic federal rate for the local business tax. In addition, the repeal of the deductibility of the local business tax from its own base as well as from the corporate income tax base had an effect on the overall statutory tax rate. While year fixed effects eliminate the average change in the overall statutory tax rate for all observations, firms are affected heterogeneously depending on their location, i.e., their local business tax burden.

2.3.3 Firm-Level Data

Firm-level data (financial statements and ownership information) are provided by the Amadeus database. Financial statement and income statement information is available for a sample of 624,425 firm-years from 2004–2014. I exclude financial and utility firms (123,541 observations) because they are subject to different regulatory and reporting requirements that could cause different investment behavior. I can merge information on local business tax rates for 457,611 firm-years.²⁵ I exclude sole proprietorships and partnerships with an individual as the major shareholder (30,722 firm-years) for two reasons. First, there is no reliable estimate for the overall statutory tax rate that the firm faces because profits will be subject to the owner's personal income tax rate, which depends on other income of the individual owner. Second, I expect these firms to be less responsive to local business tax changes because local business tax

²⁵ Tax information is often missing due to several area reforms.

can be (partly) credited against the personal income tax.²⁶ Moreover, I exclude observations for which I do not have data on all variables (fixed assets, sales growth, age, wage expense, sales, cash holdings, liabilities, EBIT, local business tax rate, local property tax rate). My regression design with firm fixed effects requires at least two observations per firm. Since fixed effects subtract the mean of each variable, the coefficient on the tax rate would not be identified otherwise. The final sample covers 111,392 firm-years from 3,897 different municipalities during 2005–2014. Table 2.2 provides descriptive statistics of the sample.

Table 2.2: Descriptive Statistics

This table presents descriptive statistics of our main variables from 2005–2014. All variables are defined in Appendix A.2.

Variable	N	Mean	Standard deviation	25th percentile	50th percentile	75th percentile
<i>Fixed Assets</i> (in T €)	111,392	18,800	344,000	141	873	5,367
<i>Investment</i> (in T €)	111,392	1,428	128,000	11	98	627
<i>Tax Rate</i>	111,392	31.9314	4.1675	28.6000	30.8750	32.9750
<i>Local Property Tax</i>	111,392	420.3463	118.8281	339.0000	400.0000	490.0000
<i>Wage</i> _{<i>t-1</i>} (in T €)	111,392	9,255	88,000	571	2,112	7,168
<i>Sales</i> _{<i>t-1</i>} (in T €)	111,392	68,000	765,000	2,831	12,100	41,300
<i>Age</i>	111,392	26.9744	29.4838	10.0000	18.0000	32.0000
<i>Sales growth</i>	111,392	0.0590	0.2787	-0.0603	0.0217	0.1250
<i>ROA</i> _{<i>t-1</i>}	111,392	0.1374	0.1480	0.0427	0.0900	0.1761
<i>Cash-to-Assets</i> _{<i>t-1</i>}	111,392	0.1322	0.1690	0.0108	0.0596	0.1915
<i>Leverage</i> _{<i>t-1</i>}	111,392	0.6981	0.3019	0.5025	0.7159	0.8759
<i>Loss</i>	111,392	0.0814	0.2735	0.0000	0.0000	0.0000
<i>Corporation</i>	111,392	0.8601	0.3469	1.0000	1.0000	1.0000
<i>Profit Margin</i>	110,982	0.0963	1.1775	0.0307	0.0620	0.1154
<i>SingleJuris</i>	85,952	0.2796	0.4488	0.0000	0.0000	1.0000
<i>Domestic</i>	85,952	0.3299	0.4702	0.0000	0.0000	1.0000
<i>MNE</i>	85,952	0.3905	0.4879	0.0000	0.0000	1.0000

2.3.4 Multi-Plant Firms

One potential concern of my research design is related to firms with plants in multiple jurisdictions because I can only observe the municipality in which the firm is registered. There is no information on the amount and location of other production plants. However, a production plant usually represents a permanent establishment and is thereby subject to the local business

²⁶ Before 2008, local business tax could be credited up to a multiplier of 180%. Starting in 2008, local business tax can be credited up to 380%.

tax rate that is levied in its location. Thus, firms with multiple plants in different jurisdictions could potentially downward bias my estimates because if a firm undertakes parts of its activity in permanent establishments outside the headquarter's municipality, I will observe lower investment elasticities to tax rate changes at the headquarter location. However, the amount of firms that have multiple establishments appears to be small. According to the Monthly Survey of Plants in Manufacturing and Mining (*Monatsbericht für Betriebe im Verarbeitenden Gewerbe sowie Bergbau und Gewinnung von Steinen und Erden*), the majority of manufacturing firms with more than 20 employees are single-plant firms (see also Becker, Egger, and Merlo 2012). Moreover, the Statistical Report on the German Local Business Tax 2010 (*Gewerbsteuerstatistik*) states that out of 3.3 million only 161,315 businesses (5%) had more than one permanent establishment.²⁷

2.4 Empirical Approach

To study the effect of taxes on a firm's capital stock, I compare a firm's fixed assets before and after changes in local business taxes to the development of capital of other firms in the same county and year that did not face a tax rate change.

$$\ln(\text{Fixed Assets})_{i,t} = \alpha_0 + \beta_1 \ln(\text{Tax Rate})_{m,t} + \beta_2 \ln(\text{Property Tax})_{m,t} + \sigma \chi_{i,t-1} + \alpha_{t,n} + \alpha_i + \varepsilon_{i,t}. \quad (1)$$

Where i , m , n , and t index firms, municipalities, counties and years. *Fixed Assets* include tangible and intangible assets and other fixed assets such as long-term investments, shares and participations, or pension funds. *Tax Rate* represents the overall statutory tax rate (sum of corporate income tax, solidarity surcharge and local business tax) that varies across municipalities and over time.²⁸ I include the logarithm of the tax rate to compute direct elasticity

²⁷ See Statistical Report on German Local Business Tax 2010, available at <https://www.destatis.de/DE/Publikationen/Thematisch/FinanzenSteuern/Steuern/Gewerbsteuer/Gewerbsteuer2141020109004.pdf?blob=publicationFile>, p. 35, last accessed August 25, 2017.

²⁸ For the computation of the corporate tax rate see Appendix A.3.

estimates. I also include the logarithm of a municipality's property tax rate to control for changes in capital that are due to (simultaneous) changes in the property tax rate.

χ is a vector of control variables that comprises of controls for firm-level investment determinants (*Start-Up*, *Sales growth*, $\ln(\text{Sales})$, $\ln(\text{Wage})$), and in some specifications also *ROA*, *Cash-to-Asset Ratio*, and *Leverage*, which is defined as ebit, cash holdings, and total liabilities relative to total assets. I include the lagged values of all control variables except for *Start-Up* because contemporaneous values could be affected by tax rate changes. Higher levels of sales and wage in the proceeding period are associated with higher capital in year t . Therefore, I expect positive coefficients on $\ln(\text{Sales})$ and $\ln(\text{Wage})$. *Start-Up* is an indicator variable equal to one if the firm has been registered for less than five years and *Sales growth* is measured as the average percentage change in sales and captures investment opportunities. While I expect a negative sign for *Start-Up* (young firms have less capital than mature firms), I expect a positive sign for the coefficient on sales growth since increases in sales (investment opportunities) lead to more capital expenditures. To control for the availability of internal funds, I include lagged values of *ROA*, *Cash-to-Asset Ratio*, and *Leverage* respectively.

In addition to controls for observable firm characteristics, I include firm fixed effect (α_i) that remove all unobservable firm specific factors that affect investment decisions over all sample years. With this, I compare the average capital stock of a firm before a tax rate change to the average capital stock after the reform.²⁹ By including county-year fixed effects ($\alpha_{n,t}$), I restrict my counterfactuals only to firm-years of the same county.³⁰ This addresses concerns of differences in regional economic developments that are correlated with tax rate changes and

²⁹ While multiple tax rate changes per firm may prevent clean estimates for the tax rate effect on capital, I note that my results are robust if I exclude firms with multiple tax rate changes.

³⁰ Note that in this case, the identification of the tax rate variable stems only from those municipalities that do not make up their own county (i.e. municipalities with no more than 100,000 inhabitants). My results are robust to using state-year (industry-year) fixed effects, i.e. to limiting counterfactuals to firms of the same state (industry) and year.

could also reduce concerns that tax enforcement varies across regions.³¹ I cluster standard errors at the municipality, which allows correlation of standard errors across time and firms within municipalities.

2.5 Results

2.5.1 Baseline Results

Column (1) of Table 2.3 reports coefficient estimates for regressions of the logarithm of fixed assets on the logarithm of the overall statutory tax rate without any firm controls. Consistent with prior literature, I find a negative effect of tax rates on a firm's capital stock. Increases in the tax rate by 1% lead to a decline in capital stock relative to firms operating in the same county equal to 0.97% in the long-term. At a first glance, this effect seems very high. A 1% increase in the tax rate (increase by 0.31 percentage points for the median firm) will lead to an increase in the tax bill of about €1,289 (taking EBIT as a proxy for a firm's taxable income). Results suggest that this would lead to a decline in fixed assets equal €8,467 ($0.0097 * €873,000$) for the median firm relative to firms operating in the same county. However, with my model, I do not only capture the decline in fixed assets in the following period but the average decline in fixed assets for all periods following the tax rate change. Thus, if the firm cuts its capital expenditures each year by the amount of additional tax payments, the decline in fixed assets will be larger than the short-term investment effect of tax rate changes.

Including controls for the lagged logarithm of a firm's wage expense and sales as well as sales growth to capture for investment opportunities and a dummy variable for start-up firms (registered for less than five years) in column (2) leads to slightly lower coefficients. Including lagged controls for a firm's availability of internal funds reduces the tax rate coefficient to 0.88

³¹ This holds if firms in the same county are audited by the same tax office. This would not be the case e.g., in larger cities, which usually have more than one tax office. However, if one assumes that the level of enforcement follows a general policy set at the state level, county-year fixed effects can mitigate concerns of different levels of tax enforcement.

(column (3)). While the sign of all control variables is in line with prior literature, most show very high correlations, which makes the interpretation of the size of the control variables more difficult. While firm and county–year fixed effects lead to very high adjusted R^2 values (0.95) in all specifications, the within R^2 increases from 0.0002 to 0.0513 when including additional firm controls.

Table 2.3: Tax Rate Elasticities of Capital, Baseline Results

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. I include firm and county–year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
Ln(Tax Rate)	-0.9726***	-0.9276***	-0.8839***
	(0.3512)	(0.3347)	(0.2881)
Ln (Local property Tax)	0.0934	0.1145	0.1096
	(0.0865)	(0.0833)	(0.0718)
Ln (Wage) _{t-1}		0.1453***	0.1334***
		(0.0202)	(0.0176)
Ln (Sales) _{t-1}		0.3294***	0.3486***
		(0.0273)	(0.0243)
Start-Up		-0.0656***	-0.0594***
		(0.0220)	(0.0190)
Sales Growth		0.2732***	0.2672***
		(0.0154)	(0.0132)
ROA _{t-1}			-0.3020***
			(0.0396)
Cash-to-Assets _{t-1}			-0.3117***
			(0.0414)
Leverage _{t-1}			-0.2213***
			(0.0295)
Firm fixed effects & county–year fixed effects included			
Observations	111,392	111,392	111,392
Adj R-squared	0.951	0.953	0.953
Within R-squared	0.0002	0.0455	0.0513

An important assumption of the (generalized) difference-in-difference design is the parallel trends assumption that could be violated if I fail to fully control for time-varying unobservables correlated with the treatment variable (*Tax Rate*) and/or the dependent variable ($\ln(\text{Fixed Assets})$). Granger-type causality tests, as suggested by Angrist and Pischke (2008) can help to

corroborate the validity of my approach. If my identification strategy is effective and the parallel trends assumption holds, I would expect to find no differences in the investments of firms before or after the treatment. Following prior literature (e.g., Autor 2003, Yagan 2015, Giroud and Rauh 2016) I include leads and lags of the treatment in $t - 2$, $t - 1$, $t + 1$, and $t + 2$, expecting to find that the treatment in $t - 2$ should have no effect on investment in t . There could be an anticipation effect in $t - 1$, however, because local business tax rates are usually set during the budgeting process in the last three months of the previous period (see Fuest, Peichl, and Siegloch 2016).

To examine the capital response to tax rate changes over time, I estimate the following dynamic specification of equation (1) in a five-year window around the tax change.

$$\begin{aligned} \Delta \ln(\text{Fixed Assets})_{i,t} = & \alpha_0 + \sum_{i=-2}^2 \beta_i \Delta \ln(\text{Tax Rate})_{m,t+i} + \beta_{2,t} \ln(\text{Property Tax})_{m,t} \\ & + \alpha_{t,n} + \alpha_i + \varepsilon_{i,t}. \end{aligned} \quad (2)$$

As opposed to the baseline model with firm fixed effects, I estimate this specification using first-differences to better identify the timing of the capital response. I do not include firm-level controls or firm fixed effects in this test. The results are reported in Table 2.4. While Panel A includes firm fixed effects that control for the firm's average change in fixed assets over the observation period, Panel B presents regression results of the first-difference estimation without firm fixed effects. Both estimations reveal that most of the capital adjustments to tax rate changes occur in the period before the actual tax change. This could be explained by anticipation effects because local business tax rates are usually set during the budgeting process in the last three months of the previous period (see Fuest, Peichl, and Siegloch 2016). If firms learn about the tax change before the fiscal year end of the previous year, it is very likely that this affects their investment decisions in that period. The coefficients in year t and $t - 1$ reveal that there are no reversals of the investment response.

In columns (2) and (3), I exclude firms with multiple tax rate changes to reduce concerns of tax rate changes in the pre or post period. In column (3), I additionally require a balanced sample. The results are robust in the specification without firm fixed effects (Panel A). While the significance of the coefficient decreases in column (2) of Panel B, the size of the coefficient is very similar to column (1) of Panel B. The decline in the significance could stem from the smaller sample size and the inclusion of firm fixed effects. Overall, the findings support the parallel trends assumption, which requires similar trends in the outcome variable between treatment and control group in the absence of the treatment effect.

Table 2.4: Tax Rate Elasticities of Capital, Timing

The dependent variable is the change in the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax, and solidarity surcharge. I rerun the same regression as in column (1) of Table 2.3 using lead, lag, and contemporaneous values of the tax rate as alternative explanatory variables. I include firm and county-year fixed effects in Panel A and county-year fixed effects in Panel B. In columns (2) and (3), I exclude firms with multiple tax rate changes and in column (3), I additionally require a balanced sample. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

Panel A: Including Firm fixed effects			
	$\Delta \ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
$\Delta \ln(\text{Tax Rate})_{t-2}$	0.2846 (0.5900)	0.0903 (0.8983)	0.8131 (0.7370)
$\Delta \ln(\text{Tax Rate})_{t-1}$	-0.5715 (0.3898)	-0.7005 (0.4892)	-0.4965 (0.5587)
$\Delta \ln(\text{Tax Rate})_t$	-0.4475 (0.4318)	-0.7508 (0.4796)	-0.6221 (0.5007)
$\Delta \ln(\text{Tax Rate})_{t+1}$	-1.2415*** (0.3759)	-1.1994** (0.5778)	-1.1120* (0.6426)
$\Delta \ln(\text{Tax Rate})_{t+2}$	-0.3174 (0.4065)	-0.1506 (0.5684)	-0.6522 (0.5055)
$\Delta \ln(\text{Local property Tax})$	-0.0426 (0.0923)	-0.0235 (0.1210)	-0.1984 (0.1292)
Firm fixed effects & county-year fixed effects included			
Observations	30,673	23,066	15,587
Within R-squared	0.0005	0.0004	0.0007

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Panel B: Without Firm fixed effects

$\Delta \ln(\text{Tax Rate})_{t-2}$	-0.0416 (0.4443)	0.0595 (0.6073)	0.8115 (0.6274)
$\Delta \ln(\text{Tax Rate})_{t-1}$	-0.4585* (0.2783)	-0.4686 (0.3410)	-0.4191 (0.4052)
$\Delta \ln(\text{Tax Rate})_t$	-0.2491 (0.3415)	-0.4733 (0.3521)	-0.7357* (0.4212)
$\Delta \ln(\text{Tax Rate})_{t+1}$	-0.7284** (0.3078)	-0.7404 (0.4574)	-0.9570* (0.5098)
$\Delta \ln(\text{Tax Rate})_{t+2}$	0.1856 (0.2833)	-0.1941 (0.3740)	-0.4724 (0.4495)
$\Delta \ln(\text{Local property Tax})$	-0.0215 (0.0832)	-0.0241 (0.1077)	0.0112 (0.1345)
County-year fixed effects included			
Observations	30,673	23,066	15,587
Within R-squared	0.0005	0.0002	0.0001

I next run a placebo test to corroborate the validity of my baseline approach by showing no or lower capital responses of firms for which I expect no or lower effects. I expect lower sensitivities for loss firms because they are not paying taxes in the current period and in the following periods where loss carryforwards shield the firm's profits from taxation.³² Since after-tax cash flows and thereby net present values of investment projects of loss firms are less affected, their capital expenditures are expected to be less dependent on taxes. To test this, I construct a dummy variable (*Loss*) equal to one for firms that report negative EBIT in year t and I interact *Loss* with $\ln(\text{Tax Rate})$. I include both variables in my baseline regression. Results are reported in Table 2.5.

In line with my expectations, I find a positive coefficient for the interaction between *Loss* and *Tax Rate*. That is, I find a weaker relation between tax rates and capital stock for loss firms. The fact that loss firms show tax rate elasticities different from zero could be explained by a change in the net present value of long-term investment projects. If the loss firm expects to return to profitability during the investment period and to use up all its loss carryforward, the

³² This holds for profits of up to €1 million. Only 60% of profits exceeding €1 million can be offset with loss carryforwards according to the German loss offset provisions, see Paragraph 10a Local Business Tax Act (GewStG).

higher tax rate will reduce future after-tax cash flows and thereby the net present value of investment projects.

Table 2.5: Tax Rate Elasticities of Capital, Loss Firms

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. *Loss* is an indicator variable equal to one if the firm reports negative EBIT. I include firm and county-year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
$\ln(\text{Tax Rate})$	-0.9991*** (0.3505)	-0.9420*** (0.3340)	-0.8991*** (0.2876)
$\ln(\text{Tax Rate}) \times \text{Loss}$	0.3484*** (0.0986)	0.2181** (0.0929)	0.2078*** (0.0798)
<i>Loss</i>	-1.1910*** (0.3405)	-0.7120** (0.3203)	-0.6913** (0.2755)
$\ln(\text{Local property Tax})$	0.0928 (0.0863)	0.1153 (0.0831)	0.1099 (0.0717)
$\ln(\text{Wage})_{t-1}$		0.1441*** (0.0202)	0.1328*** (0.0176)
$\ln(\text{Sales})_{t-1}$		0.3320*** (0.0273)	0.3496*** (0.0242)
<i>Start-Up</i>		-0.0666*** (0.0219)	-0.0604*** (0.0189)
<i>Sales Growth</i>		0.2793*** (0.0153)	0.2710*** (0.0131)
ROA_{t-1}			-0.2954*** (0.0401)
$\text{Cash-to-Assets}_{t-1}$			-0.3105*** (0.0415)
Leverage_{t-1}			-0.2175*** (0.0297)
Joint significance $\ln(\text{Tax Rate}) + \ln(\text{Tax Rate}) \times \text{Loss}$	-0.6507* (0.3647)	-0.7239** (0.3479)	-0.6913** (0.2997)
Firm fixed effects & county-year fixed effects included			
Observations	111,392	111,392	111,392
Adj R-squared	0.951	0.953	0.953
Within R-squared	0.0006	0.0460	0.0515

2.5.2 Robustness of Baseline Results

Robustness of the baseline results to different specifications are reported in Table A.2. Panel A shows robustness of the results including the tax rate in levels instead of logs. Since a one percentage point increase in the tax rate equals an increase of about 3% of the average tax rate

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(32%), I expect the size to be about three times the size of the coefficient of Table 2.3. Results are in line with this notion and suggest that a one percentage point increase in the tax rate leads to a decline in capital stock equal to 2.9–3.3%.

The inclusion of county–year fixed effects excludes tax rate changes that occur in municipalities with more than 100,000 inhabitants that usually form their own county (“*Kreisfreie Städte*”). I therefore test the robustness of my results to the inclusion of state–year instead of county–year fixed effects in Panel B of Table A.2. With this approach I broaden the control group to firms that operate in the same state (*Bundesland*). I include the unemployment rate at the county-level to control for regional differences in economic conditions. With this approach, the elasticity estimates range between 0.7% and 0.8%.³³ This suggests long-term declines in fixed assets of up to €6.984 for the median firm following a tax rate increase of 1%. In Panel C of Table A.2 I estimate the baseline model with industry–year instead of county–year fixed effects. With this approach, changes in capital stock of firms that experienced a tax rate change are compared to the change in capital stock of firms that operate in the same industry (using Fama & French 48 industry classifications) and year. I control for changes in differences in regional economic conditions by including additional state-level (logarithm of GDP and GDP growth) and county-level (unemployment rate) control variables. With this approach, elasticity estimates range between 0.58% and 0.69%, which suggests long-run capital declines of up to €6,023 for the median firm after a tax rate increase by 1%.

Panel D of Table A.2 provides estimates of the baseline regression with county–year and industry–year fixed effects. With this approach, I compare the change in fixed assets relative to the county-year average and relative to the industry-year average. Results are very similar to the baseline estimates with tax rates elasticities ranging between 0.89% and 1%. I refrain from

³³ Results are very similar when controlling for state–industry–year fixed effects instead.

using this very conservative estimation as my baseline approach because it requires the inclusion of an additional 279 dummy variables for the industry-year groups.

Table A.3 provides regression results when using the logarithm of investments (change in fixed assets before depreciation) as the dependent variable. The size of the effect is smaller than in previous regressions. The tax rate elasticity of investments of 0.9 (column 3) suggests that an increase in the tax rate by 1% decreases investments by 0.9% in the long run. Thus, a tax rate increase by 0.31 percentage points (higher tax payments of €1,289) will lead to an average decline in capital expenditures equal to €878 ($97,601 \times 0.009$) in the following periods. Put differently, each additional euro of tax payments will lead to a decline in capital expenditures relative to other firms operating in the same industry equal to 68 cents.

2.5.3 *Financial Constraints*

In this section I test for heterogeneity in capital response to tax rate changes. Following my initial hypothesis, I expect stronger elasticities for financially constrained firms. There are numerous measures to capture financial constraints such as the dividend payer status (Fazzari, Hubbard, and Petersen 1988), the KZ Index (Kaplan and Zingales 1997), or the WW Index (Whited and Wu 2006) in the literature. While my data do not allow me to construct most of these variables and while their validity has been questioned in the recent literature (e.g., Farre-Mensa and Ljungqvist 2016), I focus on an indirect measure that relies purely on size and age, two characteristics that are less endogenous than other sorting factors such as leverage or cash holdings (Hadlock and Pierce 2010). However, the suitability of the parameter estimates of the SA Index for my private firm data is questionable because their estimations are based on a sample of U.S. listed firms.³⁴ Therefore, I construct a dummy variable, *FC*, equal to one for firms that are in the lowest tertile of total assets and age. With this definition I identify about 18% of the sample firms as being financially constrained. I exclude loss firms because they are

³⁴ For similar concerns regarding the suitability see e.g., Erel, Jang, and Weisbach (2015).

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likely to be identified as being financially constrained.³⁵ This is because, as discussed above, I expect weaker elasticities for loss firms because they are not paying taxes.

Table 2.6 provides evidence for stronger elasticities of capital to tax rates for financially constrained firms. The results suggest that elasticities of these firms are about half times larger than elasticities of unconstrained firms.

Table 2.6: Tax Rate Elasticities of Capital, Financial Constraints

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. *FC* is equal to one for firms that are in the lowest tertile of total assets and age. Loss firms are excluded. I include firm and county–year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
$\ln(\text{Tax Rate})$	-0.7443** (0.3658)	-0.7131** (0.3474)	-0.6880** (0.2976)
$\ln(\text{Tax Rate}) \times FC$	-0.4363*** (0.1123)	-0.2859*** (0.1077)	-0.2710*** (0.0932)
<i>FC</i>	1.2372*** (0.3905)	0.7795** (0.3752)	0.7345** (0.3246)
<i>Local property Tax</i>	0.0750 (0.0863)	0.1000 (0.0835)	0.0963 (0.0719)
$\ln(\text{Wage})_{t-1}$		0.1387*** (0.0226)	0.1283*** (0.0195)
$\ln(\text{Sales})_{t-1}$		0.3179*** (0.0310)	0.3347*** (0.0273)
<i>Sales Growth</i>		0.2514*** (0.0171)	0.2432*** (0.0146)
ROA_{t-1}			-0.2822*** (0.0420)
$\text{Cash-to-Assets}_{t-1}$			-0.2808*** (0.0423)
Leverage_{t-1}			-0.1888*** (0.0312)
Joint significance $\ln(\text{Tax Rate}) + \ln(\text{Tax Rate}) \times FC$	-1.1806*** (0.3851)	-0.9990*** (0.3665)	-0.9591*** (0.3138)
Firm fixed effects & county–year fixed effects included			
Observations	100,302	100,302	100,302
Adj R-squared	0.952	0.954	0.954
Within R-squared	0.0065	0.0468	0.0514

³⁵ However, results are robust to the inclusion of loss firms.

The results could suggest that potential higher levels of tax avoidance of financially constrained firms (see e.g., Law and Mills 2015, Edwards, Schwab, and Shevlin 2016), which would lead to a lower responsiveness, do not outweigh the stronger responsiveness due to higher investment- cash flow sensitivities.

Given that small and young firms are expected to have lower tax avoidance possibilities, an alternative explanation could be that my measure of financial constraints correlates with the possibilities of tax avoidance. To mitigate this concern, I test the robustness of my results for a reduced sample of multi-jurisdictional firms and find robust results.

2.5.4 Tax Avoidance

I next examine the role of tax avoidance in the relation between tax rates and capital stock. I expect larger elasticities of firms that operate in only one taxing jurisdiction (single-jurisdictional firms) because they have less tax avoidance possibilities and therefore higher effective tax rates. To test this, I set the indicator variable *SingleJuris* equal to one for firms that are either stand-alone (75%) or belong to a corporate group that operates in only one municipality (25%) and I interact *SingleJuris* with the logarithm of *Tax Rate*. I exclude firms for which no ownership information is available from this regression. Results are reported in Table 2.7.

In line with my expectations, I find stronger elasticities of firms that operate in only one taxing jurisdiction, which supports the notion that this is due to better tax avoidance possibilities of multi-jurisdictional firms. In fact, capital elasticities of single-jurisdictional firms appear to be about half times larger compared to that of multi-jurisdictional firms.³⁶ Thus, while multi-jurisdictional firms may relocate their investments in response to tax rate changes, which would result in higher tax rate elasticities, lower responsiveness due to better tax avoidance

³⁶ Results are robust if I exclude loss firms to address concerns that I observe stronger responses of single-jurisdictional firms because they are more likely to incur losses.

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opportunities outweigh this effect. This could be explained with higher cost of relocating investments relative to tax planning. Moreover, the tax rate elasticity for the response of single-jurisdictional firms can be interpreted as an estimate for the change in a firm's scale of investments in response to tax rate changes as the effect cannot be explained with capital relocations for these firms.

Table 2.7: Tax Rate Elasticities of Capital, Tax Avoidance

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. *SingleJuris* is equal to one for firms that are either standalone or belong to a corporate group that operates in only one municipality. I exclude firms for which I have no ownership information from my sample. I include firm and county-year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
$\ln(\text{Tax Rate})$	-0.8529** (0.4200)	-0.7922** (0.3929)	-0.7537** (0.3398)
$\ln(\text{Tax Rate}) \times \text{SingleJuris}$	-0.3773*** (0.1026)	-0.3526*** (0.0962)	-0.3341*** (0.0829)
$\ln(\text{Local property Tax})$	0.0745 (0.1008)	0.1051 (0.0975)	0.1033 (0.0844)
$\ln(\text{Wage})_{t-1}$		0.1633*** (0.0227)	0.1501*** (0.0199)
$\ln(\text{Sales})_{t-1}$		0.3173*** (0.0313)	0.3378*** (0.0279)
<i>Start-Up</i>		-0.0595** (0.0241)	-0.0534*** (0.0206)
<i>Sales Growth</i>		0.2759*** (0.0173)	0.2699*** (0.0151)
ROA_{t-1}			-0.3113*** (0.0464)
$\text{Cash-to-Assets}_{t-1}$			-0.3187*** (0.0497)
Leverage_{t-1}			-0.2213*** (0.0349)
Joint significance $\ln(\text{Tax Rate}) + \ln(\text{Tax Rate}) \times \text{SingleJuris}$	-1.2302*** (0.4218)	-1.1448*** (0.3954)	-1.0878*** (0.3422)
Firm fixed effects & county-year fixed effects included			
Observations	85,914	85,914	85,914
Adj R-squared	0.950	0.952	0.952
Within R-squared	0.0009	0.0469	0.0525

My findings are in line with e.g., Simmler (2015) and Dobbins and Jacob (2016) who provide evidence for lower investment responses of multinational than domestic group firms to

a tax rate cut in Germany. Moreover, my results support findings by Fuest, Peichl, and Siegloch (2016) who show that plants of a multi-plant firm show less wage adjustments in response to local tax rate changes because they have better tax avoidance possibilities.

Given the stronger effects for small and young firms (Table 2.6) and the fact that single-jurisdictional firms are on average smaller than multi-jurisdictional firms, one concern could be that I capture the size difference between single-jurisdictional and multi-jurisdictional firms with this test and that my findings could thus be explained with the difference in financial constraints.³⁷ While I control for differences in size (and other time-varying observable firm characteristics) across single-jurisdictional and multi-jurisdictional firms parametrically in columns 2 and 3, I further address this concern with a matching approach that reweights observations according to their comparability with firms of the other group or restricts my sample to similar firms. Results are reported in Table A.4. In Panel A, I use entropy balancing to assign weights to single-jurisdictional and multi-jurisdictional firms based on their comparability to the other group with respect to observable firm characteristics (all firm controls used in column 3) in each year. I rerun the regression from Table 2.7 by weighting each observation according to its comparability with observations of the other group. In Panel B, I use propensity score matching in each industry to match a firm that belongs to a multi-jurisdictional group to a single-jurisdictional firm with similar observable firm characteristics. I do the matching for 2010 based on all firm control variables of column (3) and then use every observation for a matched firm in 2010 also in other years.³⁸ I rerun the regression of Table 2.7 with this smaller sample. Both approaches lead to results that are very similar to the main results in Table 2.7.

³⁷ I note that this test does not address the concern that stand-alone firms generally face higher financial constraints relative to group firms with access to intercompany financing (see e.g., Hoshi, Kashyap, and Scharfstein 1990).

³⁸ The drawback of this approach is that I may include an observation in the sample in years in which I have no observation for the matching partner of 2010. However, as opposed to a matching approach that matches firms in each industry-year, this approach ensures that I have sufficient time-series data for each firm.

2 Heterogeneity in Tax Rate Elasticities of Capital: Evidence from Local Business Tax Reforms

I further examine whether there are differences in tax elasticities of capital stock between domestic and multinational group firms. Following the argumentation above, I would expect stronger responses of domestic group firms to local tax rate changes because multinational firms can additionally reduce their tax burden via profit shifting between countries. To test this, I interact the logarithm of *Tax Rate* with *Domestic*, an indicator variable equal to one for firms that belong to a corporate group that has operations in different municipalities in Germany but no foreign operations. While the results suggest no investment responses of multinational firms, the interaction term between *Domestic* and the logarithm of *Tax Rate* indicates stronger responses of domestic relative to multinational group firms (see Appendix Table A.5).

2.5.5 Tax Incidence

I next examine the role of tax incidence in the relation between taxes and capital. Unfortunately, I can only rely on indirect proxies to measure the extent to which firms transfer the additional tax burden to their consumers or employees because I do not observe prices and individual wages per worker.³⁹ Therefore, I follow prior literature and use profit margins as a proxy for a firm's ability to transfer the tax incidence to its stakeholders. Following e.g., Lerner (1934), Kubick et al. (2015), Jacob, Michaely, and Müller (2016) and Dyreng et al. (2017) I assume that firms with high profit margins have more market power, which suggests that they face a less elastic demand. Thus, a price increase will lead to lower declines in demand relative to other firms. Moreover, Fuest, Peichl, and Siegloch (2016) show that firms with high profit margins transfer more of the additional tax burden to their employees. This follows the reasoning of the fair wage models that assumes wages to be a function of inter alia the firm's profits (see e.g., Akerlof and Yellen 1990). Therefore, shocks to profits such as increases in tax liabilities will lead to stronger wage adjustments in profitable firms. To test this, I exclude loss

³⁹ I have data on the wage expense of the firm and the number of employees. However, changes in the wage per employee could as well be due to changes in working hours or the replacement of blue collar with white collar workers.

firms ($EBIT < 0$) and then construct an indicator variable, *High Margin*, equal to one for firms that report profit margins (earnings before interest, tax, depreciation, and wages relative to sales) in the highest tertile of their industry-year group. I include *High Margin* and an interaction of *High Margin* with $\ln(Tax Rate)$ in my baseline regression. Results are reported in Table 2.8.

Table 2.8: Tax Rate Elasticities of Capital, Tax Incidence

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. *High Margin* is an indicator variable equal to one for firms that report profit margins in the highest tertile of its industry-year group. I include firm and county-year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

	$\ln(Fixed Assets)_{i,t}$		
	(1)	(2)	(3)
$\ln(Tax Rate)$	-0.9127*** (0.3225)	-0.8766*** (0.3062)	-0.8494*** (0.3058)
$\ln(Tax Rate) \times High Margin$	0.2321*** (0.0675)	0.2097*** (0.0654)	0.2100*** (0.0654)
<i>High Margin</i>	-0.7833*** (0.2320)	-0.6649*** (0.2250)	-0.6640*** (0.2251)
$\ln(Local\ property\ Tax)$	0.0700 (0.0751)	0.0965 (0.0725)	0.0927 (0.0724)
$\ln(Wage)_{t-1}$		0.1372*** (0.0211)	0.1345*** (0.0210)
$\ln(Sales)_{t-1}$		0.3305*** (0.0265)	0.3347*** (0.0263)
<i>Start-Up</i>		-0.0648*** (0.0211)	-0.0582*** (0.0211)
ROA_{t-1}		0.2658*** (0.0147)	0.2665*** (0.0146)
$Cash-to-Assets_{t-1}$			-0.3062*** (0.0442)
$Leverage_{t-1}$			-0.1759*** (0.0322)
Joint significance $\ln(Tax Rate) + \ln(Tax Rate) \times High Margin$	-0.6806** (0.3730)	-0.6679** (0.3128)	-0.6394** (0.3122)
Firm fixed effects & county-year fixed effects included			
Observations	99,613	99,613	99,613
Adj R-squared	0.952	0.954	0.954
Within R-squared	0.0006	0.0437	0.0469

2 Heterogeneity in Tax Rate Elasticities of Capital: Evidence from Local Business Tax Reforms

In line with my hypothesis, I find a weaker relation between tax rates and capital for firms with higher profitability.⁴⁰ Capital elasticities of firms with high profit margins equal about two thirds of capital elasticities of other firms. To address concerns that high profit margins negatively correlate with financing constraints, I test the robustness of my results for a sample excluding firms that I define as financially constrained in section 2.5.3 (firms with total assets and age in the lowest tertile) and find very similar results. Thus, my findings are in line with the notion that firms with higher profitability are better able to shift the additional tax burden to either their consumers or employees and therefore show lower capital elasticities to tax rate changes.

In additional tests, I examine the tax incidence on employees in more detail. As suggested in my hypothesis development, I expect lower tax rate elasticities in case of an inelastic labor supply because in that case firms are better able to shift the tax burden to their employees via an adjustment in wages. Following Dyreng et al. (2017), I measure a firm's labor supply elasticity with the share of blue collar workers. Fuest, Peichl, and Siegloch (2016) show that firms are more likely to cut wages of blue collar workers because they are less mobile, i.e. show lower labor supply elasticities than white collar workers who are better able to find employment in another firm and therefore have more negotiation power in the wage setting process. Therefore, I would expect lower capital elasticities for firms operating in industries with low average wages.

To test this, I construct an indicator variable equal to one for firms that operate in an industry with a median wage-to-sales ratio in the lowest tertile.⁴¹ I aggregate the data at the industry

⁴⁰ These findings could as well be explained by higher tax avoidance of firms with high market power (high profit margins) as suggested by Kubick et al. (2015) because these firms have more persistent profitability resulting from their product market power. However, Dyreng et al. (2017) find less tax avoidance of firms with high profit margins suggesting that they are better able to transfer the economic tax burden. The contradicting results could be explained by the failure to control for political and agency costs in Kubick et al. (2015) as suggested by Dyreng et al. (2017).

⁴¹ Results are robust to using means instead of medians.

level because I assume that the ratio of blue collar to white collar workers depends mostly on the industry. The drawback of this measure is that it may not only capture firms with blue-collar (low wage) workers, but also captures firms operating in industries with a lower ratio of labor input to capital input. However, for example for manufacturing firms this coincides with a higher degree of blue collar workers. Alternatively I use the median wage-to employee ratio as a proxy for a firm's average wage per employee. The drawback of this measure is that it does not take different working hours into account. The higher the number of employees with less than a full position, the more likely it is that the firm is falsely identified as a low wage firms. Moreover, the number of employees appears to be rather imprecise (rounded) because the variable is clustered around numbers ending on 5 or 10.

Table 2.9: Tax Rate Elasticities of Capital, Tax Incidence (Employees)

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. *Low Wages* is an indicator variable equal to one for firms that operate in an industry with a median wage-to-sales ratio (wage-to employees ratio) in the lowest tertile in Panel A (Panel B). I include firm and county-year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

Panel A: Wage-to-Sales Ratio

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
<i>Ln (Tax Rate)</i>	-1.0663*** (0.3078)	-0.9968*** (0.2923)	-0.9553*** (0.2920)
<i>Ln (Tax Rate) x Low Wages</i>	0.2046*** (0.0669)	0.1513** (0.0641)	0.1525** (0.0636)
<i>Low Wages</i>	-0.7093*** (0.2294)	-0.5323** (0.2201)	-0.5333** (0.2184)
Joint significance <i>Ln (Tax Rate) + Ln (Tax Rate) x High Margin</i>	-0.8617*** (0.3084)	-0.8455*** (0.2946)	-0.8028*** (0.2939)
Firm fixed effects & county-year fixed effects included			
Observations	111,392	111,392	111,392
Adj R-squared	0.950	0.953	0.953
Within R-squared	0.0005	0.0457	0.0497

2 Heterogeneity in Tax Rate Elasticities of Capital: Evidence from Local Business Tax Reforms

Panel B: Wage-to-Employees Ratio			
<i>Ln (Tax Rate)</i>	-0.9990*** (0.3050)	-0.9555*** (0.2902)	-0.9133*** (0.2898)
<i>Ln (Tax Rate) x Low Wages</i>	0.0962 (0.0608)	0.1031* (0.0621)	0.1024 (0.0624)
<i>Low Wages</i>	-0.3162 (0.2119)	-0.3369 (0.2163)	-0.3345 (0.2169)
Joint significance <i>Ln (Tax Rate) + Ln (Tax Rate) x High Margin</i>	-0.9028*** (0.3093)	-0.8524*** (0.2955)	-0.8109*** (0.2950)
Firm fixed effects & county-year fixed effects included			
Observations	111,392	111,392	111,392
Adj R-squared	0.950	0.953	0.953
Within R-squared	0.0003	0.0457	0.0496

Results reported in Table 2.9 indicate lower capital responses of firms operating in industries with lower wage expense. While the results are very significant when using the wage-to-sales ratio to sort firms into low and high wage firms (Panel A), results are weaker for the wage-per-employee ratio (Panel B), which could be explained with the imprecision of this measure as explained above. Overall, the results are in line with the notion that firms show lower capital responses because they shift part of the economic tax burden to their employees.

2.6 Conclusion

This study sheds light on the heterogeneity in tax rate elasticities of capital of private firms. The strength of studying local business tax reforms to analyze investment responses lies in the high internal validity of this approach. It allows me to disentangle tax rate and tax base effects and to compare similar firms within the same geographic region, which are likely to face the same economic and legal conditions. Assuming similar trends in investment behavior in the absence of a tax rate change, this allows causal inferences about the relation between tax rates and investments.

My results suggest that a tax increase by 1% translates into a long run decline in fixed assets by up to 0.97%. In line with prior literature that shows larger investment-cash flow sensitivities

of financially constrained firms, the results suggest that tax-induced changes in capital are up to half times larger for financially constrained (small and young) firms relative to unconstrained firms. Thus, potential higher levels of tax avoidance of financially constrained firms (see e.g., Law and Mills 2015, Edwards, Schwab, and Shevlin 2016) that would lead to a lower responsiveness do not outweigh the stronger responsiveness due to higher investment-cash flow sensitivities.

Moreover, firms with more tax avoidance possibilities (multi-jurisdictional firms) show lower capital elasticities to tax rate changes. That is, capital elasticities of single-jurisdictional firms are about half times larger than that of multi-jurisdictional firms. While capital declines of multi-jurisdictional firms could be explained with a relocation of capital to lower tax jurisdictions, lower investments of single-jurisdictional firms usually represent a decline in a firm's operations. While both outcomes lead to a loss in capital investments for each taxing jurisdictions, a decline in a firms overall operations represents a loss in overall corporate investments for the economy as a whole.

Finally, I find a weaker relation between taxes and capital stock for firms with high market power vis-à-vis their customers or vis-à-vis their employees, which suggests that these firms may transfer the additional tax burden to their consumers via an increase in prices or to their employees via a cut in wages following tax rate increases. While my findings are in line with the notion that firms with a better ability to shift the tax burden to either their consumers or employees actually do so and therefore show lower tax rate elasticities of capital, I note that my analysis is limited to very indirect measures and should therefore be interpreted with caution. Finding more exogenous settings to test this relation could be an interesting path for future research.

My results have important policy implications because they can help policy makers to understand cross-sectional differences in the responsiveness of corporate investments to

changes in tax policy. For example, my findings imply that the multiple tax rate increases of German municipalities over the past years have not only led to record tax revenues of €50 billion in 2016, but likely led to a reduction of corporate investments. My results suggest that the decline in investments is primarily driven by a reduction in capital of small and young firms as well as a reduction in capital of single-jurisdictional firms, i.e., firms with less tax avoidance possibilities, and of firms with less market power.

However, I acknowledge that the external validity of my study for federal tax reforms could be limited to the extent to which there are interactions between federal tax policy and other economic conditions that are held constant in the local setting, as pointed out by Ljungqvist and Smolyansky (2014). For example, a federal tax reform could induce central banks to change their monetary policy, which could affect interest rates and inflation expectations that affect investment decisions of different firm types differently.⁴² Developing a structural model to control for these interactions goes beyond the scope of this study and is therefore left to future research.

⁴² See Ljungqvist and Smolyansky (2014), p. 5.

3 Tax Loss Carrybacks: Investment Stimulus versus Misallocation⁴³

3.1 Introduction

A central issue in the design and implementation of tax systems is the treatment of losses vis-à-vis profits. In theory, treating losses and profits symmetrically, for example, via an immediate full loss offset, has the appealing feature that investment decisions are not distorted (Auerbach 1986). In practice, however, current tax systems deviate strongly from this benchmark: Profits trigger tax liabilities, but losses do not trigger immediate refunds. Loss firms can either reduce tax payments on future profits by carrying losses forward or, alternatively, obtain refunds of tax payments on past profits by carrying losses back. For loss firms with past profits, a carryback regime is less restrictive than a carryforward regime because tax refunds are independent of future profits. We examine the economic consequences of granting tax refunds through loss carrybacks to loss firms because the fiscal policy debate on the appropriate treatment of losses is longstanding (Altshuler and Auerbach 1990) and ongoing, as evidenced by the adoption of more lenient tax loss regimes during the financial crisis to stimulate investment.

The two prevailing systems—carryback versus carryforward—reflect a trade-off “between discouraging undesirable activity and not discouraging risk taking” (Auerbach 1986, 205). Prior literature shows that a less restrictive treatment of losses through carrybacks increases (ex ante) risk taking when firms decide on investments (Domar and Musgrave 1944, Stiglitz 1969, Dreßler and Overesch 2013, Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017). We complement this literature on the ex ante benefits of carrybacks by examining their potential

⁴³ This chapter is based on Bethmann, Jacob, and Müller (2017), Tax Loss Carrybacks: Investment Stimulus versus Misallocation, FAcT Center Working Paper Nr. 20/2016. The paper has been presented at 19th UNC Tax Symposium, the Accounting Section Meeting of the Verein für Socialpolitik, the Annual Meeting of the EAA, the EAA Doctoral Colloquium, and the IIPF Doctoral School on Tax Systems.

to encourage undesirable investment by granting loss firms refunds irrespective of future prospects.

It is unclear whether lenient refunds lead to undesirable activity by encouraging the “continued operation of losers” (Auerbach 1986, 205) or to desirable activity by helping loss firms overcome a temporary crisis. Evidence on this issue is important because policymakers frequently relax the asymmetric treatment of tax losses as a temporary fiscal stimulus without any comprehensive evidence on its effectiveness and on potential distortive effects. While the increase in risk taking of profitable firms in the presence of less restrictive loss offset possibilities via loss carrybacks is generally perceived as a desirable outcome (Domar and Musgrave 1944, Stiglitz 1969, Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017), loss carrybacks could lead to risky overinvestment in case of a loss where firms receive the tax refund. Prior literature provides mixed evidence on the ability of carrybacks to stimulate loss firms’ investment (Dobridge 2015) and is silent on the desirability of this effect.

Loss firms form a large part of the economy—about 30% of the U.S. firm observations in Compustat and about 24% of European private firm observations in Amadeus have negative pre-tax income—and have recently attracted interest in empirical studies, for example, on tax avoidance (e.g., Dyreng, Lewellen, and Lindsey 2017). We compare loss firms’ investment under a carryback versus only carryforward regime and its effects at the industry level to provide evidence on the potential costs and benefits of granting loss carrybacks to loss firms. Carrybacks loosen loss firms’ financing frictions, but it is unclear whether that is desirable. It is plausible that loss firms face efficient financing frictions, because capital markets ration funds to distressed and inefficient firms that are prone to overinvest in risky projects with negative net present value (NPV). Providing liquidity less restrictively to such loss firms would represent misallocation and weaken competitive forces in an industry. Policymakers, however, argue that a less restrictive allocation of tax benefits to loss firms helps them “ride out difficult times and

invest for the future, helping to boost their productivity” by giving “previously profitable companies [...] cash infusions.”⁴⁴ The implicit assumption underlying such objectives is that loss carrybacks stimulate loss firms’ investment by loosening financing frictions induced by capital market inefficiencies (e.g., adverse credit supply shocks). From this perspective, carrybacks help loss firms overcome underinvestment problems. We examine these countervailing effects—the risk of supporting “losers” versus relaxing of inefficient financing frictions—of a less restrictive tax loss treatment via loss carrybacks.

Our examination proceeds in three steps. First, we quantify the effect of refunds resulting from a less restrictive treatment of tax losses on loss firms’ investment relative to other uses. Quantifying the investment response relative to other uses speaks directly to policymakers’ claim of stimulating investment by relaxing loss firms’ financial constraints. Second, we examine which firms’ investment—distressed versus non-distressed and low- versus high-productivity firms—is most responsive to cash infusions from tax refunds. Heterogeneity in the investment response allows us to speak to its desirability. Finally, we document how the risk of misallocation maps into competitive dynamics and aggregate output and productivity. This allows us to offer general conclusions on the ex post effect that complements prior evidence on the ex ante risk taking effects of carrybacks versus carryforwards.

We use data on over 900,000 private firms from 21 European countries, five of which permit loss carrybacks. Private firm data are opportune for two reasons. First, in contrast to consolidated data on public firms, unconsolidated private firm data allow us to locate more precisely the country in which a loss is realized. Second, private firm data allow us to make inferences about a substantial part of the overall firm population. While private firms represent

⁴⁴ The first quote is from Assistant Treasurer David Bradbury, Exposure Draft Legislation and Explanatory Material for Company Loss Carry-Back, August 23, 2012, available at <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2012/091.htm&pageID=003&min=djba&Year=&DocType>, last accessed August 25, 2017. The second quote is from the U.S. Committee on Ways and Means, Summary of Camp–Cantor Substitute to H.R. 1, January 28, 2009, available at <http://waysandmeans.house.gov/summary-of-camp-cantor-substitute-to-h-r-1/>, last accessed August 25, 2017.

two-thirds (half) of the overall employment in the European Union (OECD countries), we note our evidence may not generalize to public firms, whose investments are, for example, less responsive to changes in tax policy or investment opportunities (Asker, Farre-Mensa, and Ljungqvist 2015).

Our research design exploits losses that are plausibly idiosyncratic and unanticipated because they cannot be explained by contemporaneous country–industry trends or by time-invariant firm characteristics. We then compare how these losses affect loss firms’ investment in tax regimes that grant refunds (loss carryback) or not (loss carryforward). By benchmarking loss firms with (potentially) refundable losses against profit and loss firms with no (potential) refund from the same country–industry–year, our research design eliminates observable country–industry–year-specific differences, for example, in ex ante risk taking resulting from loss carrybacks versus carryforwards. Put differently, we examine whether the difference between investments of loss firms with (potentially) refundable income and other firms from the same country and industry in the same year differs across countries with loss carrybacks and those that only allow loss carryforwards. We document the effectiveness of our identification by examining parallel trends in investments prior to the loss, by performing several placebo tests and by exploiting alternative identification strategies.

We show that a less asymmetric treatment of tax losses via loss carryback increases the investment of loss firms. We find higher capital investment for loss firms under a carryback regime relative to a carryforward regime in the year after their loss. Our estimates imply that 33 cents of each euro in tax refunds are actually used to fund additional capital investments relative to carryforward firms. Differences in between loss carryback and carryforward thus have real effects in the year after the loss as carrybacks provide loss firms with more liquidity relative to carryforwards (Graham and Kim 2009).

We validate our identification strategy with four tests. First, we document the absence of investment differences in the years leading up to a loss and in the years after the refund is paid. We only find investment differences across the two tax loss regimes when they create a liquidity differential. Put differently, the investment of firms prior to reporting a loss follows a parallel trend. At a macro level, we also find that countries with and without a carryback regime follow a common general trend in economic growth. Second, in placebo tests, we do not find investment differences across the two tax loss regimes for loss firms that cannot obtain carrybacks because of a lack of refundable profits from the previous year. We only find investment differences for firms that actually receive a refund. This result indicates that it is less likely that we are capturing some omitted correlated variable that would explain the same investment differences of unprofitable firms across the two tax loss regimes that we find. Third, to address concerns about intertemporal loss shifting as documented by Maydew (1997), we use predicted instead of reported earnings for loss carryback firms using the method of Erickson, Heitzman, and Zhang (2013) and find very similar results. Finally, we find support for our causal interpretation in a regression kink design as well as in a U.S. setting with variation in loss carryback years.

The implications of an investment response of loss firms are, however, more ambiguous than for the average profitable firm. Recall that loss carrybacks could mitigate financial constraints resulting from inefficiencies in capital markets or lead to inefficiencies by encouraging the overinvestment of distressed and inefficient firms. We use two tests to assess how descriptive these explanations are empirically.

First, we examine alternative uses of the tax refund. Firms could save additional liquidity or return it to shareholders, depending on their hedging needs and the availability of internal investment opportunities. We find that about 33 cents of each euro in tax refunds are set aside as additional cash and 26 cents are additionally distributed to shareholders relative to

carryforward firms. There is no significant change in long-term debt. While the finding of increased cash holdings can be interpreted ambiguously (i.e., loss firms anticipating financial frictions or competitive pressures), a sizable share of the refund is returned to shareholders. This result indicates that there might be a lack of attractive investment opportunities. That is, on average, loss firms do not appear to suffer from severe financing frictions.

Second, we examine heterogeneity in the investment response to refunds to disentangle whether less restrictive refunds help loss firms overcome underinvestment problems or lead to overinvestment. For one, the shareholders of distressed firms have incentives to increase the option value of equity by engaging in negative-NPV projects, which refunds could subsidize. For another, the very causes that led low-productivity firms into a loss, for example, poor management practices, are more likely to persist at inefficient loss firms receiving refunds. We find that the investment effect is much stronger for firms that are prone to engage in risky overinvestment because they are distressed or have low productivity. While high-productivity and non-distressed firms also respond weakly, tax refunds from carrybacks appear to primarily loosen the constraints of firms that have incentives to engage in risky overinvestment (Eisdorfer 2008, Parrino and Weisbach 1999) and make less efficient investment decisions (Bloom et al. 2010, Bloom et al. 2017). This evidence indicates that a less restrictive tax loss regime can result in misallocation.

In the final step, we corroborate this interpretation by examining the consequences of misallocation at the industry level. One potential channel through which misallocation would manifest is the weakening of the competitive selection of firms in an industry. While low-productivity firms generally exit more quickly (consistent with, e.g., Syverson 2004, 2011), this association is much weaker when loss firms receive a tax refund from loss carryback provisions. By not conditioning on the future prospects of a loss firm, less restrictive refunds prolong the competitive process, moving market share from less productive loss firms to more efficient

competitors and entrants. Finally, we examine how the two countervailing effects of loss carrybacks on loss firms—more investments at the cost of subsidizing distressed, low-productivity firms—map into average productivity and aggregate output in an industry. As more loss firms in an industry receive less restrictive refunds, we find lower average productivity and less aggregate sales in subsequent years relative to industries where firms only receive a refund conditional on future profits.

Taken together, we show that a less asymmetric treatment of losses increases the investments of loss firms. However, providing this less restrictive liquidity to firms comes at the cost of subsidizing distressed, low-productivity firms, delaying their exit, and thus reducing aggregate productivity and output. These findings complement prior literature in two ways. First, we complement literature on the ex ante benefits of carrybacks (Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017) by providing empirical evidence on the potential costs of granting loss carrybacks. Second, we complement recent literature on loss firms (e.g., Dobridge 2015) by examining policymakers' trade-off—increased investment at the cost of encouraging the continued operations of firms with below-normal rates of return—when allowing for a less asymmetric treatment of losses more comprehensively.

Our results also help to evaluate whether using loss carrybacks as a fiscal stimulus can be effective in economic downturns. However, we acknowledge that we cannot exploit exogenous variation in loss status. We use largely unanticipated and idiosyncratic losses in our main analysis and try to overcome endogeneity concerns in alternative identification approaches. We also caution that we do not assess whether a less asymmetric treatment of tax losses is more efficient than other stimuli under economy-wide shocks. Moreover, we cannot assess which system—carryback versus only carryforward—collectively creates more distortion, since this would require netting the ex ante benefits on all firms' investment risk incentives and ex post costs stemming from the subsidy of loss firms' investment.

3.2 Institutional Background, Identification, and Data

3.2.1 *The Concept of Tax Loss Offset Provisions*

The literature on the design of tax systems and loss offset provisions has identified two systems that do not distort economic decisions and ensure an efficient allocation of capital (Auerbach 1986): First, a cash flow tax with a full and immediate loss offset does not distort investment decisions by treating losses and profits symmetrically. Second, an accrual based tax system that allows firms to deduct the cost of equity from the tax base and to forward unused losses with interest does not distort investment decisions. This system treats losses and profits symmetrically in present value terms. Both systems also ensure that the lifetime income of a firm is taxed irrespective of its earnings timing and earnings volatility. However, actual tax systems deviate from this optimum. There is no country that runs a cash flow tax, for example, with the immediate write-off of all assets for tax purposes or that allows firms to deduct the actual cost of equity from the tax base. Hence, investment decisions are distorted irrespective of the treatment of losses. Moreover, countries tax losses and profits asymmetrically by restricting loss offset provisions. More restrictive loss offset possibilities could be due to the policymaker's preference for smooth and more predictable corporate tax revenues, because loss carrybacks likely reduce tax revenues and increase the volatility of corporate tax revenues in the event of a refundable loss (Goncharov and Jacob 2014).

Generally, countries levy corporate taxes but treat profits and losses asymmetrically. Profits trigger tax liabilities but losses do not immediately trigger tax receivables. To alleviate the tax asymmetry, loss firms receive tax refunds conditional on profitability. Two regimes prevail. First, under carryback regimes, firms offset losses with *past* profits to claim a refund of previously paid taxes: A loss in $t - 1$ triggers a refund of taxes paid on prior profits (e.g., $t - 2$)

in the period after the loss (t).⁴⁵ Second, under carryforward regimes, firms offset losses with *future* profits to reduce tax payments: A loss in $t - 1$ reduces tax payments in t if the firm reports a profit and, if not, in later years. To the extent a firm does not fully recoup its loss in t , loss carryback leads to higher liquidity than loss carryforward regimes do. We exploit the consequences of this liquidity differential in this study.

3.2.2 Tax Loss Carryback Rules in Europe

We observe heterogeneity in the treatment of tax losses across countries and over time. Table 3.1 provides an overview of tax loss carryback provisions in our sample countries over 2005–2012. Four countries (Germany, Ireland, the Netherlands, and the United Kingdom) allow tax loss carrybacks during all sample years. Some countries temporarily adopt or extend their loss carryback regimes to provide loss firms with liquidity during adverse economic conditions, such as Norway during the financial crisis. While most countries allow a carryback period of one year, the Netherlands allowed a three-year carryback window in 2005 and 2006 and Norway allowed a two-year carryback window in 2008 and 2009.⁴⁶ All sample countries allow firms to carry forward losses. Tax loss carryforward provisions primarily differ across countries in the length of the carryforward period. While some countries limit the carryforward period (five to 15 years) and only a few limit the amount (e.g., Austria, Germany, and Poland), more than half of the sample countries allow unlimited loss carryforwards (see Table B.2 for an

⁴⁵ The refund occurs in the year after the loss because the tax statement for fiscal year $t - 1$ is filed in t . We gain this insight from conversations with tax professionals in different countries and note that this differs from the way carrybacks have been modeled by prior literature (e.g., Graham 1996, Mahon and Zwick 2015).

⁴⁶ France grants a tax credit for losses carried back to the previous three years that can be used to reduce future tax liabilities during the following five years; however, because loss firms do not receive immediate refunds, France cannot be treated as a loss carryback country for examining tax-induced cash infusions to loss firms. Treating France as a country with only loss carryforward is also not entirely correct, because firms receive a refund in $t + 5$ if it is not utilized before. We thus exclude France from our main analyses. We document the robustness to including France in our sample in the Appendix. Treating France as a country without loss carrybacks, we find evidence consistent with our primary analysis (see Table B.1 Panel A). Including France as a loss carryback country—a clear misclassification of the treatment group—leads to insignificant coefficient estimates (see Table B.1, Panel B).

overview). We also note that the countries in our sample do not differ significantly based on the book tax conformity measure proposed by Atwood, Drake, and Myers (2010).

Table 3.1: Overview of Loss Carryback Provisions

This table reports the length of the loss carryback period of all countries represented in the sample. The information is taken from the International Bureau of Fiscal Documentation (IBFD) Corporate Tax Handbooks. ⁺ indicates that the carryback credit may be used to reduce corporate income tax payable during the following five years, with any balance refunded at the end of the five-year period (France); ⁺⁺ indicates that the loss carryback is limited to €511,500 and that the carryback is not available for local business tax purposes (Germany); and ⁺⁺⁺ indicates a three-year carryback option for 2009 and 2010 losses. The extended carryback is limited to €10 million per year. In such a case, the carryforward of the remaining loss is limited to six years instead of nine years (the Netherlands).

^a Note that Langenmayr and Lester (2017) do not treat Norway as a loss carryback country in 2008, since the law was not enacted until February 2009, and they study the ex ante considerations of loss offset provisions. However, in our setting, we treat Norway as a loss carryback country in 2008, since we expect firms to receive their tax refunds due to a tax loss carryback of 2008 losses in 2009.

^b Sweden allows a loss offset with a profit periodization reserve. A taxpayer is allowed to allocate up to 25% of net profits to this reserve, while allocations are not included in taxable income. The reserve must be added to taxable income six years after the allocation at the latest. We do not treat the loss offset with this profit reserve as a loss carryback provision since there will be no cash effect in the period after the loss event (only a reduction in the profit periodization reserve).

Country	2005	2006	2007	2008	2009	2010	2011	2012
Austria	0	0	0	0	0	0	0	0
Belgium	0	0	0	0	0	0	0	0
Croatia	0	0	0	0	0	0	0	0
Czech Republic	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0
France	3 ⁺	3 ⁺	3 ⁺	3 ⁺	3 ⁺	3 ⁺	3 ⁺	3 ⁺
Germany	1 ⁺⁺	1 ⁺⁺	1 ⁺⁺	1 ⁺⁺	1 ⁺⁺	1 ⁺⁺	1 ⁺⁺	1 ⁺⁺
Hungary	0	0	0	0	0	0	0	0
Ireland	1	1	1	1	1	1	1	1
Italy	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0
Netherlands	3	3	1	1	1 ⁺⁺⁺	1 ⁺⁺⁺	1	1
Norway ^a	0	0	0	2	2	0	0	0
Poland	0	0	0	0	0	0	0	0
Portugal	0	0	0	0	0	0	0	0
Slovakia	0	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0
Sweden ^b	0	0	0	0	0	0	0	0
Switzerland	0	0	0	0	0	0	0	0
United Kingdom	1	1	1	1	1	1	1	1

3.2.3 Tax Loss Carrybacks and Investments of Loss Firms

Theory as well as empirical evidence suggests that tax law asymmetry induced by a lack of full loss offset discourages risk taking (e.g., Domar and Musgrave 1944, Stiglitz 1969,

Langenmayr and Lester 2017, Ljungqvist, Zhang and Zuo 2017). These studies examine the investment responses of firms that are currently not eligible for a loss carryback but incorporate loss offset possibilities when choosing their optimal level of investment or investment risk because loss offset rules affect their cost of capital (ex ante perspective).

However, as pointed out by Auerbach (1986), encouraging risk taking via less restrictive loss offset possibilities could come at the costs of supporting losers in the event of a loss. The refund of previously paid taxes without assessment of the going-concern assumption, that is, unconditional on future profitability, could lead to cash infusions to unproductive loss firms that may be prone to undertake wasteful, that is, too risky investments with below-normal rates of return (Auerbach 1986). Loss firms are in an unusual situation of high uncertainty and are generally more likely to face financial distress relative to profitable firms (Altman 1968). Investment reductions are common when firms experience a loss (Asquith, Gertner, and Scharfstein 1994). This could be due to either a lack of profitable investment opportunities or financial constraints. Given that loss carrybacks loosen financial constraints via the refund of previously paid taxes, we expect positive investment responses of loss firms to the extent that they are financially constrained.

The implications of a positive investment response of loss firms are, however, more ambiguous than for the average (e.g., profitable) firm. Loss carrybacks could mitigate financial constraints resulting from inefficiencies in capital markets. This inefficiency could be due to the credit rationing of risky loss firms in a competitive credit market (e.g., Stiglitz and Weiss 1982) or a simultaneous adverse shock affecting credit supply during an economic downturn (e.g., Puri, Rocholl, and Steffen 2011). Under this view, tax refunds could help loss firms overcome these frictions to undertake positive-NPV projects and reduce underinvestment. Alternatively, reducing loss firms' financial constraints via tax refunds could induce inefficient overinvestment for two reasons. First, distressed firms' have elevated incentives to invest in

negative-NPV projects because the risk associated with new investments increases owners' option value of equity. Second, the very causes that led firms into a loss, such as poor management practices, could persist and lead loss firms to make less efficient investment decisions. Thus, while refunds could plausibly mitigate financial constraints, it is not clear whether an investment response of loss firms to refunds would be efficient by reducing underinvestment or inefficient by fostering risky overinvestment.

To characterize the investment efficiency implications of refunds, we exploit variation in the investment response across loss firms along two dimensions. First, prior literature shows that distressed firms' investment during periods of high volatility generate less value (Eisdorfer 2008) and, at the extreme, distressed firms choose negative-NPV projects just because of their high risk (e.g., Parrino and Weisbach 1999). Finding a stronger investment response of distressed firms would be consistent with an inefficient loosening of efficient financial constraints through refunds. In contrast, finding evidence that less distressed loss firms increase investments would be consistent with tax refunds helping to alleviate financial constraints in the market that prevent firms from conducting positive-NPV projects.

Second, we exploit how loss firms' investment response varies with their productivity. Bloom et al. (2010, 2017) provide evidence that low-productivity firms make less efficient investment decisions because, for example, they employ less sophisticated management techniques. Thus, finding stronger investment responses of low-productivity firms to tax refunds would further corroborate the notion that the investment effect is primarily driven by less efficient investments. In contrast, finding that high-productivity firms increase investments in response to the tax refund would rather support the notion that tax refunds enable firms to conduct positive-NPV projects.

Finally, we assess how providing loss firms with refunds unconditional on future profitability affects the competitive selection of firms as well as aggregate output and

productivity within an industry. Following Auerbach (1986), we interpret the risk of supporting losers as a source of potential misallocation. Inefficiently loosening the financial constraints of loss firms through refunds could weaken competitive forces in an industry by prolonging the survival of less productive firms that would have exited the market without refunds. By not conditioning on the future prospects of a loss firm, less restrictive refunds bear misallocation risk and could prolong the competitive process moving market share from less productive loss firms to more efficient competitors or entrants. At the industry level, a higher fraction of loss firms receiving refunds could therefore lead to lower aggregate output and productivity. Since we benchmark loss firms operating under the carryback regime against comparable loss firms under the carryforward regime, our examination is limited to the ex post effects of the two regimes. Our results, however, do not allow us to draw an overall welfare conclusion that would need to net the benefits of incentivizing risk taking ex ante studied by prior literature and the potential costs of subsidizing losers.

3.2.4 Identification of Investment Responses

We first need to establish the investment response as a baseline consequence of less restrictive tax refunds through carrybacks for the following reasons. First, investment vis-à-vis other uses ties directly to policymakers' claims of stimulating investment by relaxing loss firms' financial constraints. Policymakers highlight investment because it is a key determinant of aggregate growth. Second, loss firms' investment resulting from refunds can be tied to financial constraints theoretically. If refunds indeed subsidized a key factor input, namely, capital, of firms with below-normal (above-normal) rates of return, this would have negative (positive) output and productivity consequences. As such, documenting heterogeneity in the investment response informs about potential misallocation resulting from less restrictive tax refunds. Third, documenting an investment response of loss firms ensures complementarity with prior literature

focusing on potential ex ante benefits of loss carrybacks in incentivizing risk taking (Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017).

To examine how differences in loss carryback regimes are related to investments in t , we focus on firms reporting a profit in $t - 2$ and a loss in $t - 1$ because these loss firms could claim refunds that they receive in year t if loss carrybacks were allowed. We use two different variables to examine the investment response to refunds. First, we identify *Refund* firms with an indicator equal to one if they report positive earnings before interest and taxes (EBIT) in $t - 2$ and a negative EBIT in $t - 1$ and zero otherwise. Second, we use a continuous variable that estimates a firm's cash refund as an alternative, refined measure of the expected tax refund to capture variation in the intensive margin (*Cash Equivalent*). We multiply the gross (i.e., pretax) refund for a given loss in $t - 1$ and a given profit in $t - 2$ with the prior year's statutory tax rate of the country in which the firm is located and scale this variable with the prior year's total assets.⁴⁷ In all other cases, we set *Cash Equivalent* to zero.

Comparing these firms under carryback versus carryforward regimes generates variation in tax refunds because the timing and size of the loss refund are not conditional on future profits under carryback regimes. So-called *Refund* firms are more liquid under a carryback regime relative to a carryforward regime unless their profits in t equal losses in $t - 1$ in absolute terms. While prior literature suggests a higher tendency for mean reversion in case of a loss (e.g., Brooks and Buckmaster 1976, Lawrence, Sloan, and Sun 2017), prior papers still find a negative effect of losses on future earnings, suggesting that not all firms fully recoup a loss in the

⁴⁷ This is a simplification. The Netherlands allowed a loss carryback window of three years in 2005 and 2006 and Norway allowed a two-year carryback window in 2008 and 2009. However, we do not have historical information on firms' profitability for the Netherlands to adequately control for this. If anything, this biases against finding an effect. Second, when defining our control groups, we need to assume a consistent pseudo-carryback window. The most reasonable is one of one year. Hence, we need to treat Norway and Netherlands similarly. Moreover, our placebo tests use firms with consecutive losses. In addition, here, we need to assume a carryback window of one year. Importantly, as we demonstrate in Table B.3, our results are very similar once we account for a two-year carryback window in Norway. The results are very similar whether we exclude 2005–2006 from the Netherlands or not.

following period(s). Moreover, every second *Refund* firm in our sample does not fully recoup its loss in t . Therefore, we expect a higher liquidity, on average, for *Refund* firms in t under loss carrybacks regimes (see also Graham and Kim 2009).⁴⁸ Our primary analyses examine whether *Refund* firms have higher capital investments in t under loss carryback regimes because they are more liquid in t .

Our identification is based on a generalized triple difference design because we include firm as well as country–industry–year fixed effects. We estimate the investment effect of within-firm variation in $Refund_{i,t}$ (first difference) relative to counterfactual firms from the same country–industry–year (second difference). We use firms from the same country–industry–year to difference out country–industry–year specific trends in investment and country–industry–year specific characteristics potentially affecting investment. By benchmarking against counterfactuals from the same country–industry–year and by including firm fixed effects, *Refund* effectively captures the investment effect of refunds resulting from losses, with two important characteristics. First, these losses are plausibly idiosyncratic because they cannot be explained by contemporaneous country–industry trends. Second, they are largely unanticipated because they cannot be explained by time-invariant firm characteristics such as the volatility of a firm’s business model (the likelihood of repeated profit–loss sequences). Finally, by benchmarking against profit firms and loss firms with no (potential) refund from the same country–industry–year, we aim to eliminate differences in ex ante risk taking unconditional on profitability resulting from loss carrybacks versus carryforwards.⁴⁹

⁴⁸ In addition, changes in ownership and minimum taxation rules could lead to the forfeiture of carryforwards in a given year. Furthermore, loss carrybacks lead to higher refunds relative to loss carryforwards if corporate tax rates decrease in $t-1$. While tax rate changes occur only in one out of every six country–years in our sample, around 80% of these tax changes are tax rate decreases.

⁴⁹ We corroborate this interpretation in the Appendix Table B.4, where we show that firms (potentially) eligible for a tax refund do not differ in carryback versus carryforward countries with respect to their sales volatility, a proxy for uncertainty or risk (e.g., Bloom, Bond, and van Reenen 2007), in the year before suffering a loss.

The third difference compares investments between *Refund* firms and their respective counterfactuals from the same country–industry–year cluster between loss carryback countries and countries that only allow loss carryforwards. This third difference is captured by the coefficient for the interaction between *Refund* and *LCB* (β_2) in equation (1) below. Since we interact *Refund* with *LCB*, the dummy $Refund_{i,t}$ estimates the investment effect for firms that could claim a refund if allowed. The interaction $Refund_{i,t} \times LCB_{j,t}$ captures the incremental investment effect if loss carrybacks *are* allowed and *Refund* firms actually *receive* tax refunds, while country–industry–year investment trends are absorbed. To the extent the firms suffer from financial constraints, we predict that the incremental liquidity from loss carrybacks increases investments; we thus expect $\beta_2 > 0$ in our model. We thus test the following model, allowing for the correlation of standard errors across time and firms within country–industries:

$$Investment_{i,t} = \alpha_0 + \alpha_i + \alpha_{j,m,t} + \beta_1 \times Refund_{i,t} + \beta_2 \times Refund_{i,t} \times LCB_{j,t} \\ + \sum_k \gamma_k X_{k,i,t-1} + \sum_l \delta_l C_{l,j} \times Refund_{i,t} + \sum_n \phi_n X_{n,i,t-1} \times Refund_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $Investment_{i,t}$ is gross investments, defined as the change in fixed assets before depreciation, amortization, or impairment charges relative to the prior year’s total assets (see also Asker, Farre-Mensa, and Ljungqvist 2015).⁵⁰ With this definition, our measure of investment excludes any effects related to depreciations, amortizations, write-offs, or impairments. Unfortunately, due to data limitations, we do not have information on a firm’s capital expenditures. However, our gross investment measure is highly correlated with capital expenditures (correlation coefficient of 0.54) as well as the investing cash flow (correlation coefficient of 0.64) for U.S. firms based on Compustat North America data. This result makes us confident that our investment measure is comparable to measures available for public firms.

⁵⁰ Our results are robust to using the change in net fixed assets, that is, the change in fixed assets after depreciation (Table B.5 of the Appendix).

The variable $Refund_{i,t}$ is equal to one if the firm reports a loss— $EBIT < 0$ —in the previous year and a profit— $EBIT > 0$ —in $t - 2$.⁵¹ One limitation of this measure is rooted in our inability to observe the actual amount of accumulated net operating losses from prior years, since we do not have access to proprietary tax data. We widen this narrow definition in one of our placebo tests below. The main coefficient identifying loss carryback regimes (on $LCB_{j,t}$) varies at the country level and, therefore, cannot be estimated in our research design featuring firm (α_i) and country (j)–industry (m)–year (t) fixed effects ($\alpha_{j,m,t}$). This combination of fixed effects controls for unobservable time-invariant firm and time-varying industry–country factors affecting investment. While the former capture time-invariant differences, for example, in risk taking related to the level of tax asymmetry (e.g., Domar and Musgrave 1944, Stiglitz 1969, Auerbach 1986, Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017), the latter limit the confounding effect of unobserved variation in economic conditions or broader policy changes at the country–industry level.

With respect to time-varying firm characteristics, we include a vector $X_{k,i,t}$ of firm-level investment determinants (firm size, age, capital and labor intensity, sales growth, profitability, and cash holdings) and allow for distinct mappings between investments and these controls for *Refund* firms to isolate the effect of loss carrybacks on *Refund* firms' investment from other observable variables potentially correlated with *Refund* and investment.⁵² For a related reason, we interact *Refund* with a vector of country variables $C_{l,j,t}$, that is, gross domestic product

⁵¹ We assume an overlap between financial income and taxable income because tax return data are unavailable for our cross-country panel. We use EBIT instead of earnings before taxes to avoid measurement error from several tax-exempt items such as dividends or capital gains and losses from the sale or re-evaluation of participations that would drive the difference between EBIT and earnings before taxes. Further, the deductibility of interest expenses from the tax base is limited in several sample countries and we have no information on interest revenue. However, Table B.6 of the Appendix shows the robustness of our main result to using pre-tax income. The estimates are similar in magnitude and statistical significance. We also note that the adjustments to EBIT as proposed by Graham (2000) and Blouin, Core, and Guay (2010) are not feasible in our sample due to poor data coverage on items such as deferred taxes.

⁵² Since some of these variables are also potentially outcome variables, their inclusion in the estimation equation might lead to a “bad controls” problem (Angrist and Pischke 2008). When we exclude these variables (cash, debt, and sales growth) from our estimation equation, we obtain coefficient estimates that are very close to estimates including these variables.

(GDP), GDP growth, regulatory quality, corporate tax rate, and the restrictiveness of loss carryforwards. This accounts for country characteristics that may affect unprofitable and profitable firms' investment differently. For example, developed countries that allow carrybacks may put or have other stimuli in place specifically targeted at facilitating the recovery of loss firms.⁵³ Importantly, we note that carryback countries and countries without carryback appear to follow a common general trend in economic growth over our sample (see Figure B.1 of the Appendix). To further assess the validity of our identification strategy and to address concerns about time-varying unobservable economic characteristics being correlated with *Refund*, *LCB*, and/or future investment, we include tests of parallel trends in our main table and present the results of placebo tests in section 3.3.2 as well as those from other identification strategies in section 3.3.3.

Two concerns with our approach emerge based on prior literature. First, firms may manage their losses to increase refunds from tax loss carryback provisions (e.g., Maydew 1997, Erickson, Heitzman, and Zhang 2013). However, if a firm returns to profitability in t , it is unlikely that such earnings management will affect our inferences. Assuming constant corporate tax rates, shifting expenses from t (the subsequent profit year and the year of investment) to $t - 1$ (the loss year) does not alter the after-tax cash flow or the tax payment in t . However, if this is not the case, we may not compare firms with the same economic loss, since the reported losses of carryback firms may include a managed portion of future expenses shifted to the current period. Thus, an alternative explanation for the higher investment of loss firms in carryback countries could be that their economic losses are lower than those of firms that cannot carry back losses. To address this concern, we use predicted instead of reported earnings for loss carryback firms using the approach of Erickson, Heitzman, and Zhang (2013). The

⁵³ Table B.7 of the Appendix shows the robustness of our results to eight alternative research design choices with respect to including versus excluding specific interaction terms, such as interactions of firm-level variables with *LCB*.

predicted losses resulting from this equation primarily reflect the economic loss as opposed to a potentially managed loss. If we use the predicted loss when constructing *Refund* for loss carryback firms, our main results are very similar to our baseline results (see Table B.8 of the Appendix). While this does not rule out that firms manage losses to increase refunds from tax loss carryback provisions, this behavior does not appear to fully drive the investment response we document.

Second, we assume loss firms eligible for a loss carryback claim the refund. For the United States, Edgerton (2010) and Mahon and Zwick (2015) report that only a third of eligible firms do so. In contrast, carrybacks are the default option in some of our sample countries. Eligible firms would have to opt out (Germany) or have no choice (the Netherlands). While the system in the United Kingdom and Ireland is comparable to that in the United States, anecdotal evidence from conversations with tax professionals indicates that most firms eligible for a carryback actually claim the refund in these countries because corporate tax rates decreased over the sample period, making tax refunds from carrybacks strictly higher than refunds from carryforwards. We do not have proprietary data that allow us to further examine this issue, but we note that this behavior would attenuate our coefficient estimates relating to the effect of loss carrybacks on investment.

3.2.5 Data

We obtain firm-level data from Amadeus (see also De Simone 2016, De Simone, Klassen, and Seidman 2017). This database contains accounting information from the unconsolidated financial statements of European private firms. Unfortunately, we cannot include U.S. firms in our sample due to data unavailability for private firms. Relative to consolidated data, these data enable us to locate the country in which a firm incurred a loss. Private firm data also allow making inferences about investment responses of an important part of the economy responsible

for roughly two-thirds of overall employment in the European Union.⁵⁴ Private firms are more heterogeneous than public firms in important characteristics such as financial constraints (Beck, Demirgüç-Kunt, and Maksimovic 2005, Behr, Norden, and Noth 2013). Finally, we add country–year-level information on loss offset provisions and statutory tax rates from the IBFD Tax Handbooks and Ernst & Young’s Worldwide Corporate Tax Guides and on the GDP, GDP growth, and regulatory quality from the World Bank.

We eliminate financial and utility firms, since they are subject to different regulations that likely affect their investment behavior. We exclude very small companies with fixed assets and sales lower than €50,000 because the investments of such small, fast-growing firms would inflate our measure that is defined relative to the prior year’s total assets. We exclude firms with negative values for total assets and cash. The data are adjusted for inflation using each country’s Consumer Price Index in 2010 and converted into euros. All firm-level variables except for *Size* are winsorized yearly at the 1% and 99% levels. This results in 4,602,942 firm–year observations representing 905,899 firms from 21 countries over the period 2005–2013. In line with other studies using Bureau van Dijk data (e.g., Dyreng et al. 2015, De Simone 2016, De Simone, Klassen, and Seidman 2017), we have a relatively short sample period due to database limitations. Bureau van Dijk only provides the latest 10 financial statements per firm. Since we require information on a firm’s earnings sequence two years prior to the potential investment effect in order to identify firms that receive tax refunds, our sample period decreases to eight years. We also note that we only have ownership information for 1,879,775 observations (41% of our sample). Of these 55.1% are stand-alone firms and 28.5% and 16.5% belong to a domestic or multinational group, respectively.⁵⁵

⁵⁴ Source: http://siteresources.worldbank.org/CGCSRLP/Resources/SME_statistics.pdf, last accessed August 25, 2017.

⁵⁵ Controlling for firm characteristics of the parent in cases where this data are available does not change our inferences. Details on the approach as well as regression results are reported in Table B.9 of the Appendix.

Table 3.2 provides an overview of the sample composition by country. While loss carryback countries represent 6.7% of the overall sample in terms of observations, they represent more than one-third of the overall sales volume, with Germany and the United Kingdom constituting the majority. Observations under a carryforward-only regime mainly stem from Spain and Italy, which represent 27.5% and 31%, respectively, of the sample in terms of observations. The differences in observations are due to different filing requirements across countries.

Table 3.2: Country Overview

This table gives an overview of the composition of our sample by country. The variable *Refund* is a dummy variable equal to one if the firm reports a loss ($EBIT < 0$) in t and a profit ($EBIT > 0$) in $t - 1$. Panel A lists all countries in our sample without loss carryback provisions. Panel B shows all countries that allow tax loss carrybacks. The sample consists of 4,602,942 firm-year observations.

^a Norway is listed in Panel A (countries without loss carryback provisions) as well as in Panel B (loss carryback countries), since it allowed tax loss carrybacks only in 2008 and 2009.

Country	<i>Refund</i> = 1	Observations	% of full sample
Panel A: No loss carryback provision			
<i>Austria</i>	8.4%	11,060	0.2%
<i>Belgium</i>	9.3%	127,333	2.8%
<i>Croatia</i>	8.6%	1,020	0.0%
<i>Czech Republic</i>	9.7%	130,892	2.8%
<i>Denmark</i>	9.6%	6,573	0.1%
<i>Finland</i>	9.2%	155,742	3.4%
<i>Hungary</i>	8.8%	176,123	3.8%
<i>Italy</i>	9.2%	1,426,303	31.0%
<i>Luxembourg</i>	9.9%	3,893	0.1%
<i>Norway^a</i>	9.7%	157,558	3.4%
<i>Poland</i>	8.2%	130,074	2.8%
<i>Portugal</i>	10.5%	307,281	6.7%
<i>Slovakia</i>	10.4%	65,286	1.4%
<i>Slovenia</i>	7.7%	42,773	0.9%
<i>Spain</i>	10.7%	1,265,260	27.5%
<i>Sweden</i>	10.7%	288,062	6.3%
<i>Switzerland</i>	9.0%	1,503	0.0%
Total A	9.8%	4,296,736	93.3%
Panel B: Loss carryback provision			
<i>Germany</i>	7.0%	96,278	2.1%
<i>Ireland</i>	14.3%	9,290	0.2%
<i>Netherlands</i>	9.5%	3,425	0.1%
<i>Norway^a</i>	12.6%	56,770	1.2%
<i>United Kingdom</i>	9.3%	140,443	3.1%
Total B	9.3%	306,206	6.7%

Descriptive statistics are reported in Table 3.3. In our sample, 9.8% of the observations report a loss following a profit ($Refund = 1$). To address concerns about the reliability of our below results obtained from a relatively small group of firms in the sample, we document results of similar magnitude using two distinct matching algorithms.⁵⁶

Table 3.3: Descriptive Statistics

This table presents descriptive statistics of our main variables over 2005–2012. All variables are defined in Appendix B.1. In Panel C, we compare mean-centered investments across groups. We center by country and, in the case of Norway, we center within carryback regimes. ***, **, and * denote significance of t-tests at the 1%, 5%, and 10% levels, respectively.

Variable	N	Mean	Standard deviation	25 th percentile	50 th percentile	75 th percentile
Panel A: Firm-level variables						
<i>Investment</i>	4,602,942	0.0784	0.1507	0.0112	0.0326	0.0889
<i>Refund (Dummy)</i>	4,602,942	0.0977	0.2969	0.0000	0.0000	0.0000
<i>Refund (Cash Equivalent)</i>	4,602,942	0.0008	0.0033	0.0000	0.0000	0.0000
<i>Start-Up</i>	4,602,942	0.1432	0.3503	0.0000	0.0000	0.0000
<i>Age</i>	4,602,942	16.7672	13.0738	8.0000	14.0000	21.0000
<i>Firm Size</i>	4,602,942	14.1405	1.4863	13.0538	13.9446	15.0218
<i>Labor Intensity</i>	4,602,942	0.3432	0.3586	0.1146	0.2321	0.4352
<i>Capital Intensity</i>	4,602,942	0.4244	1.7099	0.2007	0.3883	0.6174
<i>Cash Holdings</i>	4,602,942	0.1196	0.1581	0.0130	0.0548	0.1628
<i>Leverage</i>	4,602,942	0.7448	0.4017	0.4740	0.7279	0.9508
<i>Profitability</i>	4,602,942	0.0649	0.1308	0.0101	0.0463	0.1056
<i>Sales</i>	4,602,942	1.5922	1.2619	0.7467	1.2842	2.0496
<i>Sales growth</i>	4,602,942	0.1142	0.4296	-0.0746	0.0523	0.1957
<i>Payout</i>	4,597,693	-0.0008	0.0928	-0.0120	-0.0029	0.0041
<i>LT Debt</i>	3,991,969	0.2335	0.3070	0.0000	0.0971	0.3814
<i>Exit</i>	4,532,131	0.0116	0.1070	0.0000	0.0000	0.0000
<i>Productivity</i>	4,532,131	0.0084	0.4710	-0.2031	0.0071	0.2291
Panel B: Country-level variables						
<i>LCB</i>	4,602,942	0.0665	0.2492	0.0000	0.0000	0.0000
<i>LCF</i>	4,602,942	0.6791	0.2215	0.5000	0.7500	0.7500
<i>STR</i>	4,602,942	0.2938	0.0513	0.2600	0.3000	0.3100
<i>ln(GDP)</i>	4,602,942	27.5176	0.9983	26.7658	27.9967	28.3515
<i>GDP growth (in %)</i>	4,602,942	0.6511	2.9215	-1.1600	0.9300	2.6700
<i>RQ</i>	4,602,942	1.1432	0.3006	0.9500	1.0900	1.2900

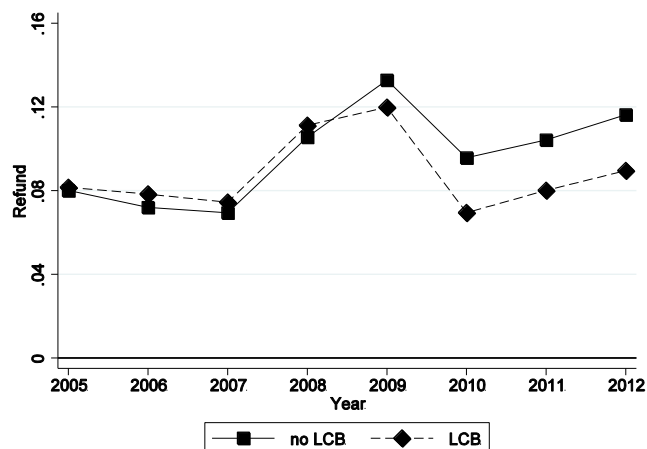
⁵⁶ We present estimation results using explicit matching algorithms that restrict and reweight our sample to similar firms in Table B.10 of the Appendix. First, we use entropy balancing to match firms in loss carryback countries to firms in non-carryback countries. Weighting firms in equation (1) accordingly ensures that they are similar in observable characteristics. Second, we perform the nearest-neighbor matching of *Refund* firms in carryback versus non-carryback countries in each industry–year combination, resulting in a balanced but much smaller sample. Both approaches support our main results. The point estimates in the second approach, even though there are only 52,076 observations, are very close to our baseline estimates from Table 3.4 and validate our identification approach of exploiting counterfactuals from the same country–industry–year.

Panel C: Comparison of investments across groups			
	Refund = 0	Refund = 1	Δ (Refund = 1 – Refund = 0)
LCB = 0	0.0016	-0.0144	-0.0160***
LCB = 1	0.0012	-0.0108	-0.0120***
Δ (LCB = 1 – LCB = 0)	-0.0004***	0.0035***	0.0039***

Figure 3.1 shows the distribution of *Refund* over the sample period for loss carryback countries and countries without loss carryback provisions. The number of *Refund* events increases for both groups during 2008 and 2009 to 11.9% for loss carryback countries and 13.3% for countries without loss carryback provisions. The average cash refund amounts to 0.08% of total assets. For the sample of *Refund* firms, the average cash refund amounts to 0.8% of total assets. About 14% of our sample firms are no older than five years. The average firm has a size of €1.38 million, capital (labor) intensity of 42% (34%), leverage of 74.5%, a sales-to-assets ratio of 159.2%, average profitability of 6.5%, and sales growth of 11.4% and holds 12% of its assets in cash.⁵⁷

Figure 3.1: Comparison of *Refund* over Time

This figure compares *Refund* events across countries with loss carryback provisions (*LCB*) and countries with no loss carryback options (*no LCB*) from 2005–2012. The variable *Refund* is a dummy variable equal to one if the firm reports a loss (EBIT < 0) in t and a profit (EBIT > 0) in $t - 1$. The variable *LCB* is a dummy variable equal to one if the country allows tax loss carrybacks.



⁵⁷ Note that the average leverage is comparable to other studies on private firms. For example, Yagan (2015) reports debt-to-assets ratios of 68% for C Corporations and 63% for S Corporations in the United States.

In Panel C of Table 3.3, we report the country mean-centered average variable *Investments* in t for *Refund* and non-*Refund* firms located in countries permitting loss carryback ($LCB = 1$) and those not permitting carryback ($LCB = 0$). In countries that do not allow loss carrybacks, *Refund* firms invest less than profitable firms do in t , which is in line with prior literature (e.g., Asquith, Gertner, and Scharfstein 1994). This difference amounts to -1.6% of total assets. In addition, *Refund* firms invest less than profitable firms do in countries that allow loss carryback. Consistent with our prediction, this difference (-1.2% of total assets) is lower than in countries that do not allow loss carrybacks. The difference in these differences amounts to 0.39% of total assets. The comparison of *Refund* and non-*Refund* firms across carryback regimes indicates that this result is primarily driven by higher investments of *Refund* firms in carryback countries. The difference in the investments of profitable firms across loss offset regimes is negligible. Taken together, this bivariate comparison is consistent with our prediction that *Refund* firms have higher investments under loss carryback regimes.

3.3 Results

3.3.1 Investment Response

Table 3.4 presents the coefficient estimates for regressions of future investment on the interaction of *Refund* and *LCB* from equation (1). We only report the interaction term, since this is the coefficient of interest. We report all other coefficients in Table B.11 of the Appendix.⁵⁸ First, we use a dummy variable equal to one for firms with a loss in $t - 1$ and a profit in $t - 2$ to identify *Refund* firms. Consistent with our expectations, the coefficient for the interaction term $Refund \times LCB$ is positive and significant. That is, a less asymmetric treatment

⁵⁸ As expected, we find negative and significant coefficients for *Refund*, indicating that, in the absence of carryback regimes, loss firms invest less than their peers from the same country and industry. Variables are mean centered to ease interpretation involving continuous variables. We find that large and mature firms show, on average, lower investment levels than growing firms. High levels of fixed assets and high leverage lead to lower investments, while cash holdings are positively associated with investments. High profitability and high sales are positively related to investments.

via loss carrybacks leads to higher investments of loss firms that are eligible for a tax refund. The corresponding investment increase amounts to 0.34% of total assets, which is equivalent to 4.3% of average investments and around 40% of the average cash refund (0.8% of total assets). This magnitude is comparable to the descriptive statistics (Panel C of Table 3.3).⁵⁹

Table 3.4: Tax Refunds from Carryback Provisions and Investment Responses

This table presents the regression results from 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Columns (1) and (2) use a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Columns (3) and (4) use a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t . We interact the *Refund* variable with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Investment_t</i>			
	<i>Dummy</i>		<i>Refund=</i> <i>Cash Equivalent</i>	
	(1)	(2)	(3)	(4)
<i>Anticipatory Response</i>				
<i>Refund_{t+2} × LCB</i>		-0.0009 (0.0020)		0.0468 (0.1735)
<i>Refund_{t+1} × LCB</i>		0.0021 (0.0026)		0.0453 (0.2237)
<i>Immediate Response</i>				
<i>Refund_t × LCB</i>	0.0034** (0.0017)	0.0049** (0.0023)	0.3284*** (0.1151)	0.3970*** (0.1292)
<i>Lagged Response</i>				
<i>Refund_{t-1} × LCB</i>		0.0024 (0.0028)		0.1071 (0.2136)
<i>Refund_{t-2} × LCB</i>		0.0008 (0.0019)		0.2335 (0.1708)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included				
Observations	4,602,942	1,882,351	4,602,942	1,882,351
Adj. R ²	0.257	0.274	0.257	0.274

⁵⁹ When using the logarithm of fixed assets as the dependent variable as in chapter 2 of this thesis, we still find a positive coefficient. The estimates suggest an increase in fixed assets equal to 1.12%. This equals about 0.42% of total assets for the average firm.

In column (3) of Table 3.4, we run equation (1) with our refined measure for the expected tax refund (*Cash Equivalent*). Recall that our model includes profitability in $t - 1$ to control for the level of the actual negative income shock. Hence, this variable is a proxy for the refund for a given loss in $t - 1$ and a given profit in $t - 2$. The results are in line with our prediction. Replacing *Refund* with our estimate for a firm's tax refund simplifies the interpretation of the economic magnitude, since the coefficient informs about the use of the actual refund: We find that from each euro in tax refund, on average, across firms, 33 cents are used for additional capital investments relative to carryforward firms. The size of the investment effect is close to that reported by Dobridge (2015). In the author's study of the extension of the loss carryback period from two to five years in the United States in 2002, \$0.40 of every tax refund dollar is allocated to investments.⁶⁰

One concern with our analysis is that the parallel trends assumption underlying the generalized difference-in-differences analysis could be invalid because we fail to fully capture time-varying unobservables correlated with *Refund*, *LCB*, and/or *Investment*. To corroborate the validity of our approach, we conduct Granger-type causality tests, as suggested by Angrist and Pischke (2008). If our identification strategy is effective and the parallel trends assumption holds, we would expect to find no differences in the investments of *Refund* firms prior to treatment; that is, the treatment should not have anticipatory effects. We follow prior literature (e.g., Autor 2003, Yagan 2015, Giroud and Rauh 2016) and include leads and lags of the treatment in $t - 2$, $t - 1$, $t + 1$, and $t + 2$, expecting to find that the treatment in $t - 2$ and $t - 1$ should have no effect on investment in t . The results are reported in columns (2) and (4) for the

⁶⁰ In contrast to Dobridge (2015), we find that our results also hold during large recessions. In Table B.12 of the Appendix, we define a dummy variable, *Crisis*, that equals one if an economy has negative GDP growth and zero otherwise and test whether the effect of a tax refund in loss carryback countries on investment is weaker during crises. We find significant investment responses during regular economic conditions but no weaker or stronger effects during economic downturns. Taken together, our evidence suggests that a less asymmetric treatment of tax losses via loss carryback provisions is effective in stimulating the investments of loss firms under different macroeconomic conditions.

indicator variable for *Refund* firms and the estimate for a firm's tax refund, respectively. Consistent with the parallel trends assumption (and with the cash mechanism), we find insignificant investment differences between *Refund* firms in loss carryback regimes versus loss carryforward regimes in the years before and after the tax refund is paid. Only the treatment (payment of the tax refund) in period t leads to an increase in investments in t . Lagged and lead treatments are not related to investments in t . These results corroborate our parallel trends assumption and suggest a causal interpretation of our results because the investment effect is only prevalent when differences in tax asymmetry lead to liquidity differentials. This result also suggests that our identification strategy that benchmarks loss firms against profitable firms from the same country–industry is effective in eliminating differences in ex ante investment incentives unrelated to firm profitability from a more lenient loss offset regime (Langenmayr and Lester 2017, Ljungqvist, Zhang, and Zuo 2017).

3.3.2 Assessing Identification with Placebo Loss Firms

We further validate the parallel trends assumption and mitigate concerns about the validity of the counterfactual using placebo tests. First, we conduct a placebo analysis with firms reporting consecutive losses in $t - 2$ and $t - 1$ under the carryback versus carryforward tax loss regimes. Since these firms are not eligible for a tax loss carryback (due to a lack of taxes paid the year before),⁶¹ they should not have higher investments under a loss carryback regime unless unobservable country characteristics correlated with carryback regimes affect unprofitable and profitable firms' investment differently. Hence, we define an additional indicator variable equal to one for *Refund* firms with profits in t and another indicator variable equal to one for *Refund* firms with losses in t and we interact these variables with *LCB*. The results are reported in Panel A of Table 3.5. While the interaction with *LCB* is positive and significant for *Refund*, it is

⁶¹ Of course, this argument does not hold for observations from the Netherlands in 2005–2006 or from Norway. If anything, the longer carryback periods in these two countries work against finding insignificance in this placebo test.

insignificant for firms with consecutive losses irrespective of whether their losses are transitory, that is, whether they return to profitability in period t or not. Loss firms that do not receive a refund but also have transitory losses in $t - 1$ invest similarly in carryback and carryforward countries.

Table 3.5: Tax Refunds from Carryback Provisions and Investment Responses, Placebo

This table presents the regression results from 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Profit (Loss) indicates whether firms report a positive or negative EBIT in the respective time period. We provide coefficient estimates for the interaction $Refund \times LCB$ where *Refund* represents a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. We control for firm variables in $t - 1$ and country variables in t and we interact all loss variables with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Refund firms vs. other loss firms				
$t - 3$	$t - 2$	$t - 1$	t	Investment Effect in LCB_t
?	Profit	Loss	?	0.0044** (0.0019)
?	Loss	Loss	Loss	0.0024 (0.0032)
?	Loss	Loss	Profit	0.0021 (0.003)
Firm controls in $t - 1$ & country controls & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included				
Observations				4,602,942
Adj. R ²				0.257
Panel B: Split on profitability in $t - 3$				
$t - 3$	$t - 2$	$t - 1$	t	Investment Effect in LCB_t
Profit	Profit	Loss	?	0.0032** (0.0016)
Loss	Profit	Loss	?	-0.001 (0.0023)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included				
Observations				3,576,464
Adj. R ²				0.259

We next divide *Refund* firms into two groups based on their profitability in $t - 3$: one with consecutive profits prior to the loss and one with a loss in period $t - 3$. We only expect to find investment differences for firms with consecutive profits prior to the loss in year $t - 1$, because *Refund* firms with losses in $t - 3$ can offset the profit in year $t - 2$ with the losses carried forward

from $t - 3$. Hence, we define an additional indicator variable equal to one for *Refund* firms with profits in $t - 3$ and another indicator variable equal to one for *Refund* firms with losses in $t - 3$ and we interact these variables with *LCB*. In line with our prediction, we only find positive investment differences between loss carryback and loss carryforward countries for (the roughly 70%) *Refund* firms with profits in $t - 3$ (see Panel B of Table 3.5). Taken together, the results in Table 3.5 corroborate that loss carrybacks—and no other correlated omitted variable—lead to the investment difference of *Refund* firms in loss carryback countries that we document in Table 3.4. Firms that receive refunds respond, while those firms that do not receive refunds but also report a loss in $t - 1$ invest similarly across carryback and carryforward regimes. Put differently, an alternative explanation for our findings would have to be rooted in correlated omitted variables that affect firms with a profit followed by a loss differently than other loss or profit firms in carryback versus carryforward countries. While we are not aware of such factors, in the following we provide further support for our results using alternative identification approaches.

3.3.3 *Assessing Identification with a Regression Kink Design and Out-of-Sample Evidence*

First, to corroborate a causal interpretation of our estimates of the carryback investment effect, we exploit a specific setting with high internal validity from our sample. Germany allows loss carrybacks but the refundable income is limited to €511,500 during our sample period. If our argument holds, then any incremental refundable income below €511,500 should increase investments. Any incremental refundable income above €511,500 should not lead to more investments. Accordingly, we document a discontinuity in the slope of the *Refund* coefficient at a refundable income of €511,500 in Germany. Only up to €511,500, German *Refund* firms increase investments but any incremental refundable income does not result in higher investment. We do not find this behavior in other loss carryback countries. This result supports

a causal interpretation of our main finding, that the cash refund from loss carrybacks positively affects capital investments. We describe this test and the results in more detail in Appendix B2.

We further corroborate our results using evidence for U.S. listed firms exploiting changes in loss carryback periods. Specifically, we replicate our results using variation in loss carryback provisions across states in the United States. While most of the variation in the interaction term of *Refund* and *LCB* in our main sample stems from changes in a firm's profitability status, the interaction term is now identified by both changes in profitability at the firm level, as well as changes in loss carryback years at the state level. In line with our main findings, we find positive investment effects of longer loss carryback periods using the *Refund* dummy or the cash equivalent. Overall, the out-of-sample robustness of our results supports the validity of our main approach. We describe this test in more detail in Appendix B3.

The U.S. setting has two primary drawbacks, which is why we do not use the U.S. setting as our primary analysis. First, we only have access to consolidated financial statements for U.S. firms. This will likely introduce measurement error in our estimate for a firm's tax refund, because the consolidated earnings are used to proxy for unconsolidated earnings of headquarters (Ljungqvist, Zhang, and Zuo 2017). In our European private firm sample, we have access to unconsolidated data.⁶² Second, our earlier discussion of the institutional background highlights that countries vary primarily at the extensive margin, which is why we focus on generating inferences that speak to the differences in allowing carrybacks versus carryforwards only. In the U.S., there are mostly changes in the years of carrybacks (the intensive margin). Hence, we maintain the focus on the European setting in our subsequent analyses.

⁶² A potential concern with our use of unconsolidated data could be that we include firms that are part of a group. If a country allows for the group taxation of multiple group firms in a "fiscal unity," a subsidiary that is part of a fiscal unity can offset its loss with the profits of other group members. We address this potential drawback of using unconsolidated data in the Appendix Table B.13 by controlling for group taxation regimes or excluding all group firms from our sample. While we only have ownership information for 41% of our sample, our inferences remain largely unaffected.

3.3.4 *Types of Investment*

While our investment measure using a firm's change in fixed assets includes tangible and intangible investment, this section examines in more detail which type of investment responds to tax refunds. Prior literature (e.g., OECD 2009, Paunov 2012) argues that willingness to invest in intangible assets such as goodwill, capitalized R&D, patents, trademarks, licensing agreements, or software is lower during economic downturns. The OECD (2009) observes that especially long-term, high-risk innovation projects are cut first in the aftermath of the financial crisis. Thus, loss firms could focus on investments that are crucial for survival in the short term. If tangible asset investments, such as investments in buildings or machinery, are more crucial for a firm's survival in the short term, we expect to observe lower investment differences for tangible investments between loss firms in loss carryback countries relative to loss firms that receive no immediate tax refunds. Moreover, given that intangible asset investments are usually riskier than tangible investments, the distinction between tangible and intangible investments could inform us about the riskiness of loss firms' investments in loss carryback relative to loss carryforward countries.

We use the change in tangible or intangible assets before depreciation relative to the prior year's total assets as alternative dependent variables. Given that depreciation is only available for the aggregate fixed assets position, we assign depreciation to each individual position using a weighted average.⁶³ The results are reported in Table 3.6. The estimates suggest that the average investment effect is primarily driven by intangible asset investments, which is in line with the notion of lower willingness to invest in innovation during economic downturns (OECD 2009, Paunov 2012) and the focus on investments that are crucial for survival in the short term.

⁶³ Our results are robust when we neglect depreciation and use the change in tangible or intangible assets as the dependent variable or when we adjust the change in tangible fixed assets with the full depreciation amount.

Thus, finding stronger investment effects for intangible assets suggests that tax refunds from loss carrybacks especially lead to the riskier investments of loss firms.

Table 3.6: Tax Refunds from Carryback Provisions, Investment Type

This table presents the regression results from 2005–2013. *Intangible Investment* represents the change in intangible fixed assets before (weighted average) depreciation relative to the prior year’s total assets; *Tangible Investment* represents the change in tangible fixed assets before (weighted average) depreciation relative to prior year’s total assets; *Labor Investment* represents a firm’s wage expense relative to prior year’s total assets. *Refund* is a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year’s loss multiplied with the prior year’s statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable:		
	<i>Intangible Investment_t</i>	<i>Tangible Investment_t</i>	<i>Labor Investment_t</i>
	(1)	(2)	(3)
<i>Refund</i> × <i>LCB</i>	0.1107*** (0.0257)	0.1258 (0.1181)	0.0994 (0.1421)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included			
Observations	4,574,402	4,602,062	4,602,942
Adj. R ²	0.216	0.253	0.906

Moreover, policymakers’ main interest may lie in stimulating employment. While economic theory suggests that an increase in capital investments stimulates employment (Keynes 1936, Domar 1946), we additionally test whether tax refunds via loss carrybacks also affect labor investments; that is, we test whether firms use part of the tax refund to increase salaries or to hire additional employees. Both effects should be reflected in an increase in wage expense. Hence, we use a firm’s wage expense relative to the prior year’s total assets (*Labor Investment*) as the dependent variable and rerun our main analysis. The results are reported in column (3) of Table 3.6 but suggest no direct labor investment increase for the average firm. Given that we examine loss firms, relatively strong labor protection laws in European countries could preclude us from detecting an effect, because labor protection could plausibly constrain firms in their adjustment in both carryback as well as carryforward countries. The OECD labor protection index of our sample countries of 2.35, on average, exceeds the OECD average of

2.15.⁶⁴ However, our results do not rule out average long-term employment effects that result from higher capital investments induced by tax refunds.

3.3.5 *Non-Investment Uses of Tax Refunds*

In section 3.3.1, we document that one-third of the cash refund is used for capital investments. Hence, in this section, we investigate alternative uses of the cash refund. Instead of investing it, part of the liquidity could be set aside by risky firms as cash due to precautionary savings motives (Bates, Kahle, and Stulz 2009), because firms anticipate financial constraints (Almeida, Campello, and Weisbach 2004) or because they hedge against predation risk (Haushalter, Klasa, and Maxwell 2007). Alternatively, part of the refund could be returned to shareholders by reducing debt or paying dividends if firms have low needs to hedge future investments against income shortfalls (Acharya, Almeida, and Campello 2007) or lack attractive internal investment opportunities (Blanchard, Lopez-de-Silanes, and Shleifer 1994). In the latter case, firms should return capital to shareholders.

We test these alternative uses of funds by using *Cash*, long-term debt (*LT Debt*), and *Payout* as alternative dependent variables.⁶⁵ We rerun our main analysis of Table 3.4 using our estimate for a firm tax refund as the *Refund* variable to obtain directly interpretable estimates of how important these alternative uses of the refund are empirically. The results are reported in Table 3.7. We find higher cash holdings and higher payouts when loss firms receive immediate refunds through loss carrybacks relative to loss firms in countries without loss carryback options. The results on cash holdings and payout are also economically significant. The results indicate that relative to carryforward firms 33% of the tax refund (i.e., 33 cents of every euro in a tax refund) is set aside as additional cash buffer, which also corroborates our earlier

⁶⁴ This refers to the employment protection of regular workers. For temporary workers, the employment protection of our sample countries (OECD average) amounts to 2.59 (2.37).

⁶⁵ The variable *Cash (LT Debt)* is defined as cash holdings (long-term debt) relative to the prior year's total assets. Since we do not observe dividends (or share repurchases) in our data, our payout proxy is defined as the change in equity net of net income relative to the prior year's total assets.

reasoning that loss carryback regimes create a temporary liquidity benefit. The results using payout as the dependent variable suggest that relative to carryforward firms about 26% of the tax refund is additionally paid out to shareholders.

Table 3.7: Tax Refunds and Alternative Uses of Funds

This table presents the regression results from 2005–2013. The variable *Investment* is defined as the change in fixed assets before depreciation relative to the prior year’s total assets; *Cash* is defined as cash holdings relative to the prior year’s total assets; *LT Debt* represents long-term debt—for example, to credit institutions (loans and credits), bonds—relative to the prior year’s total liabilities; *Payout* is defined as net income net of the change in total equity relative to the prior year’s total assets; *Refund* is a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year’s loss multiplied with the prior year’s statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable:</i>			
	<i>Investment_t</i>	<i>Cash_t</i>	<i>LT Debt_t</i>	<i>Payout_t</i>
	(1)	(2)	(3)	(4)
<i>Refund</i> × <i>LCB</i>	0.3284*** (0.1151)	0.3260*** (0.1022)	-0.1488 (0.1368)	0.2635*** (0.1008)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included				
Observations	4,602,942	4,602,942	3,763,796	4,597,652
Adj. R ²	0.257	0.675	0.696	0.313

In total, from each euro in a refund, relative carryforward firms, carryback firms use about 33 cents for additional investment, keep 33 cents as additional cash buffer (and partly invest it in the next year⁶⁶), and pay out additional 26 cents to shareholders. We do not observe any significant relative change in long-term debt as a response to the tax refund consistent with mixed predictions from theory. Graham and Kim (2009) suggest that firms increase debt because loss carrybacks increase future marginal tax rates relative to loss carryforwards. This effect could offset the benefits of using the tax refund to pay down outstanding debt to reduce distress costs. Taken together, these results indicate that the average *Refund* firm does not appear overly financially constrained as evidenced by increased payouts, but some firms appear

⁶⁶ In Table B.14 we analyze whether refund firms with excess cash in t anticipate financing frictions, as suggested by Almeida, Campello, and Weisbach (2004). We observe higher investments in $t + 1$ of *Refund* firms in loss carryback countries with excess cash in period t . This result is consistent with firms anticipating financing frictions.

to hedge against future financing frictions or competitive pressures as evidenced by increased cash holdings.

3.3.6 Cross-Sectional Variation in the Investment Effect from Carrybacks

As discussed in section 3.2, we interpret the average investment response from refunds as evidence of loosened financial constraints, assuming that there are no differences in measurement error in our proxy for investment opportunities across *Refund* firms in carryback versus carryforward countries and other potentially omitted correlated variables. The efficiency implications of this effect are, however, ambiguous. On the one hand, loosening financing constraints resulting from inefficiencies in the credit market could help firms to engage in positive-NPV projects. Alternatively, loosening efficient financial constraints could induce risky overinvestment. Therefore, we design two cross sections that aim at disentangling whether refunds incentivize risky overinvestment or mitigate underinvestment because they loosen inefficient financial constraints. First, we distinguish between the investment responses of distressed versus non-distressed firms using the Altman Z-score for private firms. Prior literature shows that distressed firms' investments during periods of high volatility generate less value (Eisdorfer 2008) and, at the extreme, distressed firms choose negative-NPV projects just because of their high risk (e.g., Parrino and Weisbach 1999).

We define *Distress* as an indicator variable equal to one for firms with an average Altman Z-score below the “distressed zone” in $t - 1$ and $t - 2$ that Altman (2000) defines at 1.23 for private firms. We interact *Distress* with *Refund*, *LCB*, and $Refund \times LCB$ and rerun our main analysis. Panel A of Table 3.8 presents the regression results. We find weak evidence that firms without distress use about one-quarter of the tax refund for investments. The effects are about two times larger for financially distressed firms, indicating that refunds primarily loosen the constraints of firms that have strong incentives to engage in risky overinvestment. The results

also indicate that our earlier reported coefficient estimate (0.3284) reflects the average use of refunds *across* very heterogeneous refund loss firms.

Table 3.8: Tax Refunds from Carryback Provisions and Investment Responses, Cross-Sectional Variation

This table presents the regression results from 2005–2013. The variable *Investment* is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. In Panel A, we additionally include interactions with a dummy variable *Distress* equal 1 if the average Altman z-score during $t - 2$ and $t - 1$ is below 1.23. We define firms as not distressed (*No Distress* = 1) if the average Altman z-score during $t - 2$ and $t - 1$ is above 1.23. In Panel B, we additionally include interactions with a dummy variable *Low Productivity* equal 1 if the average productivity during $t - 2$ and $t - 1$ is below the median within the country–industry–year–loss group. We define firms as high-productivity firms if they are above the median. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Investment_t</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i> × <i>Distress</i>	0.0088*** (0.0032)	0.7790*** (0.2573)
<i>Refund</i> × <i>LCB</i> × <i>No Distress</i>	0.0026 (0.0016)	0.2572** (0.1110)
<i>Difference in Coefficients</i>	0.0062** (0.0030)	0.5218** (0.2594)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	3,460,691	3,460,691
Adj. R ²	0.259	0.259
Panel B: Split on firm-level productivity		
<i>Refund</i> × <i>LCB</i> × <i>Low Productivity</i>	0.0047** (0.0023)	0.5563*** (0.1796)
<i>Refund</i> × <i>LCB</i> × <i>High Productivity</i>	0.0023 (0.0020)	0.2295* (0.1321)
<i>Difference in Coefficients</i>	0.0024 (0.0022)	0.3268* (0.1971)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	3,382,171	3,382,171
Adj. R ²	0.263	0.263

We next compare the investment response of low- and high-productivity firms to corroborate the notion that the investment effect is concentrated in firms with strong incentives

to engage in risky and potentially inefficient overinvestments. Prior literature finds that low-productivity firms are riskier (Imrohoroglu and Tüzel 2014) and make less efficient investment decisions, for example, because they employ less sophisticated management techniques (Bloom et al. 2010, 2017). Following prior literature (Chemmanur, He, and Nandy 2010, Cappellari, Dell’Arling, and Leonardi 2012, Kim and Ouimet 2014, Krishnan, Nandy, and Puri 2015), we define firm-level total factor productivity (*Productivity*) as the residual of a Cobb–Douglas production function where we regress value added on capital and labor proxied by fixed assets and wage expenses, respectively. We estimate this firm-level regression separately for each country–industry–year group. Thus, our measure can be interpreted as the relative productivity of a firm within its industry in any given year. This reduces concerns that our measure reflects differences in the capital or labor intensity of a firm that is industry-(year-)specific. For further details on the estimation of *Productivity*, see Appendix B.4. We define *Low Productivity* as an indicator variable equal to one for firms with average productivity below the median productivity in their country–industry in $t - 1$ and $t - 2$. We define this separately for loss-making and profitable firms. Otherwise, we would have very few high-productivity (low-productivity) loss (profitable) firms. We interact *Low Productivity* with *Refund*, *LCB*, and *Refund* \times *LCB* and rerun our main analysis. Panel B of Table 3.8 presents the regression results. Consistent with the evidence for distressed firms, the investment response is mostly driven by firms with low average productivity and is much weaker for high-productivity firms.

Overall, our findings indicate that firms with incentives to inefficiently overinvest drive the average investment response, while non-distressed high-productivity firms rather hoard the refunds as cash or pay it out to shareholders. The findings suggest that the financial constraints of loss firms are, on average, efficient. Put differently, providing refunds to loss firms unconditional on future profitability may have distortive effects because government funds are (partly) misallocated to firms prone to engaging in inefficient overinvestment (i.e., loser firms

in Auerbach 1986). We attempt to validate this interpretation by examining the firm- and industry-level implications of such misallocation in the following section.

3.4 Competitive Selection and Output Effects

3.4.1 *Distortion of Competitive Selection along the Exit Margin*

We document that a less restrictive allocation of government funds in carryback regimes to loss firms leads to greater investment. One interpretation of this result could be that refunds alleviate financing frictions resulting from potential inefficiencies in the capital market due to, for example, adverse credit supply shocks during economic downturns. This interpretation implies that a less restrictive allocation of government funds to loss firms potentially fixes misallocation and thereby reduces underinvestment. This view is articulated by policymakers such as the Australian government, which argued that the 2012 loss carryback introduction “provide[s] much-needed assistance to nearly 110,000 companies [...], helping them ride out difficult times and invest for the future, helping to boost their productivity.”⁶⁷

An alternative explanation could be that tax refunds loosen the efficient financing constraints of loss firms and thereby lead to inefficient investments. This could be due to incentives to invest in the negative-NPV projects of distressed firms because the risk associated with new investments increases owners’ option value of equity. Alternatively, poor management practices that have led firms into a loss could lead loss firms to make less efficient investment decisions.

Two previously presented results support the notion that tax refunds repeal efficient rather than inefficient financing constraints: First, we find that most of the average investment responses can be explained by the investments of distressed and low-productivity firms. Firms

⁶⁷ Assistant Treasurer David Bradbury, Exposure Draft Legislation and Explanatory Material for Company Loss Carry-Back, August 23, 2012, available at <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2012/091.htm&pageID=003&min=djba&Year=&DocType>, last accessed August 25, 2017.

with no financial distress and more productive firms appear to keep the tax refund as a cash buffer or to return most of the tax refund to their shareholders, suggesting that they lack positive-NPV internal investment opportunities. Second, we find that the investment effect is not significantly stronger during crises (as discussed in footnote 16), where capital market inefficiencies seem most plausible. Taken together, an alternative interpretation of a less restrictive allocation of tax refunds to loss firms is that it represents misallocation because it subsidizes less productive firms and delays the displacement of low-productivity firms by more productive firms (e.g., Disney, Haskel, and Heden 2003, Foster, Haltiwanger, and Krizan 2006).

A testable implication of this interpretation is a distorted selection of operating firms along the exit margin within an industry. To this end, we examine the effect of tax refunds on the exit rates of loss firms. We start by regressing an indicator, *Exit*,⁶⁸ equal to one if a firm exits the market in t because of bankruptcy, insolvency, or liquidation on the interaction of $Refund \times LCB$. To the extent refunds subsidize the risky, negative-NPV projects of inefficient firms, it is unclear whether the additional investment and risk accelerate or delay their exit. The results reported in columns (1) and (3) of Table 3.9 show that, on average, loss carryback provisions decrease the exit probability of loss firms in the period after the loss. This effect is a function of the size of the tax refund. Increasing the tax refund by one standard deviation (0.33% of total assets) leads to a reduction in exit probabilities equal to 27 basis points, which represents 23% of the average exit probability. Given the positive investment effect that we observe for the average firm, one could view the prolongation of exits as somewhat expected. Therefore, we also interpret our results as support for the validity of our exit measure. Alternatively, to the

⁶⁸ We measure exit rates with the legal status variable that is provided by the Amadeus database. The indicator variable *Exit* is equal to one for the last year for which we have data on a firm with a current legal status of “dissolved” (about 29% of all exiting firms), “in liquidation” (about 26%), “active (insolvency proceedings)” (about 13%) “dissolved (bankruptcy)” (10%), “bankruptcy” (10%), “dissolved (merger or take-over),” “dissolved (liquidation),” “active (default of payments),” or “dissolved (merger)” and zero otherwise. In our sample, we observe an average exit rate of about 1.2% (see Panel A of Table 3.3). Note that firms are deleted from the Amadeus data set for which no financial data are available for the last six years. This biases our exit probability downward in earlier periods of our sample. While exit rates range between 0.5% and 1.1% during 2005–2009, they range between 1.9% and 2.9% during 2010–2012.

extent firms suffer from inefficient financial constraints, the results could be interpreted as evidence of loss carryforward regimes being too restrictive because they condition on realizations and not expectations of future profitability.

To test whether the higher survival rate resolves financing frictions created by market imperfections or loosens efficient financing constraints that could ultimately delay the exit of low-productivity firms, we exploit cross-sectional variation in firm-level productivity. Our starting point is the finding from prior literature that low-productivity firms are more likely to exit the market (e.g., Syverson 2011). If carrybacks resolve inefficient financing frictions, we expect the negative relation between exit and productivity to be exacerbated because of strengthened competition. In contrast, if carrybacks subsidize and delay the exit of low-productivity firms, the negative relation between exit and productivity should be attenuated.

We follow the definition of low-productivity firms from section 3.3.6 and set *Low Productivity* equal to one for firms with an average productivity below the median productivity in their country–industry in $t - 1$ and $t - 2$. We define this separately for loss-making and profitable firms. We regress *Exit* on the triple interactions of *Low Productivity* and *Refund* \times *LCB* while controlling for all double interactions with *LCB* and *Refund*. We expect low-productivity firms to be more likely to exit in carryback countries. While the coefficient *Low Productivity* captures the exit probability of profitable low-productivity firms in loss carryforward countries, *Refund* \times *Low Productivity* captures the exit probability of low-productivity *Refund* firms in loss carryforward countries. While we do not have a prediction for the coefficient of *Low Productivity*, we expect a positive sign for *Refund* \times *Low Productivity*. If carrybacks subsidize and delay the exit of low-productivity firms, we expect this effect to be less pronounced in loss carryback countries. Thus, we expect a negative sign for the coefficient of the triple interaction *Refund* \times *LCB* \times *Low Productivity*.

Table 3.9: Tax Refunds, Productivity, and Exit of Firms

This table presents the regression results for exits in 2005–2013. We use *Exit* as our dependent variable, a dummy variable equal to one if the firm exits the market and zero otherwise. *Low Productivity* equal 1 if the average productivity during $t - 2$ and $t - 1$ is below the median within the country–industry–year–loss group. Columns (1) and (2) use a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Columns (3) and (4) use a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year’s loss multiplied with the prior year’s statutory tax rate) for all eligible loss firms. We interact *Low Productivity* with $Refund \times LCB$. The main effects are included in the model but are not reported in this table. We control for firm variables in $t - 1$ and country variables in t . We interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all the specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Exit_t</i>			
	<i>Refund =</i>			
	<i>Dummy</i>		<i>Cash Equivalent</i>	
	(1)	(2)	(3)	(4)
(I) <i>Refund</i> × <i>LCB</i>	-0.0061** (0.0025)	-0.0054** (0.0027)	-0.8194*** (0.2228)	-0.7254*** (0.2307)
(II) <i>Refund</i> × <i>Low Productivity</i>		0.0086*** (0.0009)		0.7630*** (0.0924)
(III) <i>Refund</i> × <i>LCB</i> × <i>Low Productivity</i>		-0.0100*** (0.0028)		-0.9836*** (0.2622)
(V) <i>LCB</i> × <i>Low Productivity</i>		-0.0002 (0.0010)		-0.0003 (0.0009)
<i>Sum of coefficients (II) + (III)</i>		-0.0013 (0.0026)		-0.2206 (0.2508)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included				
Observations	4,532,131	3,429,419	4,532,131	3,429,419
Adj. R ²	0.124	0.116	0.124	0.115

The results are reported in columns (2) and (4) of Table 3.9. The positive coefficient of $Refund \times Low Productivity$ suggests higher exit probabilities for *Refund* firms in loss carryforward countries. The relation between *Low Productivity* and exit is attenuated in loss carryback countries, as suggested by the negative coefficient of $Refund \times LCB \times Low Productivity$. The sum of the two coefficients suggests that the relation between low productivity and exits diminishes for *Refund* firms in loss carrybacks countries.⁶⁹ Further, in support of the parallel trends assumption, there are no differences in the exit probability of low-

⁶⁹ Table B.15 of the Appendix reports robustness to using a continuous variable to proxy for a firm’s productivity.

productivity firms with $Refund = 0$ between loss carryback countries and countries that only allow a loss carryforward, as suggested by the coefficient of $LCB \times Low\ Productivity$.

Taken together, our results reveal that tax refunds from loss carrybacks delay the exit of low-productivity firms relative to a loss carryforward system granting refunds only conditional on future success. This result is consistent with misallocation affecting the competitive selection of operating firms in an industry.

3.4.2 Productivity and Aggregate Output Effects

In our final set of tests, we examine how these effects of granting a loss carryback provision to loss firms map into aggregate productivity and output. Assuming that the delay in the exit of low-productivity firms prevents the entry of more productive firms or the takeover of market share by more productive incumbents, we expect to observe lower average productivity in loss carryback countries unless a portion of the increased investment enhances productivity. We test this notion using country–industry-level information and estimating the following model:

$$\begin{aligned}
 DepVar_{j,m,t} = & \alpha_0 + \alpha_i + \alpha_{j,m,t} + \beta_1 \times Refund\ Frequency_{j,m,t} \\
 & + \beta_2 \times Refund\ Frequency_{j,m,t} \times LCB_{i,t} + \sum_k \gamma_k X_{k,i,t-1} \\
 & + \sum_l \delta_l C_{l,j,t} + \sum_l \delta_l C_{l,j,t} \times Refund\ Frequency_{i,t} \\
 & + \sum_l \phi_n X_{k,i,t-1} \times Refund_{i,t} + \varepsilon_{i,t}
 \end{aligned} \tag{2}$$

where we use two different dependent variables $DepVar_{j,m,t}$. We first examine *Average Productivity*, which is defined as the annual average productivity in each country–industry in period t (the year of the tax refund and potential investment effect) and in year $t + 1$. The second dependent variable is *Aggregate Output*, which is defined as the logarithm of the sum of sales in each country–industry–year cluster. Our variable of interest is the interaction of LCB and *Refund Frequency*. The variable *Refund Frequency* is defined as the sales-weighted relative *Refund* frequency in each country–industry–year group. We expect lower productivity and less

aggregate output if there are more *Refund* firms in a country–industry–year ($\beta_1 < 0$). This negative relation is expected to be more negative in loss carryback countries, since loss carryback provisions delay the exit of low-productivity firms and prevent the entry of more productive firms ($\beta_1 < 0$).

We control for country and industry–year fixed effects to control for all observable and unobservable country and industry–year specific factors that could affect average productivity at the country–industry level. Moreover, $X_{k,i,t-1}$ represents a vector of country–industry–year-specific factors (the logarithms of the sum of total assets, of the sum of cash, and of the sum of fixed assets) that could influence productivity and output. The term $C_{l,j,t}$ represents the same vector of country controls that we use in our main analysis. As in our main analysis, we interact *Refund Frequency* with all country controls. We cluster standard errors at the country–industry level.

The results are reported in Table 3.10. In columns (1) and (2), we observe a decline in average productivity in the year of the tax refund and the previously documented investment effect. A one standard deviation increase in *Refund Frequency* (an increase of 11.92 percentage points) is associated with a reduction in average productivity of 0.025, which is equal to 12% of the standard deviation in average productivity.

In columns (3) and (4), we use *Aggregate Output* as the dependent variable. The results suggest a decline in aggregate sales in the year of the tax refund and in subsequent periods. The results indicate that a one standard deviation increase in the refund frequency is associated with a decline in aggregate sales of 9% in the year of the tax refund and a decline of 15% in the subsequent period.⁷⁰

⁷⁰ The magnitude is calculated based on the standard deviation of *Refund Frequency* of 0.1192 as $\exp(1.415 \times 0.1192) - 1$.

Table 3.10: Aggregate Output Response

This table presents the regression results for aggregate output and productivity in 2005–2013. We use *Aggregate Output (Average Productivity)* as our dependent variable, which represents the logarithm of the sum of sales (average productivity) in each country–industry–year group. We control for the logarithm of the sum of total assets, cash, and fixed assets of each country–industry–year. *Refund Frequency* is defined as the sales weighted relative *Refund* frequency in each country–industry–year group. We interact *Refund Frequency* with *LCB* and all country control controls. The main effects are included in the model but are not reported in this table. We control for all variables in period $t - 1$. We include country and industry–year fixed effects. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable:</i>			
	<i>Average Productivity_t</i>	<i>Average Productivity_{t+1}</i>	<i>Aggregate Output_t</i>	<i>Aggregate Output_{t+1}</i>
	(1)	(2)	(3)	(4)
<i>Refund Frequency</i> × <i>LCB</i>	-0.2099** (0.1011)	-0.1433 (0.1024)	-0.7907** (0.3794)	-1.4152*** (0.4318)
<i>Refund Frequency</i>	-2.7578*** (1.0489)	-0.6899 (0.8739)	-5.5203* (3.3135)	-5.2988 (3.5471)
Country–industry controls in $t - 1$ & Country controls & <i>Refund</i> interactions with country controls & country fixed effects & industry–year fixed effects included				
Observations	3,141	3,141	3,141	3,141
Adj. R ²	0.264	0.240	0.945	0.909

Taken together, this evidence indicates that the costs of granting tax refunds to loss firms translate to the product market when losses materialize. While there is an increase in investments, especially distressed and low-productivity firms use the tax refunds from loss carrybacks for capital investments. This is ultimately associated with a delay in the exit of low-productivity *Refund* firms in loss carryback countries. The results in this section further suggest that this phenomenon maps into adverse effects on average productivity and aggregate output in loss carryback countries. Our identification tries to difference out the beneficial ex ante effects on risk taking stemming from a more symmetric tax loss regime (i.e., carrybacks). Therefore, our evidence of the cost of a less restrictive loss offset regime should be interpreted as a complement to the ex ante benefits documented by prior literature.

3.5 Conclusion

This paper examines the relation between the asymmetric treatment of tax losses and the investment of loss firms by comparing firms that can carry back tax losses and receive a refund

of previously paid taxes with firms that can only carry forward tax losses to reduce their tax payments on future profits. We show that the additional cash resulting from the refund of previously paid taxes stimulates the investments of unprofitable firms. We document that the effect of loss carrybacks on loss firms' investment matches the timing of the tax refund and increases with its size. We find that about one-third of the tax refund is actually used for capital investments. About 33% of the tax refund is set aside as a cash buffer and 26% of the cash refund is returned to shareholders.

A key contribution of our paper is that we highlight and show that this investment response of loss firms is not unambiguously desirable. We show that the investment response is driven primarily by firms that are prone to engage in risky overinvestment. That is, the loosening of such firms' financial constraints likely represents misallocation. We corroborate this notion by documenting a channel through which misallocation would manifest: the weakening of the competitive selection of firms operating in an industry. Our results suggest that, by providing liquidity irrespective of future prospects, carrybacks delay the exit of low-productivity firms. We also show that this weakened competitive selection maps into lower average productivity and aggregate output at the industry level.

Our findings are relevant for policymakers, since unprofitable firms represent a substantial part of the overall firm population and their investment behavior has a substantial impact on the performance of the overall economy, particularly during economic downturns. Loss carryback rules provide earlier and less restrictive liquidity to unprofitable firms and thereby alleviate financial constraints. This facilitates investments in the period after a loss and reduces the likelihood of loss firms exiting the market. The provision of unconditional liquidity can come at the cost of reduced competition, since loss firms survive longer despite their low productivity. Our results thus suggest that loss firms do not suffer severely from financing frictions resulting from imperfect capital markets. Instead, loss firms' financing frictions that are alleviated by

loss carrybacks appear to exist because of certain firm characteristics such as low productivity or distress.

Drawing conclusions about the welfare effects of resolving the asymmetric treatment of tax losses using carrybacks versus carryforwards and accounting for associated governmental costs goes beyond the scope of this paper. This paper studies the investment response of loss firms. We show that there are costs (increased government spending, potential competitive distortions, lower output increases than in other firms) and benefits (higher investment of loss firms) of allowing loss firms to carry back losses. Prior literature finds that a less restrictive loss offset regime has benefits from encouraging the ex ante risk taking of the average firm. Hence, we view our paper as a necessary complement of an overall net benefit comparison of tax loss regimes. Our findings could therefore explain why Australia repealed its tax loss carryback provisions only two years after their introduction because it was “too costly.”⁷¹ Whether resolving the asymmetric tax treatment by providing liquidity to loss firms through loss carryback provisions is welfare enhancing or not is an interesting avenue for future research. Our results on firm investments, exits, productivity, and output add important input for such analyses.

⁷¹ An annual cash impact of AU\$300 million was estimated. See Treasurer Joe Hockey, Repeal of the Minerals Resource Rent Tax, July 18, 2014, available at <http://jbh.ministers.treasury.gov.au/media-release/034-2014/>, last accessed August 25, 2017.

4 Taxation of Foreign Earnings and the Competitiveness of Multinationals: Evidence from the U.K.⁷²

4.1 Introduction

There is an ongoing political and academic discussion about the optimal taxation of foreign profits. The two competing systems in place are the territorial and the worldwide tax regime. Under a territorial tax regime, only domestic corporate profits of multinational firms are taxed while foreign profits are excluded from the tax base. Most countries in Europe, the OECD, and around the world follow this principle. Under a worldwide tax regime both national and foreign corporate profits are taxed at the national rate but a credit is given for foreign taxes paid (usually capped at the national rate). The most prominent country with a worldwide tax regime are the United States.

The difference between the two systems lies in the taxation of foreign earnings, which is of growing concerns to national governments in order to attract multinational enterprises (MNE). Both tax regimes violate, however, the market neutrality principle developed by Devereux (2008) that suggests that firms should face the same tax burden if they compete in the same market. While territorial taxation ensures capital export neutrality, that is all firms that invest in the same location face the same tax burden (Richman 1963, Musgrave 1969), it represents a competitive disadvantage for solely domestic firms. Worldwide taxation, on the other hand, guarantees capital export neutrality because all firms in the same country of residence face the same tax burden irrespective of the location of their operations (Richman 1963, Musgrave 1969). However, worldwide taxation represents a tax induced competitive disadvantage for multinationals in foreign markets with a lower tax rate. Following this reasoning, the HM

⁷² This chapter is based on Bethmann and Simmler (2017), Taxation of Foreign Earnings and the Competitiveness of Multinationals: Evidence from the U.K. Working Paper. The paper has been presented at the 7th Conference on Current Research in Taxation in Vienna and in internal seminars at the Oxford Centre for Business Taxation, and WHU – Otto Beisheim School of Management.

4 Taxation of Foreign Earnings and the Competitiveness of Multinationals: Evidence from the U.K.

Treasury suggested a change from worldwide to territorial taxation for the U.K. in 2007 arguing that the worldwide taxation system “hinders the competitiveness of U.K. based multinationals”.⁷³ Our paper aims to shed light on this argument by investigating whether the competitiveness of U.K. subsidiaries increased after the regime change, which would lead to a crowding out of competing firms in foreign markets.

We start by setting up a stylized theoretical model to understand the distortion induced by a worldwide and territorial tax regime and the implications for firm behavior in case of a regime change. We analyze the location and production decision of a multinational that wants to serve a foreign market and where the parent company is subject to a worldwide tax regime.

Under worldwide taxation and in countries with a tax rate below the parent’s tax rate, foreign profits will be subject to a higher rate than that of their foreign competitors that are solely taxed in the foreign jurisdiction because repatriation taxes will be levied upon repatriation. In countries with a tax rate equal to or above the parent’s tax rate, foreign subsidiaries of MNEs are subject to the same rate as their competitors. There are no incentives to outsource production to a country with a lower tax rate as long as transport costs exceed the tax benefits resulting from the difference between the tax rate in the country of the market that the MNE serves and the parent’s tax rate.

A regime replacement from worldwide to territorial taxation changes two things: First, it reduces the tax rate on corporate profits in countries where the tax rate is lower than the rate in the parent company country.⁷⁴ Second, real activity is re-located from higher-tax towards lower-tax countries as the subsidiaries now benefit from lower tax rates. Both effects increase output of MNEs in foreign markets. In the low-tax country the effect is driven by a reduction in the

⁷³ See HM Treasury, 2009, available at <http://webarchive.nationalarchives.gov.uk/20140109143644/http://www.hmrc.gov.uk/ria/foreign-profits.pdf>, p. 4, last accessed August 25, 2017.

⁷⁴ It may as well reduce effective tax rates in other countries if the multinational engages in profit shifting (see e.g., Markle 2016, Maffini and Mokkas 2011).

tax burden. In high-tax countries the effect is driven by a reduction in costs resulting from outsourcing of the production into low-tax countries. Assuming a Cournot type competition with fixed costs of entry, our model predicts that the output of competitors decreases as do prices in foreign markets. Since the marginal entrant is not generating profits in equilibrium, this means that the number of competitors needs to decline.

We test the assumptions of the decline (increase) in capital in high-(low-)tax countries as well as the predictions of an increase in output and decline in the number of competitors of our model using different data sets. Our identification strategy exploits the regime change in the U.K. in 2009. We compare U.K. subsidiaries (or industries with a high share of U.K. subsidiaries) with other firms (other industries) in foreign markets before and after the reform which results in the following three findings: First, we show an increase in the share of low-tax subsidiaries relative to all subsidiaries of U.K. multinationals relative to other multinational firms starting in 2008. This could be explained by the fact that U.K. multinationals acquire new subsidiaries in low-tax countries as suggested by Feld et al. (2016).

Second, firm-level estimations reveal that output increases for U.K. subsidiaries compared to other MNEs and domestic firms in foreign markets. In line with our predictions, we find a decline in capital expenditures in high-tax countries and some evidence for a corresponding increase in low-tax countries. The effect in low-tax countries could be offset by a decline in overinvestment in low-tax countries as suggested by e.g., Egger et al. (2015), Hanlon, Lester, and Verdi (2015) and Edwards, Kravet, and Wilson (2016). Moreover, to the extent that sales increase in newly established or acquired subsidiaries (see e.g., Feld et al. 2016), we do not observe this with our data.

Third, we investigate firm entry and exit on a two-digit industry level. Conditional on a full set of country–one-digit industry–year fixed effects, we find that net entries decline after the 2009 reform in markets with a high share of U.K. subsidiaries. In other words, replacing the

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worldwide with a territorial tax regime increases the competitiveness of U.K. subsidiaries, which has adverse effects on the number of competitors. The effect is mostly driven by a decline in entries rather than increases in exits.

Our work contributes to the prior literature in multiple ways. Several papers have so far studied the regime change in the U.K. and Japan with its impact on firms' payout policy being mostly undisputed. Arena and Kutner (2015)—using consolidated accounting data—and Egger et al. (2015)—using firm-level data from Amadeus—provide evidence that dividend payouts increased after the introduction of the territorial regime. This is consistent with prior studies arguing that higher repatriation costs reduce payouts (Desai, Foley, and Hines 2009, Altshuler and Grubert 2003) and increase cash holdings (Foley et al. 2007).⁷⁵ Arena and Kutner (2015) and Egger et al. (2015) further agree on finding negative investment effects abroad, which they explain with inefficient overinvestment before the reform. This fits with the results by Hanlon, Lester, and Verdi (2015) and Edwards, Kravet, and Wilson (2016) who show that U.S. firms with a high level of locked-out foreign earnings make less profitable acquisitions of foreign target firms suggesting that this is driven by agency problems resulting from high foreign cash holdings. Two studies, who find positive investment effects, are developed by Feld et al. (2016) and Liu (2017). Feld et al. (2016) show that the regime change in Japan and the U.K. in 2009 lead to an increase in the number of foreign acquisitions by Japanese and British firms. Liu (2017) investigates in a similar spirit to Egger et al. (2015) the investment pattern of U.K. subsidiaries using firm-level data. She finds evidence for an increase in foreign investment in low-tax countries but no corresponding decrease in high-tax countries. She theoretically explains the findings by the reduction in the tax costs of new-equity-financed investment.

⁷⁵ This effect is further intensified by accounting rules that allow corporations to avoid financial accounting income tax expenses (Graham et al. 2013).

Our study brings the existing evidence closer together by adding the location decision into the picture. We outline that the investment response is likely to be different in low-tax and high-tax countries. In low-tax countries the cost effect dominates as suggested by Liu (2017). In high-tax countries, the relocation of production towards low-tax countries in contrast decreases investment but increases sales. The latter effect is consistent with the increase in the sales-to-fixed assets ratio as reported by Egger et al. (2015).

Another reason for an increased competitiveness of MNEs after the reform could be the higher incentives to shift profits into low-tax jurisdictions under territorial taxation (Markle 2016, Maffini and Mokkas 2011).⁷⁶ According to Sorbe and Johansson (2017) better tax planning possibilities could lead to a better competitive position of firms. However, as pointed out by the authors themselves, their empirical approach does not allow them to rule out reverse causality. Kubick et al. (2015) and Dyreng et al. (2017) assume the opposite direction arguing that firms' market power is a key determinant in firms' tax avoidance behavior.⁷⁷ Our study argues that the better competitive position of MNEs after the switch to territorial stems from a reduction in costs resulting from the reduction in the tax burden in low-tax countries and a relocation of production to lower tax jurisdictions. However, the relocation of production could come along with an increase in profit shifting. Thus, we acknowledge that we cannot fully rule out that the reduction in the tax burden in high-tax countries does not only stem from a relocation of real activities to low-tax countries but also from an increase in profit shifting from high-tax to low-tax countries. Both will lead to a reduction in costs and could thereby potentially

⁷⁶ Following Grubert and Slemrod (1998) this should lead to higher investments in low-tax countries in order to exploit profit shifting possibilities. However, Hong and Smart (2010), Dobbins and Jacob (2016) and Simmler (2015) argue that profit shifting possibilities encourage capital spending in high-tax countries, a finding that we do not observe in the data.

⁷⁷ They do, however, not agree on whether the effect is positive or negative. Kubick et al. (2015) suggest that firms with a higher market power engage in more tax avoidance because their market power hedges them against the risk associated with tax avoidance. Dyreng et al. (2017) provide analytical as well as empirical evidence that firms with a higher market power engage in less tax avoidance because they can shift the tax incidence to their consumers or employers. The authors argue that the contradicting findings could be explained with the failure to control for political and agency costs that are potentially correlated positively with market power (gross margin) and negatively with tax avoidance in Kubick et al. (2015).

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strengthen the competitive position of MNEs. On the other hand, the increased market power of U.K. multinationals could lead to a reduction in tax avoidance as suggested by Dyreng et al. (2017) because firms are better able to shift the tax burden to either consumers or employees.

Our work further contributes to the literature that investigates the impact of taxation on industry dynamics or more precisely the competitive position of firms within a market. Taxes affect firms' production costs and thus output if markets are not perfectly competitive (otherwise taxable profits would be zero). In a very recent contribution, Brekke et al. (2017) analyze the impact of different corporate tax systems (ACE versus CBIT) on market dynamics (number of competitors and prices). They assume, however, that all firms face the same tax system in a particular market.

The remainder of the article is structured as follows. In section 4.2, we give a brief summary of the study's institutional background. The theoretical model is presented in section 4.3. The empirical firm-level and industry-level analysis is reported in section 4.4, and 4.5. Section 4.6 summarizes our findings.

4.2 The U.K.'s Reform of Taxing Foreign Profits

In the following section, we briefly describe the tax regime for foreign profits in the U.K. before and after the reform change. Until 2009, the U.K. operated a worldwide taxation system for the taxation of foreign profits. Under this tax regime, profits generated by foreign subsidiaries of U.K. resident companies are subject to corporate taxes at the level of the parent, while a credit for foreign taxes paid is provided. Under a territorial system, profits generated by foreign subsidiaries are in general exempt from taxation at the parent level. To illustrate the difference, let us assume a subsidiary of a U.K. parent in 2008 that is located in Ireland. Under both regimes, profits of the Irish subsidiary are taxed at the Irish corporate tax rate of 12.5%.

Under a territorial regime, this is the final tax burden.⁷⁸ Under a worldwide system, the profits are also taxed in the parent company country at the domestic rate. Thus, for profits of 100, there will be a tax liability of 15.50 (28 - 12.50) in the U.K. additional to the tax liability of 12.50 in Ireland.

The scientific community in favor of the worldwide tax system argues in line with Musgrave (1969) that a worldwide tax system ensure production efficiency by means of capital export neutrality. The territorial tax system, in contrast, ensures capital import neutrality (or ownership neutrality). In reality, none of the system is implemented in a clean way. First, under a worldwide tax system profits are usually only taxed when repatriated. Second, credit of foreign taxes is limited to the national rate. Thus, if foreign taxes are higher than the corporate tax at the parent level, worldwide and territorial tax regimes lead to the same outcome. Further, if profits are distributed from a higher tax and a lower tax country, no additional tax burden may arise for the payout from the low-tax country if the weighted tax rate is not higher than the tax rate in the country of the parent company.⁷⁹

These practical difficulties have also been known to the British tax authorities, as they argued that the U.K. worldwide system has not been able to secure capital export neutrality because multinational groups take advantage of mixing, defer the repatriation of offshore profits or remit profits in non-taxable form.⁸⁰ Given these concerns and the willingness to enhance the competitiveness of U.K. multinationals, the HM Treasury and HMRC issued a discussion

⁷⁸ Dividend payments to some countries could be subject to additional withholding taxes in Ireland, and in some cases, dividends are not fully exempted but only to 95% in the receiving country. Further, if the profits stem from passive sources, controlled foreign company rules could trigger an additional tax burden in the parent country – independent of repatriation.

⁷⁹ Unlike the US that allows firms to average their worldwide foreign tax liabilities to claim the tax credit, the U.K. had a per country limitation that limits average foreign taxes to tax liabilities from the same country. This limitation was, however, not binding as a holding company in between the subsidiaries and the parent company could be set up to ‘mix’ the dividends outside the U.K..

⁸⁰ HM Treasury, June 2007, http://www.hm-treasury.gov.uk/d/consult_foreign_profits020707.pdf, p. 10.

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document in June 2007 proposing to switch to a territorial regime.⁸¹ Since most other countries in the European Union operate a territorial system, policy makers as well as economists supported the change to a territorial system to repeal the competitive disadvantage of U.K. owned MNEs that earn lower after-tax returns on foreign operations in low-tax countries relative to MNEs from territorial tax countries (Griffith, Hines, and Sørensen 2010). While the regime change to territorial was largely anticipated in 2008, the new rule for dividend exemptions was released on December 9, 2008 with the Finance Bill 2009 and then became effective on July 1, 2009.

4.3 Theory and Hypothesis Development

In the following section, we set up a stylized theoretical model to investigate location and production decisions in foreign markets of multinationals under territorial and worldwide taxation regimes. Moreover, we analyze the behavior of (domestic) competitors in the respective markets.

Let us start by assuming a MNE that is headquartered in u wants to serve the market in the high-tax country h and faces the choice between (setting up a subsidiary and) producing in low-tax country l or in h . The output price is given by p_h . If the multinational firm produces in l , it sells the output to a (trading) subsidiary in h and incurs transport costs per output unit of m . To simplify things, we assume that all profits are taxed in the country of the production and that the transport costs are deducted from the final price.⁸² In our simplified model, the production function depends only on capital, k , which is financed by new equity. We assume constant returns to scale for capital. Countries l and h are characterized by a tax rate (τ_i) and a share of non-deductible costs c from the tax base, which we assume to be the same in both countries for

⁸¹ Taxation of the foreign profits of companies: a discussion document, June 2007, available at <https://www.treasurers.org/ACTmedia/TaxationForeignProfits.pdf>, last accessed August 25, 2017.

⁸² This rules out price distortions due to profit shifting, although this is likely to be true in reality it is unlikely to explain the empirical finding for the regime changes so far.

simplicity. We assume that for the same amount of sold output the subsidiaries' after tax-profits are larger the lower the tax rate.

After tax profits under a territorial tax regime (T) when production takes place in $i = l, h$ are given by equation (1), with $p_l = p_h - m$. Although it will be shown later in the Cournot model that the output price p_h depends on the output decision, we assume the output price to be the same, independent whether production takes place in l or h . This seems reasonable as long as the MNE output is sufficiently small compared to the overall output.

$$\pi_{T,i} = (1 - \tau_i)[p_i F(k_i, g_i) - (1 - c)k_i] - ck_i \quad (1)$$

Under a worldwide tax system (W) when production takes place in $i = l, h$, after tax profits are given by equation (2), with $p_l = p_h - m$, and u indicates the country of the parent company. We assume immediate repatriation to the parent.

$$\pi_{W,i} = (1 - \max(\tau_i, \tau_u))[p_i F(k_i, g_i) - (1 - c)k_i] - ck_i \quad (2)$$

Location Decision under Territorial Taxation

Given the after-tax profits (and the constant returns to scale assumption), we start by determining the location of production. Comparing $\pi_{T,h}$ to $\pi_{T,l}$ shows first that the MNE will only produce in l if tax rates are lower in l compared to h since transport costs are strictly positive (see equation (3)) and by assumption $\pi_{T,l}(\tau_l, p_h) > \pi_{T,h}(\tau_h, p_h)$ if and only if $\tau_l < \tau_h$. Further, we can re-arrange the profits in l and h to show explicitly, that the MNE will produce in l if the tax penalty from producing in h (left term in equation (5)) exceeds the after-tax transport cost penalty from producing in l (right term in equation (5)). Table 4.1 summarizes the different cases for the location under a territorial and worldwide tax regime. If $\tau_l < \tau_h$ and transport costs $m < m^{**}$ with m^{**} such that $\pi_{T,l}(\tau_l, p_h - m^{**}) = \pi_{T,h}(\tau_h, p_h)$, the MNE will produce in l , otherwise, the MNE will produce in h .

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$$\pi_{T,l}(\tau_l, p_h - m) > \pi_{T,h}(\tau_h, p_h) \quad (3)$$

$$\pi_{T,l}(\tau_l, p_h) - (1 - \tau_l)mF_l > \pi_{T,h}(\tau_h, p_h) \quad (4)$$

$$(\tau_h - \tau_l)[p_h F_h - (1 - c)k_h] > (1 - \tau_l)mF_l + [(1 - \tau_l)p_h(F_h - F_l) - (1 - \tau_l(1 - c))(k_h - k_l)] \quad (5)$$

Location Decision under Worldwide Taxation

We compare the derived condition with the optimal production location if the MNE is subject to a worldwide tax regime. By definition, the worldwide regime is always binding in the low-tax country (i.e., $\tau_l < \tau_u$) and the tax burden in the low-tax country is always lower than in the high-tax country ($\tau_l < \tau_h$). If the regime is not binding, after tax profits are the same under worldwide and territorial taxation. Starting from the inequality in equation (6), we can replace $\pi_{W,l}(\tau_u, p_h - m)$ with $\pi_{W,l}(\tau_l, p_h)$ net of the after tax transport costs $((1 - \tau_l)mF_l)$ and net of the tax penalty due to the binding worldwide regime $((\tau_u - \tau_l)[(p_h - m)F_l - (1 - c)k_l])$ (see equation (7)). Since the new tax penalty term is positive, it is obvious that under a worldwide regime it is less likely that the MNE produces in the low-tax country l . This is the case as the MNE does not benefit from the low tax rates but still incurs transport costs. Under a worldwide tax regime, the MNE will always produce in h , unless $\tau_u < \tau_h$ and $m < m^*$ such that

$$\pi_{W,l}(\tau_u, p_h - m^*) = \pi_{T,h}(\tau_h, p_h).$$

$$\pi_{W,l}(\tau_u, p_h - m) > \pi_{T=W,h}(\tau_h, p_h) \quad (6)$$

$$\pi_{W,l}(\tau_l, p_h) - (1 - \tau_l)mF_l - (\tau_u - \tau_l)[(p_h - m)F_l - (1 - c)k_l] > \pi_{T=W,h}(\tau_h, p_h) \quad (7)$$

Output Decision and Production Location

Let us now turn to the output decision of the MNE. We assume Cournot competition in the foreign market and assume that there are $N-1$ domestic competitors. Their tax rate on profits is τ_h ; otherwise they are identical to the U.K. subsidiary. We assume the following price function, $p = a - bQ$ with Q being the overall demand. We solve for the optimal output by deriving the FOC of the MNE's and the competitor's profits with respect to k while taking into account the strategy of the other firm(s). The results are given in Table 4.1.

Comparing the output in high-tax country h under the worldwide and territorial tax regimes shows that a regime change increases output of the MNE by $N\{UCC_{parent} - UCC_h\}/b(N+1)$ and furthermore decreases output of the $(N-1)$ competitors by $(N-1)\{UCC_{parent} - UCC_h\}/b(N+1)$. Overall output is therefore increased by $\{UCC_{parent} - UCC_h\}/b(N+1)$. This means that the equilibrium price falls. With fixed costs of entry, the number of competitors in the equilibrium is thus lower compared with a territorial tax regime in place.

Our simplified model suggests that MNEs always produce in l to serve the market in l because of the strictly positive transport costs and the tax advantage under worldwide if $\tau_u < \tau_h$ and under territorial if $\tau_l < \tau_h$. If $\tau_l < \tau_u$, the change from worldwide to territorial taxation will also increase the output of the MNE in low-tax countries.

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Table 4.1: Overview about Production Location for Market in h under a Worldwide and Territorial Tax Regime

This table gives an overview about the optimal location of production for the market in high-tax country h under worldwide and territorial taxation and the corresponding output of MNEs and other market participants in each scenario with $UCC_i = \frac{1-\tau_i(1-c)}{(1-\tau_i)}$ and $UCC_{i,j} = \frac{1-\tau_j(1-c)}{(1-\tau_j)}$.

Scenarios	Territorial Tax Regime	Worldwide Tax Regime
<p>Scenario 1: Production in L</p> <p>$\tau_l < \tau_u \leq \tau_h$ and $m < m^*$</p> <p>with m^* such that</p> <p>$\pi_{W,l}(\tau_u, p_h - m^*)$</p> <p>$= \pi_{T=W,h}(\tau_h, p_h)$</p>	<p><i>Production in L</i> (τ_l)</p> <p>Output MNE:</p> $\frac{a - UCC_h - N\{(UCC_l + m) - UCC_h\}}{b(N+1)}$ <p>Output Domestic:</p> $\frac{a - UCC_h + \{(UCC_l + m) - UCC_h\}}{b(N+1)}$ <p>Overall Output:</p> $\frac{[Na - (UCC_l + m) - (N-1)UCC_h]}{b(N+1)}$ <p>Price:</p> $\frac{a}{N+1} + \frac{(UCC_l + m)}{N+1} + \frac{(N-1)UCC_h}{N+1}$	<p><i>Production in L</i> (τ_u)</p> <p>Output MNE:</p> $\frac{a - UCC_h - N\{(UCC_{l,u} + m) - UCC_h\}}{b(N+1)}$ <p>Output Domestic:</p> $\frac{a - UCC_h + \{(UCC_{l,u} + m) - UCC_h\}}{b(N+1)}$ <p>Overall Output:</p> $\frac{[Na - (UCC_{l,u} + m) - (N-1)UCC_h]}{b(N+1)}$ <p>Price:</p> $\frac{a}{N+1} + \frac{(UCC_{l,u} + m)}{N+1} + \frac{(N-1)UCC_h}{N+1}$
<p>Scenario 2: Production in L (H) under Territorial (Worldwide)</p> <p>$\tau_l < \tau_u \leq \tau_h$ and $m^* < m < m^{**}$</p> <p>with m^{**} such that</p> <p>$\pi_{T,l}(\tau_u, g_l, p_h - m^{**}) =$</p> <p>$\pi_{T,h}(\tau_h, p_h)$</p>		<p><i>Production in H</i></p> <p>Output MNE/Domestic:</p> $\frac{[(a - UCC_h)]}{b(N+1)}$ <p>Overall Output:</p> $\frac{[N(a - UCC_h)]}{b(N+1)}$ <p>Price:</p> $\frac{a}{N+1} + \frac{N UCC_h}{N+1}$
<p>Scenario 3: Production in H</p> <p>$\tau_l < \tau_u \leq \tau_h$ and $m^{**} < m$</p>		

Testable Predictions

The previous analysis has shown that the change in the taxation regime for foreign earnings impacts the optimal location of capital of U.K. multinationals. After the change to territorial taxation, U.K. multinationals have incentives to relocate capital from high-tax to low-tax subsidiaries. This could either be done via a relocation of assets into existing low-tax subsidiaries or via the acquisition of new subsidiaries as suggested by e.g., Feld et al. (2016).

The regime change leads to cost savings of U.K. multinationals in low-tax countries because they face a lower tax burden on low-tax profits that are repatriated to the parent. The previous section has shown that they will benefit from this reduction in the tax burden in high-tax countries if they relocate (part) of their production for the market in high-tax countries to low-tax countries. A simple Cournot model suggests that the cost savings lead to an increase in optimal output of U.K. multinationals and to an overall increase in output in markets with U.K. multinationals.

The increase in output in industries with U.K. multinationals will lead to a decline in the equilibrium price and thereby to lower profits in these industries. This prevents new firms from entering the market and/or forces competitors out of the market. Therefore, in order to provide support for an increase in the competitiveness of U.K. multinationals, we study the effect of the reform on industry dynamics in foreign markets: We expect less entries and/or more exits in industries with a high share of U.K. multinationals after the reform.

4.4 Development of U.K. multinationals after the Reform

In the following section, we empirically test the prediction of our model. In particular, we investigate (i) whether foreign subsidiaries of U.K. multinationals increased their output after the regime change, and (ii) whether U.K. multinationals relocate part of their capital from high-

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tax to low-tax countries after the regime change. We analyze the effect on the number of competitors in the section 4.5.

4.4.1 Data

For this set of analyses, we use financial statement data of subsidiaries of domestic and multinational group firms provided by Bureau van Dyk's Amadeus database. To increase the sample size, which allows us to control for a wider range of control variables, we include also firms that are part of a domestic group. We exclude financial industries and utility firms and we require ownership information as well as data on all our regression variables. We chose our sample countries based on available Eurostat data for our sample period, which is required for the subsequent analysis of industry dynamics. Based on non-missing values for our control variable, described in the following, we are left with 536,396 firm-year observations in high-tax countries and 350,057 observations in low-tax countries from 2006 to 2012. Low-tax countries are defined as countries with an average corporate tax rate below 30% (the average U.K. corporate tax rate) before the reform. Table 4.2 gives an overview of the sample countries. While almost 90% of the observations in high-tax countries stem from France, Italy, and Spain, Sweden represents 41% of the observations from low-tax countries. Ireland, Netherlands and Malta have the highest number of U.K. multinationals relative to the total number of firm-years.

Clearly the sample composition is not representative but rather reflects difference in data availability, which is partly caused by difference in publication requirements in the countries. Since we include a full set of firm and country–industry–year fixed effects in all regressions, we are confident that selection will not drive the result. Nevertheless, the effect we are estimating still represents the sample composition.

Table 4.2: Country Overview

This table provides information on the country composition of our firm sample and the average share of U.K. multinationals in each country in our firm sample (Amadeus) in columns (1) and (2). Column (3) lists the number of observations in the industry analysis in section 4.5.

Country	Firm sample		Industry sample
	n	% of total	n
Low-tax countries			
Austria	7,080	3.8%	336
Cyprus	-	-	195
Czech Republic	30,563	3.7%	288
Denmark	2,114	2.6%	212
Finland	15,759	1.2%	243
Hungary	4,029	4.3%	293
Ireland	3,729	16.1%	162
Lithuania	-	-	210
Latvia	2,974	3.3%	193
Netherlands	5,738	6.9%	232
Norway	50,176	1.1%	277
Poland	34,028	3.4%	277
Portugal	35,461	2.4%	336
Sweden	142,547	0.6%	268
Slovenia	4,744	2.0%	293
Slovakia	11,115	1.9%	285
Total	350,057	1.9%	4,100
High-tax countries			
Germany	56,890	3.3%	242
Spain	112,847	2.4%	271
France	208,526	2.1%	244
Italy	157,696	2.1%	293
Malta	437	4.8%	56
Total	536,396	2.3%	1,106

Table 4.3 reveals that almost two thirds of the observations stem from domestic groups, almost 40% belong to multinational groups with headquarters outside the U.K. and about 2% represent subsidiaries of U.K. multinationals. There are no differences between the ownership structure in high and low-tax countries.

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Table 4.3: Ownership Type in Firm-Level Analysis

This table provides information on the ownership structure of our firm sample. *DomesticGroup* (*MNE*) is defined as a subsidiary that belongs to a domestic (multinational) group. *UK MNE* is defined as a subsidiary of a multinational group where the ultimate owner is located in the U.K.

Panel A: Low-tax countries		
Ownership type	Number of firms	Ownership in %
Domestic group	204,160	58.32
Other MNE	139,244	39.78
U.K. multinationals	6,653	1.9
Total	350,057	100
Panel B: High-tax countries		
Domestic group	313,259	58.4
Other MNE	210,848	39.31
U.K. multinationals	12,289	2.29
Total	536,396	100

Table 4.4 provides descriptive statistics of our firm sample. The average firm in our sample reports total sales (total assets) of 2.8 (2.1) million euros. Less than 14% of the observations represent firms that are incorporated for five years or less. The ratio of total liabilities (long-term and short-term) to total assets amounts to 65.8% and cash to total assets amounts to 14.2% for the average firm. The average firm reports a sales growth of 13.3%. All ratio variables are winsorized at the 1% and 99% percentile. We further winsorize *Leverage* at 100% and *Sales growth* at 200%.⁸³ There appears to be no systematic differences between our observations in high-tax and low-tax countries as suggested by Panel A and Panel B of Table 4.4.

Table 4.4: Descriptive Statistics (Firm Sample)

This table provides descriptive statistics of our firm sample. All variables are defined in Appendix C.1.

Panel A: Low-tax countries							
Variables	mean	sd	p1	p25	p50	p75	p99
<i>Ln(Sales)</i>	14.6369	2.0775	9.0711	13.3956	14.6096	15.9404	19.6237
<i>Ln(Fixed Assets)</i>	12.2714	2.6712	6.1845	10.4290	12.2600	14.0948	18.5626
<i>Start-Up</i>	0.1384	0.3453	0.0000	0.0000	0.0000	0.0000	1.0000
<i>Leverage_{t-1}</i>	0.6239	0.2607	0.0476	0.4301	0.6543	0.8401	1.0000
<i>Cash-to-Assets_{t-1}</i>	0.1683	0.1937	0.0001	0.0188	0.0904	0.2565	0.7934
<i>Sales growth_{t-1}</i>	0.1483	0.4835	-0.7905	-0.0717	0.0550	0.2241	2.0000
<i>Size_{t-1}</i>	14.2220	1.9221	10.2745	12.8757	14.0525	15.4254	19.3072

⁸³ Results are robust if we refrain from this additional winsorizing.

Panel B: High-tax countries							
Variables	mean	sd	p1	p25	p50	p75	p99
<i>Ln (Sales)</i>	15.0055	2.0327	9.7826	13.7715	14.9780	16.2767	19.8912
<i>Ln(Fixed Assets)</i>	12.8297	2.5925	6.2634	11.1967	12.8376	14.5489	18.8011
<i>Start-Up</i>	0.1358	0.3426	0.0000	0.0000	0.0000	0.0000	1.0000
<i>Leverage_{t-1}</i>	0.6811	0.2482	0.0598	0.5102	0.7235	0.8903	1.0000
<i>Cash-to-Assets_{t-1}</i>	0.1251	0.1645	0.0000	0.0107	0.0552	0.1758	0.7445
<i>Sales growth_{t-1}</i>	0.1233	0.4661	-0.7909	-0.0688	0.0361	0.1766	2.0000
<i>Size_{t-1}</i>	14.8133	1.8510	10.9328	13.5303	14.6862	15.9782	19.6476
Panel C: Full sample							
Variables	mean	sd	p1	p25	p50	p75	p99
<i>Ln (Sales)</i>	14.8599	2.0584	9.4540	13.6142	14.8373	16.1510	19.7901
<i>Ln(Fixed Assets)</i>	12.6092	2.6380	6.2265	10.8840	12.6269	14.3778	18.7165
<i>Start-Up</i>	0.1368	0.3437	0.0000	0.0000	0.0000	0.0000	1.0000
<i>Leverage_{t-1}</i>	0.6585	0.2547	0.0511	0.4778	0.6965	0.8725	1.0000
<i>Cash-to-Assets_{t-1}</i>	0.1422	0.1779	0.0000	0.0134	0.0669	0.2070	0.7829
<i>Sales growth_{t-1}</i>	0.1332	0.4732	-0.7909	-0.0699	0.0428	0.1951	2.0000
<i>Size_{t-1}</i>	14.5798	1.9015	10.5953	13.2538	14.4466	15.7837	19.5286

4.4.2 Univariate Analysis

We start our analysis at the group level as this capture difference in the extensive margin, that is, the number of subsidiaries in high-tax and low-tax countries. For this analysis, we limit the sample to multinational groups with their headquarter in the EU 28 countries. To avoid that sample selection drives the results, we include only groups in our analysis for which we observe at least one affiliate in each year of our observation period. This leads to 91,504 multinational group observations of which about 10.15% represent U.K. multinationals. To further increase the comparability between U.K. multinationals and other multinationals, we use a propensity score matching (1 to 1 nearest neighbor matching). Our set of matching variables includes the natural logarithm of total *Fixed Assets*, the number of subsidiaries, and the ratio of subsidiaries in each industry group (1 digit NACE code). We match on data in 2006. This limits the sample of group firms to 18,046 observations.

In the matched sample, most of the headquarters of other multinationals are located in Germany (8.2%), Luxembourg (6%), Sweden (5.5%), Italy (4.4%), France (4.3%), and the Netherlands (3.3%). On average, U.K. multinationals have 5.3 affiliates and other multinational groups have

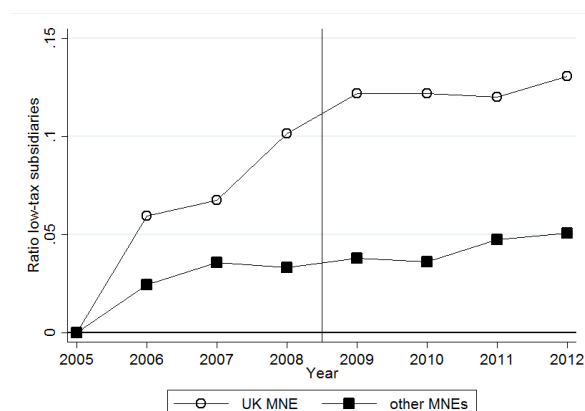
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5.4 affiliates. The location of the subsidiaries is similar to the location of firms described in Table 4.1. Clearly, the number of subsidiaries in different countries is likely to be driven by publication requirement. We believe, however, that the selection is unlikely to affect our results as this would require that the sample selection depends on location of the headquarter, which is less likely.

We compute the ratio of subsidiaries in low-tax countries relative to the number of total subsidiaries per group. The average ratio of low-tax subsidiaries to total subsidiaries amounts to 19.8% for U.K. multinationals and to 42.5% for other multinationals. Figure 4.1 plots the increase in the average low-tax ratio for U.K. multinationals and other multinationals from 2005 to 2012 relative to the average low-tax ratio in 2005. We observe a stronger increase in this ratio for U.K. multinationals relative to other multinational groups starting in 2008.

Figure 4.1: Development of the Share of Low-Tax Subsidiaries of U.K. Multinationals and Other Multinationals

This figure compares the ratio of low-tax subsidiaries to total subsidiaries of U.K. multinationals and other multinationals from 2005 to 2012. We focus on subsidiaries of MNEs from the same countries as in our regression analysis. We include U.K. subsidiaries to increase the comparability of the total number of subsidiaries of U.K. multinationals and other MNEs. We further limit the sample to observations where the parent is located in an EU country. This leads to a balanced panel of 91,504 parent observations. We match U.K. parents to other parents based on the percentage of firms in each industry (1 digit NACE code), the number of subsidiaries and the logarithm of the sum of fixed assets in year 2006 using a 1:1 matching approach. This leads to 18,046 parent observations.



However, this analysis could be affected by differences in the inclusion of new firms in the Amadeus dataset across countries. Therefore, we do not further exploit this in a regression

analysis but rather focus on subsidiary-level data in the following analysis that examines changes in capital and sales at the intensive margin.

We hypothesize that U.K. multinationals increase their output under territorial taxation because they face a lower tax burden in low-tax countries and they can reduce production costs by relocating production to low-tax countries. Thus, we expect a decline in fixed assets in high-tax and a corresponding increase in fixed assets in low-tax countries.

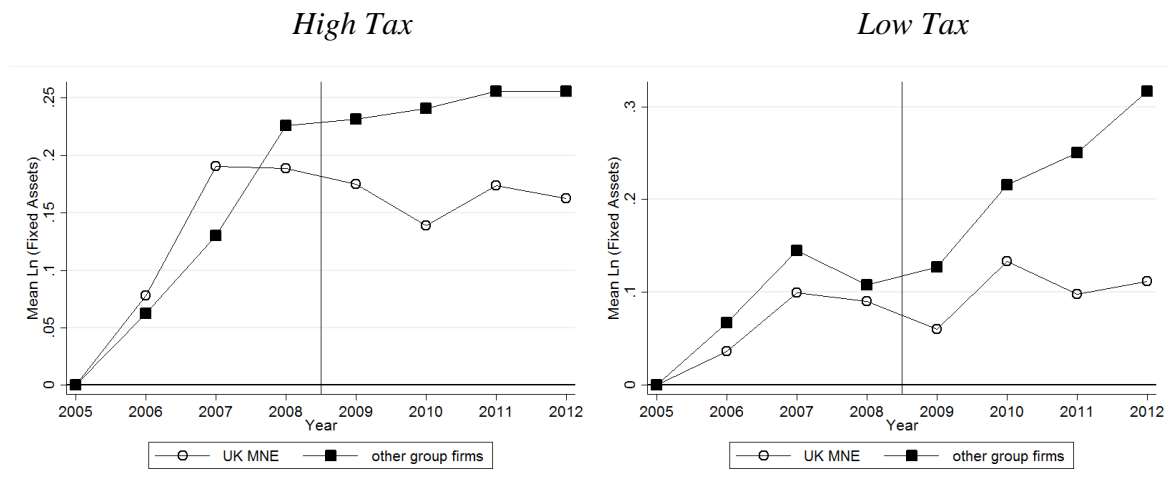
Figure 4.2 plots the logarithm of the average $\ln(\text{Fixed Assets})$ separately for high-tax and low-tax countries over our observation period. $\ln(\text{Fixed Assets})$ is defined as the natural logarithm of a firm's fixed assets in euro. We require a balanced panel of subsidiaries for this graphical analysis to reduce concerns that changes in reporting requirements affect the mean comparison. We standardize all values with the value in 2005 through subtracting the average $\ln(\text{Fixed Assets})$ in 2005 from all values. Thereby, each data point reflects the change in fixed assets relative to 2005. The graphical evidence reveals a decline in fixed assets of U.K. multinationals in high-tax countries relative to the development of fixed assets of other group firms. Our findings support the notion that U.K. multinationals reduce their capital in high-tax countries to relocate production to low-tax countries. Panel B plots the difference in means between U.K. multinationals and other group firms together with the lower and upper bound of the 90% confidence interval. While the simple mean comparison suggests a downward trend in fixed assets of U.K. multinationals relative to their counterfactuals in high-tax countries, the difference in means in the pre and post period is not statistically significant. We test this more formally with a multivariate regression design that controls for firm level and country–industry level characteristics in the following section.

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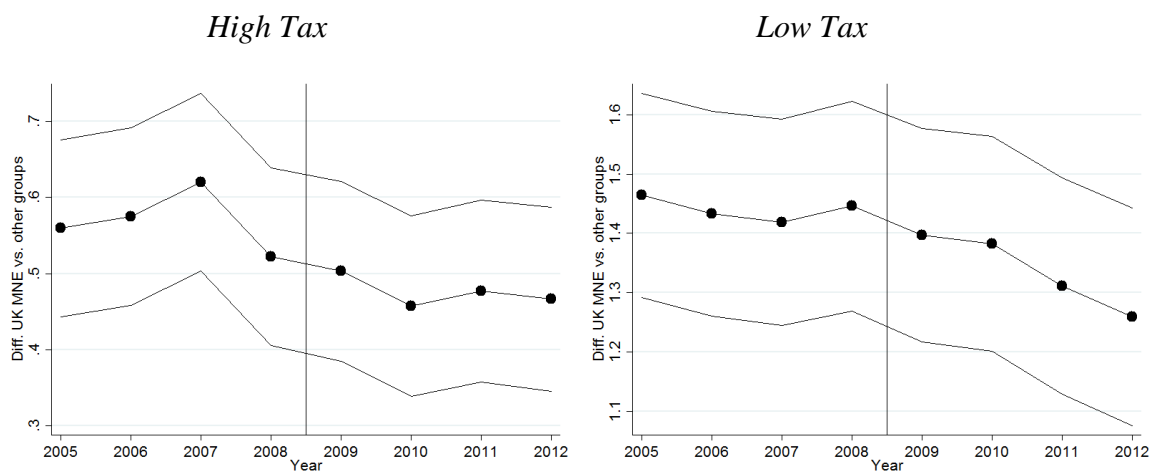
Figure 4.2: Development of U.K. Multinationals – Fixed Assets

This Figure plots the logarithm of the average fixed assets of U.K. multinationals and other group firms over our observation period. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We use data from all countries of our regression analysis. We require a balanced sample, which leads to 451,976 observations in high-tax and 318,000 observations in low-tax countries. We standardize all values with the value in 2005. Panel B plots the difference in means between U.K. multinationals and other group firms and the corresponding 90% confidence intervals.

Panel A: Mean Ln (Fixed Assets)



Panel B: Differences in Ln (Fixed Assets) between U.K. Multinationals and other Group Firms



As opposed to our prediction, the graphical evidence suggests a decline in fixed assets of subsidiaries of U.K. multinationals in low-tax countries after the reform relative to other group firms. There are at least two explanations for this. First, Arena and Kutner (2015) and Egger et

al. (2015) suggest a decline in overinvestments of subsidiaries of U.K. multinationals after the reform because profits are no longer hoarded in foreign subsidiaries to avoid taxation at the parent level.⁸⁴ This effect could offset the increase in capital that results from a relocation of fixed assets from high to low-tax countries. Second, capital could be relocated to newly established or acquired low-tax subsidiaries. Newly acquired subsidiaries are not included in this dataset because we require a balanced sample.⁸⁵ Thus, it is possible that U.K. multinationals relocate production capacities into new subsidiaries. This would be in line with results in Feld et al. (2016) who find an increase in M&A activities of U.K. multinationals after the change to territorial taxation in low-tax countries. Moreover, our group-level analysis in Figure 4.1 suggests an increase in the number of low-tax subsidiaries relative to total subsidiaries of U.K. multinational groups after the reform relative to other multinationals.

Figure 4.3 plots the logarithm of the average $\ln(\text{Sales})$ of foreign subsidiaries of U.K. multinationals relative to subsidiaries of other group firms. $\ln(\text{Sales})$ is defined as the natural logarithm of a firm's total sales in euro. We observe an increase in sales of U.K. multinationals and other group firms over our observation period. Moreover, in line with our hypothesis, we find that the increase in sales is more pronounced for U.K. multinationals starting in 2008. Since the reform was first discussed in 2007, it is reasonable to expect anticipatory effects already in 2008. Panel B plots the difference in means together with the lower and upper bound of the 90% confidence interval over our sample period.

⁸⁴ Evidence for overinvestment in low tax subsidiaries of U.S. multinationals that operate under a worldwide taxation regime can be found in Hanlon, Lester, and Verdi (2015) and Edwards, Kravet, and Wilson (2016).

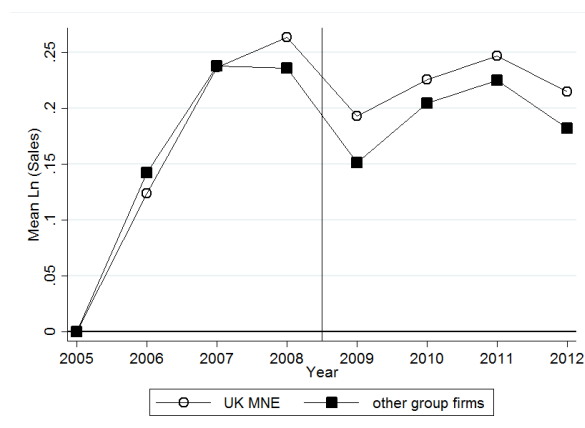
⁸⁵ In the regression analysis the sales coefficient will only be estimated for subsidiaries with at least one observation before and one observation after the reform due to the inclusion of firm fixed effect.

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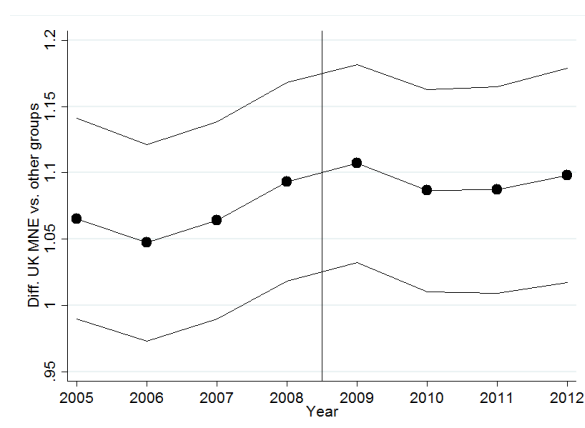
Figure 4.3: Development of U.K. Multinationals – Sales

This Figure plots the logarithm of the average sales of U.K. multinationals and other group firms over our observation period. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We use data from all countries of our regression analysis. We require a balanced sample, which leads to 769,976 observations. We standardize all values with the value in 2005. Panel B plots the difference in means between U.K. multinationals and other group firms and the corresponding 90% confidence intervals.

Panel A: Mean Ln (Sales)



Panel B: Differences between U.K. multinationals and other Group Firms



As in the mean comparison of fixed assets, we observe an upward trend in sales that is in line with our predictions. The difference in means in the pre and post period is, however, not statistically significant. Since this approach fails to control for firm-, country-, or industry- level characteristics, we test the effect on output and capital more formally in a multivariate regression design that controls for observable and unobservable firm and country–industry–year characteristics in the following section.

4.4.3 Empirical Approach

To empirically test the impact of the change from a worldwide to a territorial tax regime on total output and the location of capital, we follow prior literature (Arena and Kutner 2015, Egger et al. 2015, Liu 2017, and Feld et al. 2016) and employ a difference-in-differences design. This approach compares the development of foreign subsidiaries of U.K. multinationals to the development of other group firms before and after the policy reform. Our estimation equation reads as follows:

$$DepVar_{i,t} = \alpha_0 + \alpha_{j,n,t} + \alpha_i + \beta_1 * UKMNE_i \times After_t + \sum_k \gamma_k \chi_{k,i,t-1} + \varepsilon_{i,t} \quad (1)$$

Where i , j , n and t index firms, industries, countries, and years, respectively. As dependent variables we use $\ln(Sales)$ and $\ln(Fixed Assets)$. We run the regression separately for high-tax and low-tax countries for $\ln(Fixed Assets)$. We define low-tax countries as countries with an average corporate tax rate below 30% (U.K. average tax rate) before the reform.

The variable $UKMNE$ is a dummy variable equal to one if the firm belongs to a U.K. multinational group. $After$ is an indicator variable equal to one for years after 2008. $\chi_{i,t-1}$ is a vector of lagged firm control variables that have been shown to affect sales and fixed assets in prior literature. This vector includes controls for a firm's leverage, cash-to-asset ratio, sales growth and size in year $t - 1$ and an indicator variable equal to one for start-up firms, i.e., for firms that are registered for five years or less.⁸⁶ We further include firm fixed effects (α_i) to control for all observable and unobservable firm characteristics that are constant over time that could influence sales, and fixed assets such as the ownership structure or location of a firm. In addition, we include country–industry–year fixed effects ($\alpha_{j,n,t}$) to control for all observable and unobservable time varying country and industry specific events that could influence sales,

⁸⁶ Robustness to the exclusion of firm controls are reported in Table B.2 in the Appendix. Moreover, untabulated tests reveal robustness to the inclusion of $\ln(Sales)$, $\ln(Wage)$ and ROA instead of size as in chapter 2 of this thesis.

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and fixed assets.⁸⁷ Thereby, we control, e.g., for industry-wide demand shocks, oil price or exchange rate fluctuations as well as tax policy changes. With this design we compare the difference in sales and fixed assets of U.K. subsidiaries before and after the reform relative to the change in sales and fixed assets of subsidiaries from the same country and industry that belong to other group firms. To account for a potential correlation of error terms with respect to subsidiary and parent country, we cluster standard errors at the parent-subsidiary country level.

Based on our theoretical prediction, we expect β_1 to be positive for $\ln(Sales)$ suggesting that subsidiaries of U.K. multinationals increase their sales relative to other market participants in the same country and industry because the change from worldwide to territorial taxation leads to cost savings for U.K. multinationals. Regarding capital spending ($\ln(Fixed Assets)$), we expect a decrease in high-tax countries (negative β_1) and an increase in low-tax countries (positive β_1).

4.4.4 Results

Table 4.5 reports regression results of estimating equation (1) with $\ln(Fixed Assets)$ as the dependent variable between 2006 and 2012, separately for high and low-tax countries.⁸⁸ Firm controls are included in the model but are not reported in the main table.⁸⁹ In line with our univariate analysis, the coefficient estimate for the interaction of *UK MNE* and *After* (β_1) suggests an average decline in fixed assets in foreign subsidiaries of U.K. multinationals in high-tax countries. The results suggest a decline by 10.2% ($100 * e^{0.0969} - 1$), which equals about €38,000 for the average firm.

⁸⁷ We define an industry group based on two-digit NACE codes because the industry data for the subsequent analysis of industry dynamics is provided at the two-digit NACE code level.

⁸⁸ We have financial statement data starting in 2005. Since we control for lagged firm characteristics, our sample period starts only in 2006.

⁸⁹ Coefficient estimates on the control variables are reported in Table C.1 in the Online Appendix.

Table 4.5: Fixed Assets of U.K. Multinationals after the Reform

This table provides regression results of estimating equation (1) using $\ln(\text{Fixed Assets})$ as the dependent variable. In columns (2) and (4), we interact *UK MNE* separately with each year dummy to observe the time trend. *Low Tax* (*High Tax*) defines countries with a pre-reform average corporate tax rate below (above) 30%. We include firm controls as well as firm, country–industry–year fixed effects in all regressions. We report standard errors that are clustered at the parent–subsidiary country level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>High Tax</i>		<i>Low Tax</i>	
	<i>Ln (Fixed Assets)</i>			
	(1)	(2)	(3)	(4)
<i>UK MNE</i> × <i>After</i>	-0.0969*** (0.0241)		-0.0109 (0.0413)	
<i>UK MNE</i> × 2007		0.0136* (0.0079)		0.0153 (0.0278)
<i>UK MNE</i> × 2008		-0.0792*** (0.0273)		0.0177 (0.0319)
<i>UK MNE</i> × 2009		-0.1070** (0.0475)		-0.0120 (0.0436)
<i>UK MNE</i> × 2010		-0.1192*** (0.0360)		-0.0100 (0.0467)
<i>UK MNE</i> × 2011		-0.1242*** (0.0365)		0.0236 (0.0558)
<i>UK MNE</i> × 2012		-0.1417*** (0.0356)		0.0080 (0.0748)
Firm controls & firm fixed effects & country–industry–year fixed effects included				
Observations	536,396	536,396	350,057	350,057
Adj. R ²	0.935	0.935	0.922	0.922

One concern of our difference-in-difference approach is the violation of the parallel trends assumption if we fail to fully capture time-varying unobservable factors that could explain different fixed assets of U.K. multinationals after the reform. In order to assess the validity of our identification strategy with respect to this concern, we conduct a Granger-type causality test as suggested by Angrist and Pischke (2008). If the treatment of the change in the taxation regime for U.K. multinationals in 2009 is causal and the parallel trends assumption holds, we would expect to find no differences in fixed assets between our treatment and control firms prior to treatment, that is, the treatment should not have anticipatory effects. To test this, we interact each year dummy with *UK MNE*. Results are reported in column (2) of Table 4.4. We observe a significant decline in fixed assets of U.K. MNEs in high-tax countries starting in 2008. Given that the U.K. government issued the first discussion document on the proposed switch to a

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territorial regime in June 2007, it is reasonable to expect firms to respond to the reform one year in advance.

In low-tax countries, we observe no significant change in the capital stock of U.K. subsidiaries relative to other group firms. This could either be explained with a concurrent decline in investments resulting from a reduction in overinvestment (Arena and Kutner 2015, Egger et al. 2015, Hanlon, Lester, and Verdi 2015, Edwards, Kravet, and Wilson 2016) or with the fact that capital is relocated to new subsidiaries, which we do not observe with our approach.

We note that our findings are not in line with Liu (2017) who observes an increase in aggregate outbound investments of U.K. multinationals in countries with a lower corporate tax rate than the U.K and no corresponding decline in investments in high-tax countries. The different approaches could explain why she observes no corresponding decline in investments in high-tax countries. Most of the relocation effect that we observe takes place in 2008. Liu (2017) does not capture this with the dependent variable, which is defined as the change in fixed assets relative to prior year's total assets because her first treatment year will be the change in fixed assets from 2008 to 2009. Our approach, on the other hand, relies on a comparison of average fixed assets before and after the reform and will thus capture this decline.⁹⁰ Our findings are, however, in line with the average negative investment effect found by Arena and Kutner (2015) and Egger et al. (2015).

Table 4.6 reports regression results of estimating equation (1) with $\ln(Sales)$ as the dependent variable. In line with our univariate analysis in section 4.2.2, the coefficient estimate for the interaction of $UK\ MNE$ and $After$ (β_1) suggests that U.K. subsidiaries increase their sales by 3.4% ($100 * e^{0.038} - 1$) after the reform relative to subsidiaries from the same country—

⁹⁰ We note that Liu (2017) chooses a narrower definition of low-tax countries. While we treat all countries as low-tax countries that have an average corporate tax rate below the U.K. rate before the regime change, she defines low-tax countries as countries with corporate tax rates below the U.K. rate during 2005–2011. However, our results remain unchanged with this alternative definition of low-tax countries. Moreover, our results remain unchanged if we do not limit the sample to countries with available Eurostat data.

industry group that belong to other group firms.⁹¹ This equals about €97,700 for the average firm.

In column (2), we interact the variable U.K. multinationals with each year dummy to observe time trends. While the coefficient on *UK MNE* in the sales regression is increasing in 2009, it is not statistically significant from the *UK MNE* effect in 2006 until 2011.

Table 4.6: Sales of U.K. Multinationals after the Reform

This table provides regression results of estimating equation (1) using $\ln(\text{Sales})$ as the dependent variable. In column (2), we interact *UK MNE* separately with each year dummy to observe the time trend. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We include firm controls as well as firm, and country–industry–year fixed effects in all regressions. We report standard errors that are clustered at the parent–subsidiary country level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Ln (Sales)</i>	
	(1)	(2)
<i>UK MNE</i> × <i>After</i>	0.0338*** (0.0121)	
<i>UK MNE</i> × 2007		0.0028 (0.0225)
<i>UK MNE</i> × 2008		0.0077 (0.0241)
<i>UK MNE</i> × 2009		0.0167 (0.0231)
<i>UK MNE</i> × 2010		0.0209 (0.0245)
<i>UK MNE</i> × 2011		0.0463** (0.0224)
<i>UK MNE</i> × 2012		0.0717*** (0.0217)
Firm controls & firm fixed effects & country–industry–year fixed effects included		
Observations	886,453	886,453
Adj. R ²	0.937	0.937

4.4.5 Robustness Tests

We run several tests to validate the robustness of our results. Since some of our control variables could be affected by the regime change themselves (e.g., sales growth, leverage) their

⁹¹ Untabulated tests reveal that the increase in sales of U.K. multinationals is more pronounced in high-tax than in low-tax countries. This finding supports the notion that we underestimate the response in low-tax countries because the increased competitiveness of U.K. multinationals incentivizes U.K. multinationals to start or acquire new firms in low-tax countries.

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inclusion in the estimation equation could lead to a “bad controls” problem as suggested by Angrist and Pischke (2008). Therefore, we exclude all firm control variables to validate that our results are not driven by our choice of firm controls. Results reported in Table C.2 in the Appendix reveal that the exclusion of firm controls does not affect our results.

To address concerns that our results reflect general differences between multinational and domestic group firms after 2008, we additionally control for an interaction between *After* and *MNE*, a dummy variable equal to one if the firm belongs to a foreign multinational. With this approach, the coefficient estimate on the interaction term between *UK MNE* and *After* reflects the effect of being a multinational with a U.K. parent relative to being a multinational with another foreign parent. In column (1) of Table C.3, we observe that part of the decline in fixed assets can be explained by a general decline in fixed assets of multinationals in high-tax countries. The coefficient estimate for U.K. multinationals drops by almost half of its size but remains significant at the 5% level suggesting that U.K. multinationals decrease their capital expenditures more than other MNEs in high-tax countries after the reform. The coefficient estimate on the interaction of *UK MNE* and *After* remains positive in the sales regression. However, the significance level declines to 26% (t-stat of 1.13).

While we control for differences in time-varying observables across U.K. multinationals and other group firms parametrically, we also present estimation results using explicit 1:1 matching that restrict the sample to firms with similar leverage, cash, age, sales growth and size in 2006 from the same country and industry. This matching approach reduces our sample to 24,852 observations. Our estimation results in Table C.4 appear even stronger in this small sample that is limited to control firms with very similar characteristics.

In sum, the firm-level analyses provide evidence that U.K. multinationals relocate part of their production from high-tax to low-tax countries after the switch to territorial taxation. Moreover, we observe an increase in output of U.K. multinationals after the change in the

taxation regime. Our evidence for an increase in sales with a concurrent decline in fixed assets in high-tax countries appears to be robust. Untabulated tests reveal significant increases in sales-to-fixed asset ratios, which is in line with findings by Egger et al. (2015). This could either suggest massive productivity gains in high-tax countries or – as our model predicts – a relocation of production to low-tax countries.

The next section analyzes whether this can be interpreted as an increase in the competitiveness of U.K. multinationals under territorial taxation as suggested by the U.K. government. For this analysis we study the effect of the regime change on market dynamics in industries with a high share of U.K. multinationals. Studying the impact on competitor firms at the industry level instead of analyzing firm-level variables reduces measurement error that e.g., stems from a delayed recognition of new firms in Amadeus.

4.5 Industry Dynamics

In this section, we investigate how the increase in output of U.K. subsidiaries affect market dynamics, in particular net entry rates in industries with a high share of U.K. multinationals.

4.5.1 Data and Univariate Analysis

For this set of tests, we use industry data that we download from Eurostat on the number of firms that enter and exit an industry in each year of the sample period.⁹² We combine this data with another Eurostat dataset with information on the percentage of market share owned by U.K. multinationals in foreign countries as of 2008. We exclude financial and utility industries. This leaves us with 43 different industries in 21 countries from 2005–2012. The composition

⁹² One limitation of this data is that the total number of firms as well as the number of firms that enter and exit include U.K. subsidiaries. Thus, if more U.K. firms enter a market after the regime change because of the better competitive position, this would increase the number of entering firms. If they are more likely to enter in industries with a high share of U.K. firms, this would work against us finding declines in (net) entry ratios in industries with a high share of UK MNEs.

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of the sample countries can be found in Table 4.2, column (3). Table C.5 of the Appendix provides information on the industries of the analysis and their respective U.K. market shares.

Table 4.7 reveals that the average multinational market share in our sample industries amounts to 35% while 1.2% of the total market share is owned by U.K. multinationals on average. While the average entry ratio (number of entering firms relative to beginning of the year's total number of firms) amounts to 11%, the exit ratio amounts to 9.3% on average. This leads to an average net entry ratio of 1.9%.

Table 4.7: Descriptive Statistics (Industry Sample)

This table provides descriptive statistics of the industry data (n=5,206). All industry data is taken from Eurostat and all variables are defined in Appendix C.1.

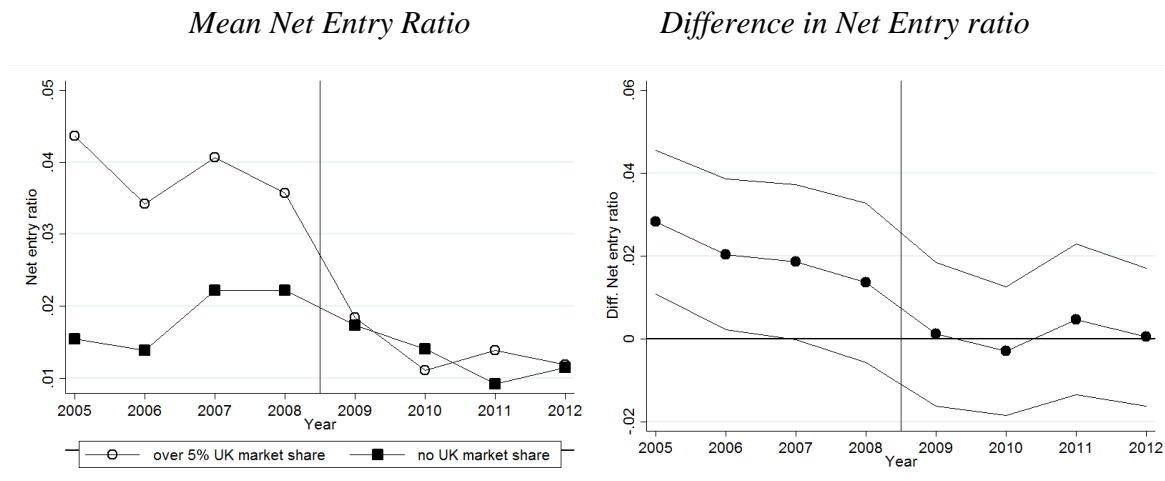
Variables	mean	sd	p1	p25	p50	p75	p99
<i>Net entries</i>	0.0187	0.0534	-0.0952	-0.0112	0.0093	0.0394	0.2235
<i>Entries</i>	0.1079	0.0612	0.0109	0.0615	0.0940	0.1426	0.2418
<i>Exits</i>	0.0929	0.0476	0.0123	0.0594	0.0843	0.1152	0.2418
<i>U.K. Ratio</i>	0.0121	0.0291	0.0000	0.0000	0.0000	0.0112	0.1845
<i>MNE Ratio</i>	0.3498	0.2732	0.0000	0.1542	0.2877	0.4427	1.0000
<i>Low Tax</i>	0.7876	0.4091	0.0000	1.0000	1.0000	1.0000	1.0000

First, we compare the development of net entry rates in industries with a high U.K. market share relative to industries with no U.K. firms over the observation period to find support for our hypothesis of less firms in industries with a high share of U.K. multinationals. Panel A of Figure 4.4 plots the net entry rates in industries with at least 5% U.K. market share relative to industries with no U.K. activity where at least 5% of the market share is owned by multinationals to reduce concerns that we capture a general multinational effect. We observe stronger declines in net entries in U.K. industries relative to other industries with a high share of multinationals.

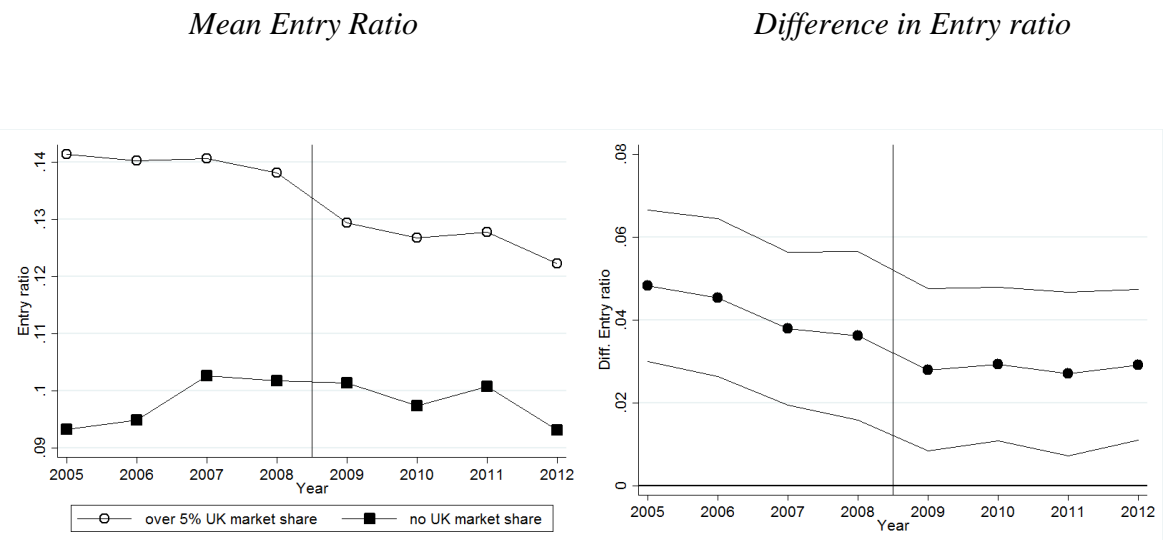
Figure 4.4: Industry Dynamics in Industries of U.K. multinationals

This figure plots net entry ratios (Panel A), entry ratios (Panel B) and exit ratios (Panel C) in industries with at least 5% U.K. market share relative to industries with no U.K. market share if at least 5% of the market share is owned by multinationals. *Net Entry Ratio* is defined as the difference in number of entering and exiting firms relative to beginning of the year's total number of firms in the industry. *Entry (Exit) Ratio* is defined as the number of entering (exiting) firms relative to beginning of the year's total number of firms in the industry. The second graph in each panel plots the difference between the average ratio for industries with at least 5% market share and industries with no U.K. market share together with the 90% confidence interval.

Panel A: Net Entry Ratio

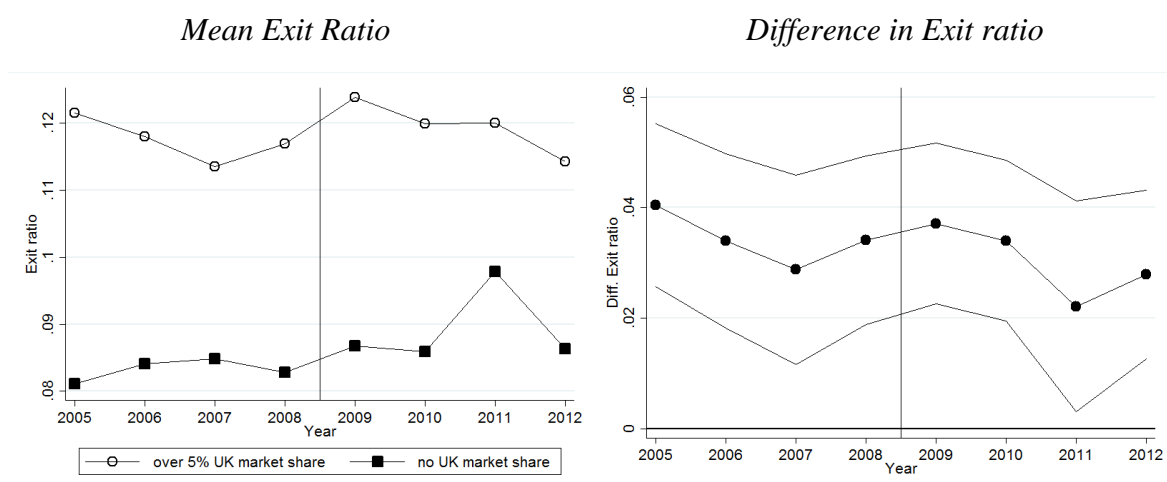


Panel B: Entry Ratio



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Panel C: Exit Ratio



In Panel A, the graph on the right hand side plots the difference in net entries between U.K. industries and industries with no U.K. activity and the corresponding 90% confidence intervals. While we observe a decline in net entries in industries with a high share of U.K. multinationals, the difference is not significant in this univariate analysis. Panel B and C of Figure 4.4 suggest that the effect is driven by a decline in entries rather than an increase in exits in industries with a high share of U.K. multinationals. Since the effect may be driven by differences in industries and/or country characteristics, we analyze the impact on net entry rates in the next section in more detail using a regression design with a battery of fixed effects.

4.5.2 Empirical Approach

Our empirical identification strategy exploits again a difference-in-differences design. Based on the theoretical prediction, we expect less market participants (and thus either more exits or less entries) in country–industries with a high share of U.K. subsidiaries after the 2009 reform.

Our estimation equation reads thus as follows:

$$\begin{aligned}
 \text{Net Entries}_{m,n,t} = & \alpha_0 + \alpha_{j,n} + \alpha_{j,n1,t} + \beta_1 * \text{UK Ratio}_{j,n} \times \text{After}_t + \beta_2 * \\
 & \text{MNE Ratio}_{j,n} \times \text{After}_t + \varepsilon_{m,n1,t}.
 \end{aligned} \tag{2}$$

The dependent variable *Net Entries* is equal to the difference between entries and exits in a country and industry in a given year relative to the number of firms at the beginning of the period. The variable *U.K. Ratio* is the percent of market share (=sales in each country–industry) that is owned by subsidiaries of U.K. multinationals in 2008 (winsorized at 99%). We interact *U.K. Ratio* with *After*, an indicator variable equal to one for all years after 2008. We expect the coefficient β_1 to be negative suggesting that the reform has led to less entries and/or more exits in industries with a high ratio of U.K. multinationals in response to the decrease in costs (and the related increase in output) of U.K. multinationals.

We include country–industry fixed effects to control for observable and unobservable time invariant factors that could affect (net) entry ratios or exits. This controls, for example, for the average entry costs of a specific (country–)industry. Moreover, we include country–industry–year fixed effects to control for time varying country–industry characteristics that could influence industry dynamics, such as the exposure to exchange rate fluctuations or country–year specific factors such as the general economic situation or changes in the legislation. Note that we define industries at the one digit NACE code for the country–industry–year fixed effects. We cannot include country–industry–year fixed effects where we define industries at the two digit level because the treatment is at the country–industry level in this test. Standard errors are clustered at the country–industry (one digit) level.

4.5.3 Results

To corroborate our non-parametric results of the previous section, we run a multivariate regression analysis using net entries as the dependent variable (equation (2)). Results are reported in Table 4.8. The results are in line with our prediction and suggest that a one standard deviation increase in the U.K. market share (an increase by 2.91 percentage points) leads to a decline in net entries by 0.22 percentage points and a decline in entry ratios equal to entry ratio by 0.15 percentage points. This is equal to 1.4% of the average entry rate. The small economic

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magnitudes are reasonable given that we would not expect large effects of U.K. multinationals on industry dynamics in foreign countries. We observe no significant impact on exits.

Table 4.8: Industry Dynamics in Industries with U.K. multinationals, Regression Results

This table provides regression results of estimating equation (3) using *Net Entry Ratio* (Panel A) and *Entry Ratio* (Panel B) as dependent variables. We include country–industry and country-1 digit industry–year fixed effects (where we define industry at the one digit level), in all regressions. We report standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Net Entry Ratio</i>	<i>Entry Ratio</i>	<i>Exit Ratio</i>
<i>U.K. Ratio</i> × <i>After</i>	-0.0763** (0.0370)	-0.0524** (0.0260)	-0.0225 (0.0286)
<i>MNE Ratio</i> × <i>After</i>	-0.0017 (0.0062)	0.0042 (0.0055)	0.0051 (0.0042)
Country–Industry & country–1digit–industry–year fixed effects included			
Observations	5,206	5,206	5,206
Adj. R ²	0.638	0.849	0.844

4.5.4 Placebo Results

One concern of our analysis could be that the observed effects for U.K. subsidiaries are driven by changes in the exchange rate. After 2008, the British Pound was very weak compared to the Euro. This could incentivize U.K. multinationals to broaden their foreign activities in the Euro area because their products are (temporarily) less expensive. This could also give them a competitive advantage relative to other market participants from the EURO area. If the exchange rate is driving the results, we expect to find similar results when using another large non Euro country to calculate the market shares. Since the Norwegian Krone lost value relative to the Euro in 2008 and 2009 as well, we use the market share of Norwegian multinationals as a placebo treatment in the following test.

Table 4.9 provides descriptive statistics of this sample. While the number of observations with information on the activity of Norwegian firms declines, the sample countries remain the same as reported in Table 4.2. Table 4.9 reveals that Norwegian multinationals have lower market shares in foreign markets (*NO Ratio*) relative to U.K. multinationals. The average share

amounts to only 0.15%. The descriptive statistics of all other variables are in line with those of the main sample.

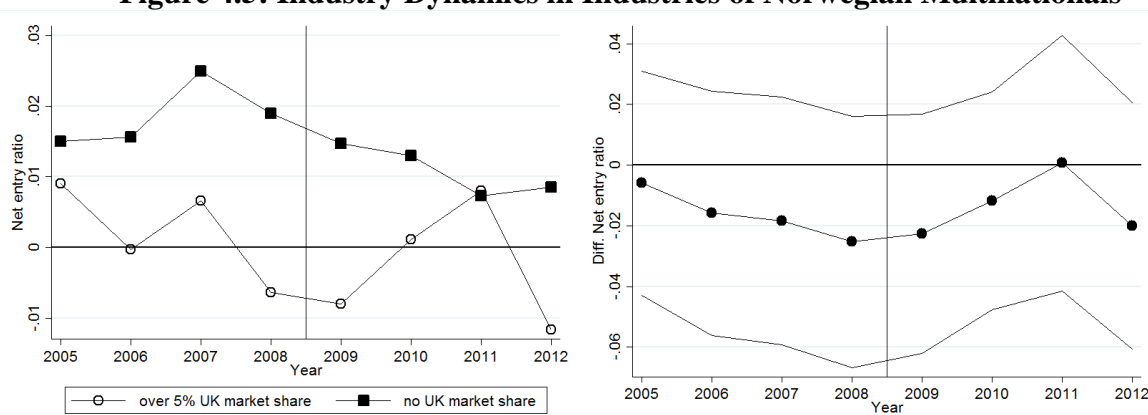
Table 4.9: Descriptive Statistics (Industry Sample Norway)

This table provides descriptive statistics of the industry data with Norwegian market shares (n=2,021). All industry data are taken from Eurostat and all variables are defined in Appendix C.1.

Variables	mean	sd	p1	p25	p50	p75	p99
<i>Net entries</i>	0.0101	0.0517	-0.1103	-0.0160	0.0018	0.0272	0.2235
<i>Entries</i>	0.0976	0.0614	0.0000	0.0535	0.0832	0.1229	0.2605
<i>Exits</i>	0.0899	0.0486	0.0000	0.0577	0.0806	0.1109	0.2605
<i>NO Ratio</i>	0.0015	0.0065	0.0000	0.0000	0.0000	0.0000	0.0404
<i>MNE Ratio</i>	0.3613	0.2724	0.0000	0.1713	0.3069	0.4489	1.0000
<i>Low Tax</i>	0.7754	0.4174	0.0000	1.0000	1.0000	1.0000	1.0000

Given the low average market share held by Norwegian multinationals, we use a threshold of 1% market share to reproduce Figure 4.4 for this sample. We plot the difference in net entry rates and observe no differences in net entry ratios between industries with no Norwegian multinationals (but at least 5 % market share held by multinationals) and industries with at least 1% market share owned by Norwegian firms. If at all, we observe a small increase in net entry rates after 2008.

Figure 4.5: Industry Dynamics in Industries of Norwegian Multinationals



We rerun our multivariate regression approach of equation (2) replacing the *U.K. Ratio* with *NO Ratio*, which represents the percent of market share owned by Norwegian firms. Results

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are reported in Table 4.10 and support the nonparametric results of Figure 4.5. We observe an increase in net entry ratios after 2008, which is driven by a decline in exit ratios.

Table 4.10: Industry Dynamics in Industries with Norwegian MNEs

This table provides regression results of estimating equation (3) using *Net Entry Ratio* (Panel A) and *Entry Ratio* (Panel B) as dependent variables. We include country–industry and country-1 digit industry–year fixed effects (where we define industry at the one digit level), in all regressions. We report standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Net Entry Ratio</i>	<i>Entry Ratio</i>	<i>Exit Ratio</i>
<i>NO Ratio</i> × <i>After</i>	0.6254* (0.3670)	-0.0092 (0.1684)	-0.2145* (0.1223)
<i>MNE Ratio</i> × <i>After</i>	0.0003 (0.0110)	0.0173* (0.0098)	0.0170** (0.0078)
Country–Industry & country–1digit–industry–year fixed effects included			
Observations	2,021	2,021	2,021
Adj. R ²	0.467	0.801	0.814

Thus, we do not find declines in (net) entry ratios as in industries with a high share of U.K. multinationals. This mitigates concerns that the decline in (net) entry ratios in U.K. industries can be explained with exchange rate fluctuations that foster foreign activities of U.K. multinationals and could lead to (temporary competitive advantages) in the Euro area after 2008. In that case, we would expect to find similar results for Norwegian firms that also benefited from a weak Norwegian Krone relative to the euro.

Another concern could be that the decline in (net) entry ratios is a phenomenon that we observe in industries with a high share of multinationals (for example because their competitive position due to cartels or lobbying) and that we are not able to fully disentangle a high ratio of U.K. multinationals from a general high market share of multinational firms in our main analysis.⁹³ If Norwegian as well as U.K. multinationals are more likely to operate in industries with a high share of multinationals this test also mitigates these concerns.

⁹³ Note that we address this concern in our main test by limiting control industries only to industries with at least 5 % market share of multinationals in Figure 4.4 and by including an interaction of the multinational market share and *After* in the regression.

Overall, this study provides evidence in line with the notion of an increased competitiveness of U.K. multinationals after the reform. While the firm-level analysis reveals increases in output of foreign subsidiaries of U.K. multinationals, the industry analysis suggests a decline in (net) entry ratios in industries with a high share of U.K. multinationals. While the timing of the decline in (net) entry ratios supports the notion that the tax reform has led to changes in foreign market dynamics and while the placebo test with Norwegian firms tries to mitigate concerns that exchange rate fluctuations explain our findings, we acknowledge that we are not able to fully rule out alternative explanations for the change in market dynamics in these industries. Thus, we rather see the industry analysis as supportive evidence and we refrain from causal interpretations.

4.6 Conclusion

This study contributes to the ongoing discussion about the optimal taxation of foreign profits by examining differences in the competitiveness of multinationals depending on the taxation regime in their headquarter location.

We expect multinationals to experience a competitive disadvantage relative to their competitors in foreign markets with a tax rate below their headquarter's tax rate under worldwide taxation. In line with prior literature, we expect worldwide taxation to refrain multinationals from investments in low-tax countries (Liu 2017, Feld et al. 2016). Thus, we expect multinationals to increase investments and potentially relocate (part of) their production to low-tax countries under territorial taxation. This should lead to an increase in profitability and output of their subsidiaries after the regime change irrespective of their location. We expect this to have adverse effects on the number of competitors as the equilibrium price falls.

Our empirical analysis exploits the change from worldwide to territorial taxation in the U.K. in 2009. Firm-level results using private firm data from Amadeus reveal that U.K. subsidiaries

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increase their output after the reform. Moreover, firm-level analyses provides support for a relocation process of capital from high-tax to low-tax countries. Using industry-level data from Eurostat, we observe a decline in entries in industries with a high share of U.K. multinationals. This supports the notion that the increase in output of U.K. multinationals leads to a decline in expected profits in the respective industries, which prevents new firms from entering. We do not find evidence for an increase in exit ratios in these industries. While the placebo test with Norwegian firms tries to mitigate concerns that exchange rate fluctuations explain our findings, we acknowledge that we cannot fully rule out alternative explanations for the change in market dynamics in these industries.

To the best of our knowledge, this paper is the first that studies the effect of the foreign taxation regime on the competitiveness of multinationals. We provide support for the notion of the U.K. government that worldwide taxation “hinders the competitiveness of U.K. based multinationals”, a major motivation for U.K. policy makers to change from worldwide to territorial taxation in 2009.⁹⁴ Moreover, we highlight a potential trade-off which needs to be considered when changing to a territorial regime: While multinationals increase their competitiveness under territorial taxation, our results suggest adverse effects on firms that compete with multinationals on foreign markets. However, we refrain from causal interpretations.

An interesting path for future research could be to analyze the overall impact on industry concentration and to discuss potential welfare implications. While we only focus on the competitiveness of U.K. multinationals in foreign markets, another interesting path for future research could be to analyze the effect of increased competitiveness of U.K. multinationals in domestic markets and to identify potential losers of the reform in the U.K.

⁹⁴ See HM Treasury 2009, <http://webarchive.nationalarchives.gov.uk/20140109143644/http://www.hmrc.gov.uk/ria/foreign-profits.pdf>, p. 4 last accessed August 25, 2017.

5 Summary and Conclusion

The three studies in this dissertation contribute to existing streams of literature which focus on investment responses and other economic consequences of tax policy and thereby answers the call for papers on the “real-effects” of tax policy of Hanlon and Heitzman (2010). The three studies inform policy makers about major beneficiaries of their reforms and in some cases raise concerns about the desirability of the investment response (chapter 3). Finally, this thesis gives first insights into the impact of taxation on the competitiveness of firms by studying market dynamics following a quasi-natural experiment that changes the taxation system of foreign income (chapter 4).

Chapter 2 supports prior literature in showing a negative relation between statutory tax rates and investments in a setting that exploits local business tax rate changes which are set at the municipality level and thereby allows the comparison of investments of treated and control firms in a very homogeneous institutional and economic environment. In line with prior literature that shows larger investment-cash flow sensitivities of financially constrained firms, the results suggest that tax-induced changes in capital are up to half times larger for financially constrained (small and young) firms relative to unconstrained firms. Moreover, firms with more tax avoidance possibilities (multi-jurisdictional firms) show lower capital elasticities to tax rate changes. This is an interesting insight because it provides evidence that the negative relation between taxes and capital does not only represent capital relocations to lower tax jurisdictions of multi-jurisdictional firms. The decline in capital after a tax rate increase rather represents a decline in operations of single-jurisdictional firms stemming from the increase in the costs of capital. Finally, chapter 2 finds support for the notion that tax incidence influences the relation between taxes and capital stock. There is a weaker relation between taxes and capital stock for firms with high market power vis-à-vis their customers or vis-à-vis their employees, which suggests that these firms may transfer the additional tax burden to their consumers via an

increase in prices or to their employees via a cut in wages following tax rate increases. However, the analysis is limited to very indirect measures for the tax incidence and should therefore be interpreted with caution.

This dissertation further examines the investment response of loss firms to the availability of tax loss carryback provisions in chapter 3. Results suggest that the additional cash resulting from the tax refund of previously paid taxes stimulates the investments of loss firms. A key contribution of this paper lies in the discussion about the desirability of the investment response, which is driven primarily by firms that are prone to engage in risky overinvestment. That is, loosening such firms' financial constraints likely represents misallocation. The fact that this weakens the competitive selection of firms by delaying the exit of low-productivity firms corroborates this notion. This weakened competitive selection maps into lower average productivity and aggregate output at the industry level. The findings are relevant for policymakers, since unprofitable firms represent a substantial part of the overall firm population and their investment behavior has a substantial impact on the performance of the overall economy, particularly during economic downturns. However, this dissertation refrains from drawing conclusions about the welfare effects of reducing tax asymmetry via loss carrybacks. The findings complement prior literature that finds a positive effect of tax loss carrybacks on risk taking for an overall net benefit comparison of tax loss regimes.

Chapter 4 contributes to the ongoing discussion about the optimal taxation of foreign profits by examining differences in the competitiveness of multinationals depending on the taxation regime in their headquarter location. This study makes use of a quasi-natural experiment in the U.K. that changed from a worldwide to a territorial taxation regime in 2009 to improve the competitiveness of their multinational firms. It is shown that foreign subsidiaries of U.K. multinationals increase their output, which could partly be explained with a relocation of capital from high-tax to low-tax countries. Moreover, results suggest a decline in entry rates in foreign

markets in industries with a high ratio of U.K. multinationals. The decline in entry rates is in line with the notion of an increased competitiveness of U.K. multinationals that lead to a decline in expected profits in the respective industries. The findings highlight a potential trade-off of changing to a territorial regime: while multinationals increase their competitiveness under territorial taxation, we observe adverse effects on firms that compete with multinationals on foreign markets. Once again, this study refrains from analyzing the effect on industry concentration or potential welfare implications.

Overall this dissertation highlights the important role of taxation in corporate decision-making and discusses its potential impact on macroeconomic outcomes. While lower statutory tax rates as well as more lenient loss offset possibilities appear to stimulate investments, these studies also provide evidence on the potential (economic) costs of stimulating investments (chapter 3) depending on the type of firm that drives the average investment response. The studies further examine potential effects on competition and aggregate output and productivity. Finally, it is shown how a change in tax policy (taxation of foreign income) affects the competitiveness of multinational firms and thereby foreign market dynamics.

This dissertation opens several paths for future research. First, more research is needed to analyze heterogeneity in firms' responsiveness to tax policy to inform policy makers about the main beneficiaries of their reforms, which could help to evaluate the desirability of a tax reform. For example, the fact that mostly small and domestic firms bear the additional costs of a tax rate increase while larger firms are better able to avoid the additional tax burden, could inform the political debate. While prior literature has focused on the average response for a long time, a growing stream of literature analyzes cross-sectional variation in the investment response to tax policy. For example, it is shown that financial constraints, tax avoidance possibilities, or the availability of tax loss carryforwards mitigate the impact of taxes on investments (Edgerton 2010, Schreiber and Overesch 2010, Faulkender and Petersen 2012, Mahon and Zwick 2014,

Dobbins and Jacob 2016). In this context, it could be an interesting path to further analyze the role of tax incidence in the relation between taxation and investment decisions as suggested by Dyreng et al. (2017). Firms with higher market power could be less likely to bear the economic tax burden because they are better able to shift the tax incidence to their consumers or employers. While findings in this thesis support the notion that tax incidence influences the relation between taxation and investments, the mitigating role of tax incidence should be examined in more detail using more exogenous settings and more direct measure for tax incidence in future research.

Second, this dissertation could generally be seen as a motivation to go beyond the analysis of investment responses in order to examine the desirability of the response and to consider more general welfare implications of changes in tax policy such as effects on the competitive selection of firms. While chapter 3 reveals positive investment responses to more lenient tax loss offset possibilities which loosen financial constraints of loss making firms on average, it raises concerns about the desirability of investments of these firms. Prior literature usually considers the loosening of financial constraints as the repeal of inefficient constraints which are induced by market inefficiencies. On the other hand, especially in case of loss-making firms, the loosening of financial frictions could encourage overinvestments of distressed and inefficient firms and thereby delay their exit. Thus, future research should discuss and analyze in more detail the opportunity costs of government funds: even if changes in tax policy increase average investments, the same amount of government funds could have been more welfare-increasing if spent differently.

Finally, if changes in tax policy help especially one group of firms, e.g., by stimulating investments or facilitating profit shifting this will directly impact their competitive position relative to other firms in their industry. Thus, tax policy will impact competition. While there is a large stream of theoretical evidence on the relation between tax policy and competition (for

a review see e.g., Brekke et al. 2017), empirical evidence is still scant. Empirical tax research has broadly focused on firm-level outcomes such as investments, leverage, or tax avoidance. A more detailed focus on macroeconomic outcomes such as industry concentration or industry dynamics could represent an interesting complement to prior literature. The studies by Hoopes, Thornock, and Williams (2015) who find a competitive advantage of e-tailers who benefit from a sales tax exemption and the study by Sorbe and Johansson (2017) who find that tax avoidance improves the competitive position of multinational firms represent first examples for empirical evidence in this respect.

A. Appendix to Chapter 2

A.1 Extended Theory⁹⁵

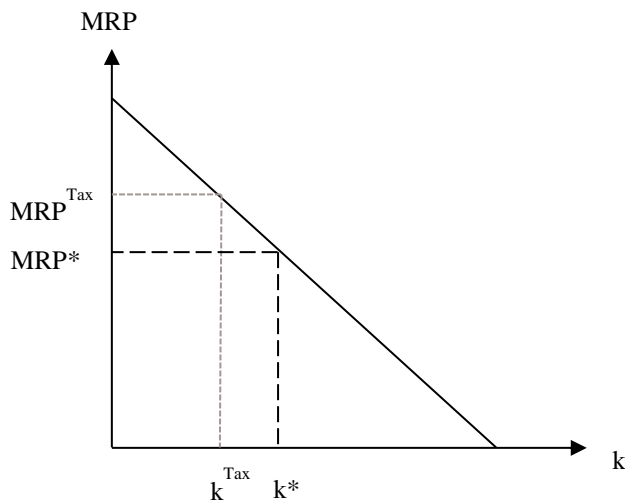
In this section, I provide more formal evidence for

- (i) the negative effect of tax rates on the required marginal product of capital, and
- (ii) the mitigating role of consumer demand elasticity in the relation between taxes and the required marginal product of capital.

Choosing the optimal level of capital

According to standard neoclassical investment theory (Jorgenson 1963, Hall and Jorgenson 1967) firms choose their optimal level of capital (k^*) where the marginal revenue product (MRP) of capital equals the user cost of capital (required rate of return) (r). The marginal revenue product represents the product of the output price (p) and the firm's marginal product of capital (MP). Taxes increase the required return for each additional unit of capital.

Figure A.1-1: Required rates of return and marginal revenue product



⁹⁵ I am thankful to Michael Devereux who helped developing this section.

(i) Marginal product of capital and income taxes

Let us assume a producer with market power who can influence the market price (p) with his output $Y(k, l)$. He pays a wage (w) for each unit of labor (l) and r for each unit of capital (k). An income tax is levied on revenues net of wage expense and capital costs. Capital costs are deductible at a rate $1 - \alpha$.

Demand for capital stock (k) is determined to maximize profits (Π):

$$\Pi = \underbrace{p(Y(k, l)) \times Y(k, l)}_{\text{Revenue}} - \underbrace{wl - rk}_{\text{Labor and capital costs}} - \underbrace{t [p(Y(k, l)) * Y(k, l) - wl - (1 - \alpha)rk]}_{\text{Tax expense}}$$

$$\frac{\partial \Pi}{\partial k} = \frac{\partial p}{\partial Y} Y_k Y + p Y_k - r - t \left[\frac{\partial p}{\partial Y} Y_k Y - (1 - \alpha)r \right] = 0$$

Rearranging for the profit maximizing marginal product of capital (Y_k) yields:

$$\Leftrightarrow (1 - t) \left[Y_k \left(p + Y \frac{\partial p}{\partial Y} \right) - r \right] - r [1 - t(1 - \alpha)] = 0 \mid \varepsilon = - \frac{Y}{p} \frac{\partial p}{\partial Y}$$

$$\Leftrightarrow (1 - t) p Y_k (1 - \varepsilon) - r [1 - t(1 - \alpha)] = 0$$

$$\Leftrightarrow Y_k = \frac{r(1 - t(1 - \alpha))}{(1 - t) p (1 - \varepsilon)} > 0$$

With $0 > r < 1$, $0 > \varepsilon < 1$, $0 > t < 1$, $0 > \alpha < 1$, and $p > 0$ the marginal product of capital is increasing with corporate income tax. Thus, increasing corporate tax rates, increases the marginal revenue (the marginal product) that each additional unit of capital must yield in order to equal marginal costs. If the marginal product of capital increases, the optimal level of capital (k) decreases.

(ii) The role of demand elasticity in the relation between the marginal product of capital and taxes

To examine the role of demand elasticity (ε) in the relation between taxes and the marginal product of capital, I further differentiate Y_k with respect to t .

$$\frac{\partial Y_k}{t} = \frac{-r(1-\alpha)}{(1-t)p(1-\varepsilon)} + \frac{r(1-t)(1-\alpha)}{p(1-\varepsilon)(1-t)^2}$$

$$\frac{\partial Y_k}{t} = \frac{-r(1-t(1-\alpha)) - r(1-\alpha)(1-t)}{p(1-\varepsilon)(1-t)^2}$$

$$\frac{\partial Y_k}{t} = \frac{\alpha r}{p(1-\varepsilon)(1-t)^2} > 0$$

With $0 > r < 1$, $0 > \varepsilon < 1$, $0 > t < 1$, $0 > \alpha < 1$, and $p > 0$, the effect of corporate income tax (t) on the marginal product of capital is increasing with the demand elasticity. Thus, the more elastic the consumer demand (the more of the tax incidence falls on the producer), the stronger is the effect of a change in tax policy on the marginal product of capital and thereby the level of optimal capital stock.

A.2 Variable Descriptions

Variable	Definition
Firm-level variables	
<i>Age</i>	Age of firm measured as the time period between t and the date of incorporation.
<i>Cash</i>	Cash holdings.
<i>Domestic</i>	Firm belongs to a domestic corporate group that operates in more than one municipality.
<i>EBIT</i>	Earnings before interest and taxes.
<i>Fixed Assets</i>	Fixed assets include tangible and intangible assets and other fixed assets such as long term investments, shares and participations, or pension funds.
<i>Liabilities</i>	Long-term and short-term liabilities.
<i>MNE</i>	Firm belongs to a multinational corporate group.
<i>Profit margin</i>	Earnings before interest, tax, depreciation, and wages relative to sales.
<i>Sales growth</i>	Average percentage change in sales, winsorized at 1% and 99%.
<i>SingleJuris</i>	Firm is either stand-alone or belongs to a domestic group that operates in only one municipality.
<i>Start-Up</i>	Dummy variable equal to one if the firm was registered for less than five years.
<i>Wage</i>	Wage expense.
Country- and industry-level variables	
<i>GDP growth</i>	Annual percentage change in <i>GDP</i> .
<i>Ln(GDP)</i>	Logarithm of the GDP measured at state level in year 2010 real euros (in billions).
<i>Local Property Tax</i>	Multiplier for local property taxes that is set at municipality level.
<i>Tax Rate</i>	Overall statutory corporate tax rate including corporate income tax (“Koerperschaftssteuer”), solidarity surcharge (“Solidaritaetszuschlag”), and local business tax (“Gewerbsteuer”).
<i>Unemployment</i>	Unemployment rate at county (<i>Kreis</i>) level.

A.3 Computation of the Local Business Tax

This table gives an overview of the computation of the local business tax and overall corporate income tax burden before and after the 2008 Business Tax Reform.

Before	After
<i>Computation of the Local Business Tax (LBT):</i>	
$\frac{\text{Multiplier} * 5\%}{1 + (\text{Multiplier} * 5\%)}$	$\text{Multiplier} * 3.5\%$
<i>Computation of the Overall Statutory Tax Rate:</i>	
$25\% \times (1 - \text{LBT}) \times (1 + 5.5\%) + \text{LBT}$	$15\% \times (1 + 5.5\%) + \text{LBT}$

A.4 Additional Tables

Table A.1: Descriptive Statistics

This table presents descriptive statistics of our main variables over the sample period for domestic and multinational group firms in Panel A and single-jurisdictional firms in Panel B. All variables are defined in Appendix A.2. I have no ownership information on the remaining number of observations.

Panel A: Domestic Groups and MNE

Variable	N	Mean	Standard deviation	25 th percentile	50 th percentile	75 th percentile
<i>FixedAssets</i> (inT€)	61,917	30,800	452,000	441	2,532	10,900
<i>TaxRate</i>	61,917	32.0369	4.1506	28.9500	31.2250	32.9750
<i>LocalPropertyTax</i>	61,917	426.7402	119.7797	345.0000	412.0000	490.0000
<i>Wage_{t-1}</i> (inT€)	61,917	13,800	80,800	1,662	4,481	12,200
<i>Sales_{t-1}</i> (inT€)	61,917	103,000	947,000	9,389	24,700	63,300
<i>Start-Up</i>	61,917	0.0836	0.2768	0.0000	0.0000	0.0000
<i>Salesgrowth</i>	61,917	0.0490	0.2624	-0.0548	0.0179	0.1075
<i>ROA_{t-1}</i>	61,917	0.1254	0.1306	0.0383	0.0846	0.1672
<i>Cash-to-Assets_{t-1}</i>	61,917	0.1264	0.1677	0.0096	0.0536	0.1770
<i>Leverage_{t-1}</i>	61,917	0.6583	0.2782	0.4641	0.6822	0.8487
<i>Loss</i>	61,917	0.0882	0.2836	0.0000	0.0000	0.0000
<i>Corporation</i>	61,917	0.9044	0.2941	1.0000	1.0000	1.0000
<i>ProfitMargin</i>	61,626	0.0950	0.8059	0.0319	0.0639	0.1158

Panel B: Single-jurisdictional firms

Variable	N	Mean	Standard deviation	25 th percentile	50 th percentile	75 th percentile
<i>Fixed Assets</i> (in T €)	24,035	2,546	145,000	47	181	755
<i>Tax Rate</i>	24,035	31.8080	4.1764	28.4250	30.6300	35.4167
<i>Local Property Tax</i>	24,035	413.9948	121.0360	330.0000	390.0000	470.0000
<i>Wage_{t-1}</i> (in T €)	24,035	2,126	25,800	235	602	1,581
<i>Sales_{t-1}</i> (in T €)	24,035	14,600	197,000	1,076	2,905	9,105
<i>Start-Up</i>	24,035	0.1348	0.3415	0.0000	0.0000	0.0000
<i>Sales growth</i>	24,035	0.0784	0.3105	-0.0714	0.0312	0.1600
<i>ROA_{t-1}</i>	24,035	0.1421	0.1475	0.0489	0.0947	0.1789
<i>Cash-to-Assets_{t-1}</i>	24,035	0.1361	0.1664	0.0120	0.0657	0.2050
<i>Leverage_{t-1}</i>	24,035	0.7565	0.3182	0.5696	0.7633	0.9082
<i>Loss</i>	24,035	0.0800	0.2712	0.0000	0.0000	0.0000
<i>Corporation</i>	24,035	0.9238	0.2653	1.0000	1.0000	1.0000
<i>Profit Margin</i>	23,976	0.0778	0.2135	0.0279	0.0549	0.1016

Table A.2: Tax Rate Elasticities of Capital, Baseline, Robustness

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. Columns (1) to (3) include the same firm control variables as in Table 2.3. I include firm fixed effects in all specifications. In Panel A, I include county–year fixed effect. In Panel B and C, I include state–year and industry–year fixed effects, respectively. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

Panel A: Semi-elasticities

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
<i>Tax Rate</i>	-0.0330** (0.0129)	-0.0302** (0.0123)	-0.0291*** (0.0106)
<i>Local property Tax</i>	0.0003 (0.0002)	0.0003 (0.0002)	0.0003* (0.0002)

Firm fixed effects & county–year fixed effects included

Observations	111,392	111,392	111,392
Adj R-squared	0.951	0.953	0.953
Within R-squared	0.0002	0.0455	0.0512

Panel B: State–year fixed effects

$\ln(\text{Tax Rate})$	-0.8010*** (0.2936)	-0.7294** (0.3042)	-0.6971*** (0.2615)
<i>Unemployment Rate</i>	-0.0084 (0.0075)	-0.0050 (0.0076)	-0.0061 (0.0066)
$\ln(\text{Local property Tax})$	0.0660 (0.0950)	0.0689 (0.0914)	0.0649 (0.0794)

Firm fixed effects & state–year fixed effects included

Observations	111,392	111,392	111,392
Adj R-squared	0.950	0.953	0.953
Within R-squared	0.0003	0.0462	0.0519

Panel C: Industry–year fixed effects

$\ln(\text{Tax Rate})$	-0.6895*** (0.2560)	-0.5831** (0.2460)	-0.5760*** (0.2114)
$\ln(\text{GDP})$	0.7901** (0.3438)	0.6457* (0.3383)	0.6375** (0.2913)
<i>GDP growth</i>	-0.5327** (0.2392)	-0.5234** (0.2347)	-0.5221** (0.2067)
<i>Unemployment rate</i>	0.0011 (0.0061)	0.0033 (0.0060)	0.0025 (0.0052)
$\ln(\text{Local property Tax})$	0.0417 (0.0769)	0.0403 (0.0748)	0.0397 (0.0652)

Firm fixed effects & industry–year fixed effects included

Observations	111,391	111,391	111,391
Adj R-squared	0.950	0.953	0.953
Within R-squared	0.0007	0.0466	0.0522

Panel D: County-year and industry-year fixed effects

Ln(Tax Rate)	-1.0044*** (0.3118)	-0.9352*** (0.2953)	-0.8925*** (0.2928)
Ln(Local property Tax)	0.0879 (0.0758)	0.1075 (0.0731)	0.1025 (0.0725)

Firm fixed effects & county-year & industry-year fixed effects included

Observations	111,391	111,391	111,391
Adj R-squared	0.950	0.953	0.953
Within R-squared	0.0002	0.0453	0.0510

Table A.3: Tax Rate Elasticities of Capital, Alternative Dependent Variable

The dependent variable is the logarithm of *Investment*, which is defined as the change in fixed assets before depreciation. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. I include firm and industry-year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

Panel A: Industry-year fixed effects

	$\ln(Investment)_{i,t}$		
	(1)	(2)	(3)
Ln(Tax Rate)	-1.0850*** (0.3520)	-0.9518*** (0.3427)	-0.9031*** (0.3417)
Ln (GDP)	0.9478*** (0.3326)	0.7170** (0.3232)	0.6290* (0.3263)
GDP growth	-0.7244 (0.5146)	-0.8422* (0.4971)	-0.8473* (0.4947)
Unemployment rate	-0.0111 (0.0081)	-0.0093 (0.0079)	-0.0077 (0.0077)
Ln(Local property Tax)	0.1396 (0.0898)	0.1290 (0.0870)	0.1107 (0.0857)
Ln (Wage) _{t-1}		-0.0477* (0.0251)	-0.0161 (0.0252)
Ln (Sales) _{t-1}		0.5468*** (0.0403)	0.5151*** (0.0397)
Start-Up		-0.0401 (0.0268)	-0.0407 (0.0274)
Sales Growth		0.7775*** (0.0281)	0.8177*** (0.0284)
ROA _{t-1}			0.8588*** (0.0689)
Cash-to-Assets _{t-1}			0.6968*** (0.0652)
Leverage _{t-1}			-0.3753*** (0.0426)

Firm fixed effects & industry-year fixed effects included

Observations	93,094	93,094	93,094
Adj R-squared	0.766	0.771	0.773
Within R-squared	0.0004	0.0216	0.0309

Panel B: State–year fixed effects

	$\ln(\text{Investment})_{i,t}$		
Ln(Tax Rate)	-1.0920*** (0.3997)	-1.0426*** (0.3959)	-1.0140** (0.3948)
Firm fixed effects & state–year fixed effects included			
Observations	93,095	93,095	93,095
Adj R-squared	0.766	0.771	0.772
Within R-squared	0.0003	0.0216	0.0297

Table A.4: Single-Jurisdictional Firms vs. Multi-Jurisdictional Firms, Matching

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. I include firm and county–year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

Panel A: Entropy Balancing

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
Ln (Tax Rate)	-0.9112* (0.5531)	-0.9331* (0.5362)	-0.8465 (0.5338)
Ln (Tax Rate) x SingleJuris	-0.4288*** (0.1163)	-0.4270*** (0.1122)	-0.4158*** (0.1125)
Joint significance Ln (Tax Rate) + Ln (Tax Rate) x SingleJuris	-1.3401** (0.5553)	-1.3600** (0.5375)	-1.2623** (0.5349)
Firm fixed effects & county–year fixed effects included			
Observations	85,914	85,914	85,914
Adj R-squared	0.935	0.938	0.938
Within R-squared	0.0013	0.0430	0.0472

Panel B: Propensity Score Matching

Ln (Tax Rate)	-1.1548 (0.7754)	-1.3377* (0.7322)	-1.3312* (0.7244)
Ln (Tax Rate) x SingleJuris	-0.5528** (0.2241)	-0.4527** (0.2145)	-0.4397** (0.2150)
Joint significance Ln (Tax Rate) + Ln (Tax Rate) x SingleJuris	-1.7076** (0.77859)	-1.7904** (0.7314)	-1.7709** (0.7273)
Firm fixed effects & county–year fixed effects included			
Observations	12,974	12,974	12,974
Adj R-squared	0.945	0.947	0.947
Within R-squared	0.0022	0.0449	0.0456

Table A.5: Tax Rate Elasticities of Capital, Domestic vs. Multinational Groups

The dependent variable is the logarithm of *Fixed Assets*. *Tax Rate* represents the overall statutory tax rate including corporate income tax, local business tax and solidarity surcharge. I exclude firms that operate in a single municipality (single jurisdictional firms) and firms for which I have no ownership information from my sample. I include firm and county–year fixed effects in all specifications. Standard errors are clustered at the municipality level and reported in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

	$\ln(\text{Fixed Assets})_{i,t}$		
	(1)	(2)	(3)
$\ln(\text{Tax Rate})$	-0.5109 (0.5174)	-0.4290 (0.4763)	-0.4056 (0.4185)
$\ln(\text{Tax Rate}) \times \text{Domestic}$	-0.3057*** (0.0937)	-0.2619*** (0.0871)	-0.2665*** (0.0777)
$\ln(\text{Local property Tax})$	-0.0131 (0.1214)	0.0070 (0.1176)	0.0093 (0.1026)
$\ln(\text{Wage})_{t-1}$		0.1664*** (0.0253)	0.1540*** (0.0220)
$\ln(\text{Sales})_{t-1}$		0.2937*** (0.0337)	0.3134*** (0.0306)
<i>Start-Up</i>		-0.0361 (0.0268)	-0.0313 (0.0233)
<i>Sales Growth</i>		0.2862*** (0.0215)	0.2760*** (0.0187)
ROA_{t-1}			-0.3753*** (0.0565)
$\text{Cash-to-Assets}_{t-1}$			-0.4103*** (0.0625)
Leverage_{t-1}			-0.1733*** (0.0396)
Joint significance $\ln(\text{Tax Rate}) + \ln(\text{Tax Rate}) \times \text{Domestic}$	-0.8166 (0.5165)	-0.6909 (0.4761)	-0.6721 (0.4181)
Firm fixed effects & county–year fixed effects included			
Observations	61,796	61,796	61,796
Adj R-squared	0.945	0.947	0.961
Within R-squared	0.0008	0.0456	0.947

B. Appendix to Chapter 3

B.1 Variable Definitions

Variable	Definition
Firm-level variables	
<i>Accruals</i>	$[(\Delta \text{ Current Assets } (cuas) - \Delta \text{ Cash } (cash)) - (\Delta \text{ Current Liabilities } (culi) - \Delta \text{ Current Debt } (loan) - \Delta \text{ Taxes payable } (taxa)) - \text{ Depreciation } (depr)]$, relative to prior year's total assets (<i>toas</i>), winsorized yearly at 1% and 99%.
<i>Age</i>	Age of firm measured as the period between t and the date of incorporation.
<i>Cash Holdings</i>	Cash (<i>cash</i>) relative to the prior year's total assets (<i>toas</i>), winsorized yearly at 1% and 99%.
<i>Cash Refund</i>	Proxy for the tax refund (minimum of the prior year's profits and this year's loss multiplied by the prior year's statutory tax rate) relative to the prior year's total assets (<i>toas</i>) if <i>Refund</i> is equal to one and zero otherwise. For German firms, the maximum refundable income equals €511,500.
<i>Capital Intensity</i>	Prior year's fixed assets (<i>fias</i>) relative to the prior year's total assets (<i>toas</i>), winsorized yearly at 1% and 99%.
<i>Exit</i>	Dummy variable equal to one if the firm exits the market in the next period.
<i>Firm Size</i>	Natural logarithm of the prior year's total assets (<i>toas</i>) in euros.
<i>Investment</i>	Change in fixed assets (<i>fias</i>) before depreciation (<i>depr</i>) relative to the prior year's total assets (<i>toas</i>).
<i>Labor Intensity</i>	Wage expense (<i>staf</i>) relative to the prior year's total assets (<i>toas</i>), winsorized yearly at 1% and 99%.
<i>Leverage</i>	Total liabilities (<i>tshf - shfd</i>) relative to the prior year's total assets (<i>toas</i>), winsorized yearly at 1% and 99%.
<i>Loss</i>	Dummy variable equal to one if the firm reports a loss ($ebit < 0$) in t .
<i>LT Debt</i>	Long-term debt (<i>ltdb</i>)—e.g., to credit institutions (loans and credits), bonds—relative to the prior year's total liabilities ($ncli + culi$), winsorized yearly at 1% and 99%.
<i>Payout</i>	Net income (<i>pl</i>) net of the change in total equity (<i>shfd</i>) relative to the prior year's total assets (<i>toas</i>), winsorized yearly at 1% and 99%.
<i>Productivity</i>	Residuals of the following log-linear Cobb–Douglas production function that we estimate for every country–industry–year: $\ln(\text{Value Added})_{i,t} = \alpha_0 + \beta_1 \ln(\text{Labor})_{i,t} + \beta_2 \ln(\text{Capital})_{i,t} + \varepsilon_{j,t}$, where <i>Value Added</i> is defined as a firm's EBIT, depreciation, and amortization (<i>ebita</i>); labor expense, <i>Labor</i> , is defined as a firm's overall wage expense (<i>staf</i>); <i>capital</i> is defined as fixed assets (<i>fias</i>) at the beginning of the period, winsorized yearly at 1% and 99%.
<i>Profitability</i>	EBIT (<i>ebit</i>) relative to the prior year's total assets, winsorized yearly at 1% and 99%.
<i>Refund</i>	Dummy variable equal to one if the firm reports a loss ($ebit < 0$) in $t - 1$ and a profit ($ebit > 0$) in t .
<i>Sales</i>	Annual sales (<i>turn/opre</i>) relative to the prior year's total assets, winsorized yearly at 1% and 99%.
<i>Sales growth</i>	Annual percentage change in sales (<i>turn/opre</i>), winsorized yearly at 1% and 99%.
<i>Start-Up</i>	Dummy variable equal to one if the firm was registered for less than five years.

Country-level variables

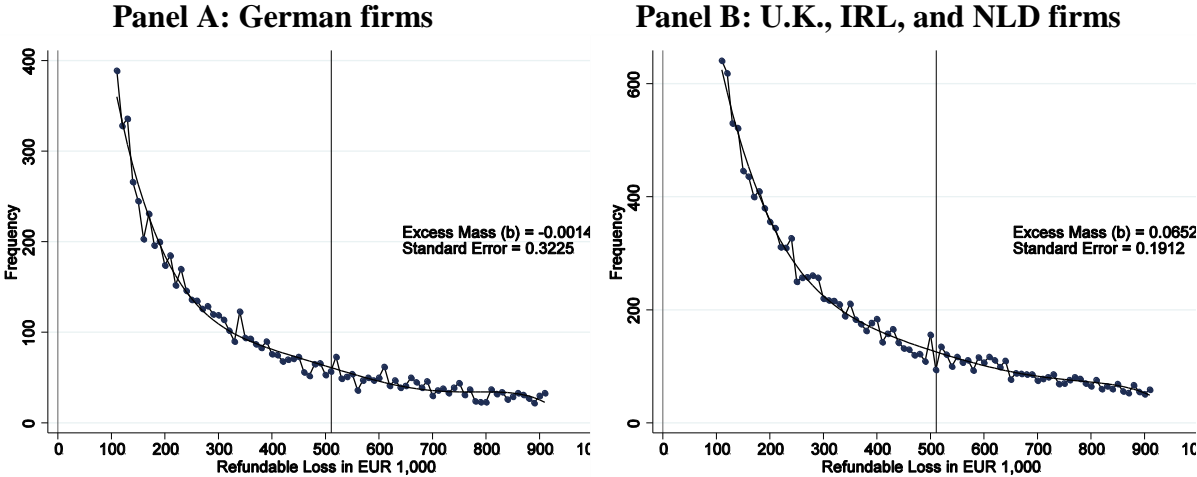
<i>GDP growth</i>	Annual percentage change in the GDP.
<i>LCB</i>	Dummy variable equal to one if the country allows tax loss carrybacks.
<i>LCF</i>	Index for the restrictiveness of loss carryforward provisions. We define three categories to evaluate the restrictiveness of loss carryforward periods: (i) the length of the loss carryforward period, (ii) minimum taxation rules, and (iii) other criteria, such as longer carryforward periods for start-up firms or special industries. We assign zero points if the carryforward period is less than five years, 0.5 points for periods between five and 15 years, and one point if the carryforward period is more than 15 years. We subtract 0.25 points if there are minimum taxation rules in place. We add 0.25 if there are any other benefits such as longer carryforward periods for start-up firms if the carryforward period is no longer than 15 years. With this ranking, we assign an index that ranges between zero and one for every jurisdiction in every year of our sample.
$\ln(GDP)$	Logarithm of the GDP in current U.S. dollars.
<i>RQ</i>	Regulatory quality, which captures perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private sector development.
<i>STR</i>	Statutory corporate tax rate. If there are progressive rates, this reflects the highest marginal rate. If tax rates depend on industries, we use the one that is applicable to industrial firms.

B.2 Assessing Identification with a Regression Kink Design around the German Carryback Limit

In this section, we exploit the limitation of refundable income from loss carrybacks in Germany using a regression kink design similar to that of Dobridge (2015). This test aims at providing evidence of the effect of loss carrybacks on investments in a setting with high internal validity. Germany limits refundable income to €511,500 during our sample period. If our argument holds, then any incremental refundable income below €511,500 should increase investments. Any incremental refundable income above €511,500 should not lead to more investments. This result predicts a discontinuity in the slope of the *Refund* coefficient at a refundable income of €511,500. This strategy relies on the identification assumption that the kink point does not introduce selection bias that would lead to bunching around the kink point. With respect to this identification assumption, we observe a smooth distribution of refundable income around the €511,500 threshold, as suggested by the following figure.

Figure B.2-1: Non-Bunching at the €511,500 Threshold

This figure presents the empirical distribution of firms' total assets around €511,500. Each point represents the number of observations in a €1,000 bin. Excess mass estimates compare the actual distribution around €511,500 to a fifth-degree polynomial fitted to the empirical distribution excluding bins within the range [-€1,000; +€1,000] around €511,500. Panel A shows the results for German firms and Panel B the results for our control firms from the United Kingdom, Ireland, and the Netherlands (from 2007).



For this analysis, we restrict the sample to German firms that are eligible for a tax refund with refundable income below €1 million. We use the estimate for a firm's tax refund as our *Refund* variable in this test. We allow the *Refund* coefficient to vary above and below a refundable income of €511,500 by introducing the indicator variable *Above*, which is equal to one if the refundable income is above €511,000. We estimate the following regression including firm controls from our main model:

$$\begin{aligned} Investment_{i,t} = & \alpha_0 + \alpha_{j,t} + \beta_1 \times Refund_{i,t} + \beta_2 \times Refund_{i,t} \times Above_{j,t} \\ & + \sum_k \gamma_k X_{k,i,t-1} + \varepsilon_i \end{aligned} \quad (B.1)$$

We expect the effect of larger cash refunds for a given loss on investment to be positive, that is, $\beta_1 > 0$. Since any incremental euros above the kink point do not yield an additional refund, the total effect of *Refund* above the threshold, the sum of β_1 and β_2 , should be insignificant. Therefore, β_2 is expected to be negative. Panel A of Table B.2-1 presents the regression results from estimating equation (B.1). As expected, below the threshold, there is a positive association of a tax refund on investment. Above the threshold, this association weakens and becomes insignificant. The negative β_2 coefficient has about the same magnitude as the positive β_1 coefficient. In other words, above the threshold of €511,500, there is no effect of a (hypothetical) tax refund on investment because the sum of both coefficients is insignificant. Our results are similar if we allow the control variables to have a different slope above and below the threshold (column (2), Panel A of Table B.2-1).

One potential concern with this result is that we pick up non-linearities in the effect of cash refunds on investment, that is, the incremental effect of an additional euro in the refund on investment weakens for firms with larger refunds. To address this concern, we rerun equation (B.1) in a placebo test using other countries that allow one-year carrybacks without limiting the amount of refundable income. The results are presented in columns (3) and (4) in Panel A of

Table B.2-1. The main effect of *Refund* is significant and positive, but its interaction with *Above* is insignificant; that is, the incremental effect of a tax refund does not change around the German threshold in other countries that allow carrybacks.

Table B.2-1: Tax Refunds and Investments, Identification around the German Threshold

This table presents the regression results from 2005–2013 using the sample of *Refund* firms in Germany, the United Kingdom, Ireland, and the Netherlands (as of 2007). The variable *Refund* refers to the estimate for a firm's tax refund in year t throughout the analysis. In Panel A, we separately run the analysis for Germany (columns (1) and (2)) and the control group (columns (3) and (4)). We define the cash equivalent as before but do not limit the refundable income to €511,500 in Germany (the legal maximum). We additionally introduce a dummy variable, *Above*, equal to one if the refundable income is above €511,500. In columns (2) and (4), we interact all firm controls with *Above*. In Panel B, we jointly analyze all countries and additionally include interactions with *Germany*, which is a dummy variable equal to one if the company is registered in Germany. We limit the sample to all firms with refundable income below €1 million. In columns (3) and (4), we further limit the sample to firms with refundable income between €100,000 and €900,000. In columns (2) and (4), we interact all firm controls with *Above*. We control for firm variables in $t-1$. We interact *Above* with all the control variables in columns (2) and (4). We include industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the firm level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Separate analysis

	Germany		Control group	
	(1)	(2)	(3)	(4)
<i>Refund</i>	1.6305*** (0.313)	1.2300*** (0.327)	1.0407*** (0.234)	0.8006*** (0.231)
<i>Refund</i> × <i>Above</i>	-2.0989*** (0.587)	-1.9308*** (0.584)	-0.4337 (0.565)	-0.4611 (0.556)
Firm controls in $t-1$ & firm fixed effects & industry–year fixed effects included				
Controls × <i>Above</i>	No	Yes	No	Yes
Observations	4,251	4,251	9,412	9,412
Adjusted R ²	0.035	0.053	0.019	0.038

Panel B: Analyzing all firms eligible for a tax refund

	All firms		Limited sample	
	(1)	(2)	(3)	(4)
<i>Refund</i>	0.7395*** (0.248)	0.8450*** (0.229)	0.6371* (0.338)	0.6680* (0.341)
<i>Refund</i> × <i>Germany</i>	0.3077 (0.381)	0.2959 (0.380)	0.3863 (0.521)	0.4013 (0.522)
<i>Refund</i> × <i>Above</i> × <i>Germany</i>	-1.4130* (0.794)	-1.5182* (0.795)	-1.7614* (0.917)	-1.9273** (0.909)
Firm controls in $t-1$ & firm fixed effects & industry–year fixed effects included				
Controls × <i>Above</i>	No	Yes	No	Yes
Observations	13,663	13,663	6,652	6,652
Adjusted R ²	0.042	0.042	0.042	0.043

We corroborate this inference in Panel B, where we pool all observations from Panel A and allow the coefficients of *Refund*, *Above*, and their interaction to vary between Germany and the

remaining countries' estimate. In line with our main results, the coefficient of *Refund* is positive and significant: An increase in the cash refund leads to more investments. This effect does not differ between Germany and other countries, as indicated by the insignificant coefficient of *Refund* \times *Germany*. However, above the €511,500 threshold, German firms' responsiveness to additional (hypothetical) cash refunds is weaker, as indicated by the significantly negative coefficient of *Refund* \times *Above* \times *Germany*. This result holds when we allow firm controls to have different slopes above and below the threshold (column (2)) and when we limit the sample to observations with a refundable income between €100,000 and €900,000 (columns (3) and (4)).

B.3 Assessing Identification with Out-of-Sample Evidence

In this section, we replicate our results using variation in loss carryback provisions across states in the United States. We use information on changes in a state's loss carryback provisions from Table A.2 of Ljungqvist, Zhang, and Zuo (2017) and we combine this information with firm-level data from Compustat. Our sample period covers 1988–2011. We drop observations with negative total assets or cash holdings. In line with the sample selection in our main test, we exclude financial and utility firms and firms missing industry information. Specifically, we test the following model allowing for the correlation of standard errors across time and firms within state–industries:

$$\begin{aligned}
 Investment_{i,t} = & \alpha_0 + \alpha_i + \alpha_{j,m,t} + \beta_1 \times Refund_{i,t} + \beta_2 \times Refund_{i,t} \times LCB y_{j,t} \\
 & + \sum_k \gamma_k X_{k,i,t-1} + \sum_l \delta_l C_{l,j} \times Refund_{i,t} + \sum_l \phi_n X_{k,i,t-1} \times Refund_{i,t} + \varepsilon_{i,t}
 \end{aligned}
 \tag{B.2}$$

where i , j , m , and t capture firms, states, industries, and years, respectively, and *Investment* is defined as capital expenditures relative to the prior year's total assets. Since there is mainly variation at the intensive margin across U.S. states, that is, in the number of carryback years, we define *LCB* as the number of loss carryback years rather than as a dummy for allowing loss carrybacks at all. The variable *Refund* is equal to one if the firm reports a loss—EBIT < 0—in the previous year and a profit—EBIT > 0—in $t - 2$. Alternatively, we use a continuous variable for *Refund* that proxies for the size of the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory state tax rate) for all eligible loss firms. The term $X_{k,i,t-1}$ represents a vector of lagged firm controls (*Firm Size*, *Cash Holdings*, *Leverage*, *Profitability*, *Sales growth*, *Capital Intensity*, and *Labor Intensity*). For this test, *Firm Size* is defined as the logarithm of the prior year's total assets (*at*); *Cash Holdings* is defined as cash (*che*) over the prior year's total assets; *Leverage* is defined as long-term and short-term debt (*dlc* and *dltt*) over the prior year's total assets; *Profitability* is defined as EBIT (*ebit*)

relative to the prior year's total assets; *Sales growth* is defined as the percentage change in sales (sale); *Capital Intensity* is defined as property, plant, and equipment (ppent) relative to the prior year's total assets; and *Labor Intensity* is defined as the number of employees (emp) relative to the prior year's total assets. The term $C_{l,j}$ represents a vector of state-level control variables that equal our country controls from the main analysis and *LCF* and *STR* represent the loss carryforward years and statutory tax rates of each state, respectively. We interact *Refund* with all the control variables. We include firm and state–industry–year fixed effects in all specifications to control for unobservable time-invariant firm-level characteristics and state–industry–year-specific factors that influence investment.

The results are reported in Table B.3-1. In line with our findings in the cross-country setting, we find positive investment effects of longer loss carryback periods. The effect is again a function of the size of a firm's tax refund. Even though the effects represent the investment responses of U.S. listed firms to a change in loss carrybacks at the intensive margin (number of carryback years), the results are similar to our main estimates that represent investment responses at the extensive margin for European private firms.

Table B.3-1: Loss Carrybacks and Investments, using U.S. State-Level Variation

This table presents the regression results from 1990–2010 using Compustat data. The variable *Investment* is defined as capital expenditures relative to the prior year's total assets; *LCB* is defined as the number of carryback years (carryback period). Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory state tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and state–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Investment_t</i>	
	<i>Refund =</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0075* (0.0042)	0.5481*** (0.1783)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and state-level controls & firm fixed effects & state–industry–year fixed effects included		
Observations	47,619	47,619
Adj. R ²	0.544	0.543

B.4 Measuring total factor productivity

To measure *Productivity*, we follow prior literature (e.g., Chemmanur, He, and Nandy 2010, Cappellari, Dell’Arling, and Leonardi 2012, Kim and Ouimet 2014, Krishnan, Nandy, and Puri 2015), and estimate firm-level total factor productivity (*TFP*) using a log-linear Cobb–Douglas production function that we estimate annually for every country and every Fama–French 48-industry code. We estimate the following equation for firm i , country k , industry j , and year t :

$$\ln(Y_{i,j,k,t}) = \alpha_{j,k,t} + \beta_1 \times \ln(K_{i,j,k,t}) + \beta_2 \times \ln(L_{i,j,k,t}) + \varepsilon_{i,j,k,t} \quad (\text{B.3})$$

The dependent output variable Y is defined as a firm’s value added (EBITDA plus labor expenses).⁹⁶ The capital input K is defined as fixed assets at the end of period t and the labor input L represents total wage expenses.⁹⁷ All values are inflation adjusted using the 2010 Consumer Price Index.⁹⁸ We require a minimum of 10 observations for every regression.

Since the coefficient estimates of capital and labor inputs can vary by each country, industry, and year combination, this specification allows for different factor intensities across these groups. The *TFP* measure for each firm is the estimated residual of these regressions. The residual represents the gap between a firm’s observed output and its predicted output based on observable input factors and the average production technology in its industry. Therefore, *TFP* can be interpreted as the relative productivity of a firm within its industry in any given year. Since these regressions include a constant term that captures industry- and country–year-specific productivity factors, the residual contains only the idiosyncratic part of firm productivity. This approach assigns a productivity value of zero to the average firm in each country, industry, and year cluster. This reduces concerns that TFP could be, for example, a

⁹⁶ We follow the approach suggested by Gal (2013) to impute value added from data available from Amadeus.

⁹⁷ Note that fixed assets include tangible as well as intangible fixed assets to the extent that intangible assets are capitalized.

⁹⁸ Prior literature usually uses industry-specific price deflators. However, due to limited data availability, we use only country-specific inflation adjustments.

measure of intangible asset investment within the industry. While we control for firm-specific intangible asset investment that explains a firm's output level to the extent that intangible assets are capitalized, we determine a firm's unexplained part of output relative to other firms in the same year and industry. This controls for the average level of intangible asset investment in an industry. We winsorize *TFP* at the first and 99th percentiles to arrive at our measure *Productivity*.

Marschak and Andrews (1944) were the first to raise concerns about potential correlations between input factors and unobserved firm-specific productivity. That is, in the case of positive productivity shocks, firms could use more input. In this case, ordinary least squares (OLS) estimations would lead to biased parameters. More sophisticated estimators have been developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) to address this problem by including investment or material inputs in the model, with further approaches developed by, for example, Akerberg, Caves, and Frazer (2006) and Wooldridge (2009b). Alternative measures for firm-level productivity are index numbers that relate output to a weighted sum of inputs using industry- or firm-level input shares. However, these measures usually assume constant returns to scale. A large variety of different measures for *TFP* have been used in prior literature, with no dominant approach.

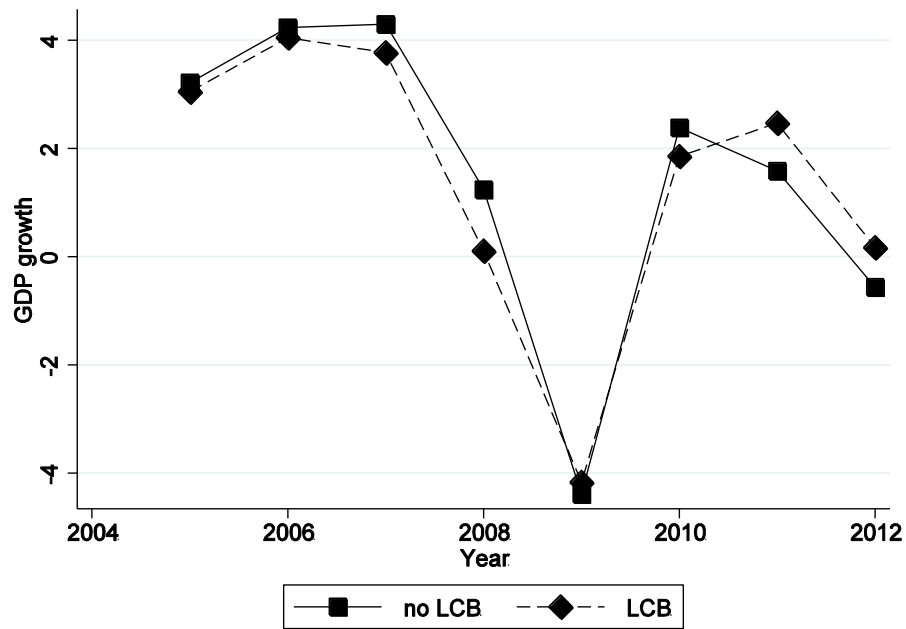
We cannot use more sophisticated estimators or index measures to proxy for productivity because these methods are more data intensive. They require additional information, for example, on material inputs or industry-level data on labor cost shares that are not available for all firms and countries in our sample in the OECD STAN Database for Structural Analysis or the EU KLEMS database. Prior literature shows a high correlation between different measures for *TFP*. Gal (2013) shows high correlations of different *TFP* proxies using computations based on Bureau van Dijk's ORBIS Database (with the same coverage as Amadeus but with additional countries, e.g., Japan, Korea, and the United States). While

correlations range from 0.71 to 0.74 between residuals based on OLS estimates and index-based measures of *TFP*, the correlation with more sophisticated types of estimates (Wooldridge 2009a) amounts to 0.90 for a sample including Spain, Italy, the United Kingdom, France, and Germany in 2008. Wooldridge (2009a) indicates that there are similar patterns in other years. Moreover, Syverson (2011) points out that other studies testing the robustness of different productivity measures usually find little sensitivity of the results to the measurement choices. According to the author, high-productivity firms will be ranked as productive irrespective of the specific method chosen. Moreover, the fact that we find a positive relation between our productivity measure based on simple OLS estimates and survival rates, “one of the most robust findings in the literature” (Syverson 2011: 332), provides further evidence that our simple measure sorts firms correctly into low- and high-productivity firms.

B.5 Additional Figures

Figure B.1: GDP Growth Across Groups

This figure compares *GDP growth* across the group of countries allowing loss carryback (*LCB*) and those countries permitting only loss carryforward (*no LCB*).



B.6 Additional Tables

Table B.1: Main Results, Robustness to Inclusion of France

This table presents the regression results for investments for 2005–2013, treating France as a country without loss carryback provisions ($LCB = 0$) in Panel A and as a country that allows loss carryback provisions ($LCB = 1$) in Panel B. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, i.e., firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We limit the refund to a refundable income of 1 million for all periods after 2010 when treating France as a carryback country in Panel B. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: France, no loss carryback country

	Dependent Variable: $Investment_t$	
	Refund=	
	Dummy (1)	Cash Equivalent (2)
$Refund \times LCB$	0.0037** (0.0016)	0.3648*** (0.1071)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	6,307,177	6,307,177
Adj. R ²	0.262	0.262

Panel B: France, loss carryback country

	Dependent Variable: $Investment_t$	
	Refund=	
	Dummy (1)	Cash Equivalent (2)
$Refund \times LCB$	-0.0006 (0.0013)	-0.0680 (0.1038)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	6,307,177	6,307,177
Adj. R ²	0.262	0.262

Table B.2: Overview of Loss Carryforward Provisions

This table reports the length of the loss carryforward period of all the countries represented in the sample. The information is taken from the IBFD Global Corporate Tax Handbooks. The superscript * indicates that minimum taxation rules are in place, that is, the use of the loss carryforward is limited in amount (e.g., as a percentage of future profits or of the loss carryforward).

Country	2005	2006	2007	2008	2009	2010	2011	2012
Austria	∞*	∞*	∞*	∞*	∞*	∞*	∞*	∞*
Belgium	∞	∞	∞	∞	∞	∞	∞	∞
Croatia	5	5	5	5	5	5	5	5
Czech Republic	5	5	5	5	5	5	5	5
Denmark	∞	∞	∞	∞	∞	∞	∞	∞
Finland	10	10	10	10	10	10	10	10
France	∞	∞	∞	∞	∞	∞	∞	∞
Germany	∞*	∞*	∞*	∞*	∞*	∞*	∞*	∞*
Hungary	∞	∞	∞	∞	∞	∞	∞	∞*
Ireland	∞	∞	∞	∞	∞	∞	∞	∞
Italy	5	5	5	5	5	5	5	∞*
Luxembourg	∞	∞	∞	∞	∞	∞	∞	∞
Netherlands	∞	∞	9	9	9	9	9	9
Norway	10	∞	∞	∞	∞	∞	∞	∞
Poland	5*	5*	5*	5*	5*	5*	5*	5*
Portugal	6	6	6	6	6	6	4	4*
Slovakia	5	5	5	5	5	7	7	7
Slovenia	5	5	∞	∞	∞	∞	∞	∞
Spain	15	15	15	15	15	15	15	18
Sweden	∞	∞	∞	∞	∞	∞	∞	∞
Switzerland	7	7	7	7	7	7	7	7
United Kingdom	∞	∞	∞	∞	∞	∞	∞	∞

Table B.3: Main Test, Robustness to Longer Carryback Periods

This table presents the regression results for investments for 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. In Norway, we specifically account for a carryback of two years. In the Netherlands, we cannot do this because of lack of historical data. We therefore exclude 2005–2006 from the Netherlands in Panel B. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Results with Norway (2y Carryback) and Netherlands		
	<i>Dependent Variable: Investment_t</i>	
	<i>Refund=</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0032** (0.0016)	0.3870*** (0.1065)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,602,942	4,602,942
Adj. R ²	0.257	0.257
Panel B: Results with Norway (2y LCB), excl. 2005–2006 from Netherlands		
	<i>Dependent Variable: Investment_t</i>	
	<i>Refund=</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0032** (0.0016)	0.3914*** (0.1064)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,602,122	4,602,122
Adj. R ²	0.257	0.257

Table B.4: Parallel Trend – Uncertainty

This table presents the regression results from 2006–2013. The dependent variable *Sales Volatility* is defined as the standard deviation of sales growth over the last two years. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm and country variables in t and we interact *Refund* in $t + 2$ with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Sales Volatility</i>	
	<i>Refund=</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> $t+2 \times$ <i>LCB</i> $t+2$	-0.0011 (0.0029)	-0.1289 (0.2358)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	3,471,733	3,471,733
Adj. R ²	0.353	0.353

Table B.5: Tax Refunds from Carryback Provisions and Investment Responses, Net Investment

This table presents the regression results from 2005–2013. The dependent variable is *Net Investment*, which is defined as the change in fixed assets after depreciation relative to the prior year's total assets. Columns (1) and (2) use a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Columns (3) and (4) use a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t . We interact the *Refund* variable with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Net Investment_t</i>	
	<i>Refund=</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
<i>Refund</i> \times <i>LCB</i>	0.0042** (0.0017)	0.3638*** (0.1168)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,602,942	4,602,942
Adj. R ²	0.191	0.191

Table B.6: Tax Refunds from Carryback Provisions and Investments, Pretax Income

This table presents the regression results for investments for 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. In this test, we define the profitability status based on pretax income as opposed to EBIT. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Investment_t</i>	
	<i>Refund</i> =	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0038** (0.0017)	0.3321** (0.1290)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,600,601	4,600,601
Adj. R ²	0.257	0.257

Table B.7: Tax Refunds and Investment, Alternative Interaction Choices

This table presents the regression results from 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in t and country variables in $t + 1$. We allow for all possible combinations of interactions between our treatment variables, *Refund*, and country and firm controls, as well as interactions between the *LCB* indicator and firm variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Model	<i>Refund</i> =		Treatment ×		<i>LCB</i> ×
	<i>Dummy</i>	<i>Cash Equivalent</i>	Country	Firm	Firm
	(1)	(2)			
(1)	0.0039*** (0.0013)	0.3520*** (0.0986)	No	No	No
(2)	0.0047*** (0.0018)	0.3371*** (0.1241)	Yes	No	No
(3)	0.0028** (0.0013)	0.3078*** (0.0911)	No	Yes	No
(4)	0.0024** (0.0011)	0.2740*** (0.0840)	No	No	Yes
(5)	0.0034** (0.0017)	0.3284*** (0.1151)	Yes	Yes	No
(6)	0.0033** (0.0016)	0.2798** (0.1167)	Yes	No	Yes
(7)	0.0013 (0.0011)	0.2349*** (0.0792)	No	Yes	Yes
(8)	0.0020 (0.0015)	0.2761** (0.1097)	Yes	Yes	Yes

Table B.8: Main Test, Robustness using Predicted Earnings

This table presents the regression results for investments for 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. In Panel B we construct *Refund* using predicted values for EBIT in year $t - 1$ for firms located in loss carryback countries. We follow the approach put forward by Erickson, Heitzman, and Zhang (2013) and estimate true earnings (EBIT) using lagged earnings information. We modify the approach slightly since we do not have information on analyst forecasts and a firm's market value:

$$EBIT_t = \alpha_0 + \alpha_i + \alpha_{j,m,t} + \beta_1 * Refund + \beta_2 * EBIT_{t-1} + \beta_3 * EBIT_{t-2} + \beta_4 * Loss_{t-1} + \beta_5 * Loss_{t-2} + \beta_6 * EBIT_{t-1} * Loss_{t-1} + \beta_7 * EBIT_{t-2} * Loss_{t-2} + \beta_8 * Accruals_{t-1} + \varepsilon_t.$$

We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Old definition

	<i>Dependent Variable: Investment_t</i>	
	<i>Refund=</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0038** (0.0019)	0.4263*** (0.1297)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	2,315,950	2,315,950
Adj. R ²	0.265	0.265

Panel B: Use predicted EBIT for LCB firms in year t

	<i>Dependent Variable: Investment_t</i>	
	<i>Refund=</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
\widehat{Refund} × <i>LCB</i>	0.0043** (0.0021)	0.3869*** (0.1441)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	2,315,950	2,315,950
Adj. R ²	0.265	0.265

Table B.9: Main Table controlling for Firm Characteristics of Parent Firm

This table presents the regression results from 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We additionally control for unconsolidated firm-level variables of the parent (if available) and we interact them with *Refund*. For this, we merge information of up to five layers of immediate shareholders, that is, we merge data on the immediate shareholders of the immediate shareholder in five rounds. We include dummy variables equal to one if we have information on parent-level controls (*Start-Up*, *Firm Size*, *Labor Intensity*, *Capital Intensity*, *Cash Holdings*, *Leverage*, *Profitability*, *Sales growth*) and we set missing values equal to zero. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Investment_t</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0034** (0.0017)	0.3287*** (0.1153)
Firm controls in $t - 1$ & parent- level controls in $t - 1$ & <i>Refund</i> interactions with firm-, parent-, and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,602,942	4,602,942
Adj. R ²	0.257	0.257

Table B.10: Tax Refunds and Investments, Matching Results

This table presents the regression results for investments for 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. We use entropy-balancing matching with *LCB* as the treatment variable. We use all firm controls (from $t - 1$ and $t - 2$) as matching variables. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. In Panel B, we run propensity score matching in each industry–year. We only use firms with *Refund* dummy= 1. We then match firms in countries with *LCB* = 1 to firms in countries with *LCB* = 0. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Matching <i>LCB</i> versus non-<i>LCB</i> observations, all firms		
	<i>Dependent Variable: Investment_t</i>	
	<i>Dummy</i>	<i>Refund</i> = <i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0056*** (0.0016)	0.4195*** (0.1094)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	3,602,216	3,602,216
Adj. R ²	0.266	0.266
Panel B: Matching <i>LCB</i> versus non-<i>LCB</i> observations, only <i>Refund</i> firms		
	<i>Dependent Variable: Investment_t</i>	
	<i>Refund</i> = <i>Cash Equivalent</i>	
<i>Refund</i> × <i>LCB</i>	0.2976* (0.1708)	
Firm controls in $t - 1$ & country–industry–year fixed effects included		
Observations	52,076	
Adj. R ²	0.052	

Table B.11: Regression Results, Control Variables

This table reports the regression results of the investment regression of Table 4. All continuous variables are centered around their mean. We include firm and country–industry–year fixed effects and we report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

		<i>Refund</i> =	
		<i>Dummy</i>	<i>Cash Equivalent</i>
		(1)	(2)
<i>Refund</i>	-	-0.0062*** (0.0007)	-0.8217*** (0.0794)
<i>Refund</i> × <i>LCB</i>	+	0.0034** (0.0017)	0.3284*** (0.1151)
<i>Start-Up</i>	+	0.0086*** (0.0009)	0.0086*** (0.0009)
<i>Firm Size</i>	-	-0.1512*** (0.0046)	-0.1512*** (0.0046)
<i>Labor Intensity</i>	+	0.0224*** (0.0020)	0.0224*** (0.0020)
<i>Capital Intensity</i>	-	-0.2595*** (0.0031)	-0.2604*** (0.0031)
<i>Cash Holdings</i>	+	0.0774*** (0.0043)	0.0777*** (0.0043)
<i>Leverage</i>	+/-	-0.1201*** (0.0050)	-0.1201*** (0.0050)
<i>Profitability</i>	+	0.0031 (0.0029)	0.0035 (0.0029)
<i>Sales growth</i>	+	0.0066*** (0.0006)	0.0069*** (0.0007)
<i>Refund</i> × <i>GDP</i>	+	-0.0004 (0.0007)	0.0876 (0.0627)
<i>Refund</i> × <i>GDP growth</i>	+	0.0002*** (0.0001)	0.0196* (0.0101)
<i>Refund</i> × <i>RQ</i>	+/-	0.0018 (0.0019)	0.2492 (0.1664)
<i>Refund</i> × <i>LCF</i>	+	-0.0023 (0.0021)	-0.3669* (0.2208)
<i>Refund</i> × <i>STR</i>	+	0.0588*** (0.0135)	5.5039*** (1.2858)
<i>Refund</i> × <i>Start-Up</i>	+	0.0017* (0.0009)	0.1611** (0.0807)
<i>Refund</i> × <i>Firm Size</i>	+/-	0.0001 (0.0002)	-0.0214 (0.0212)
<i>Refund</i> × <i>Labor Investment</i>	-	-0.0053*** (0.0010)	-0.3494*** (0.0788)
<i>Refund</i> × <i>Capital Intensity</i>	-	-0.0143*** (0.0015)	-0.6639*** (0.1592)
<i>Refund</i> × <i>Cash Holdings</i>	+	0.0157*** (0.0020)	1.1653*** (0.1957)
<i>Refund</i> × <i>Leverage</i>	-	-0.0053*** (0.0009)	-0.5926*** (0.0919)
<i>Refund</i> × <i>Sales growth</i>	+	0.0028*** (0.0008)	0.0999 (0.0871)
<i>Refund</i> × <i>Profitability</i>	+	-0.0201*** (0.0050)	-2.8977*** (0.4000)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included			
Observations		4,602,942	4,602,942
Adj. R ²		0.257	0.257

Table B.12: Tax Refunds and Investments, Robustness to Crisis Years

This table presents the regression results for investments in 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all the control variables. We additionally include interactions with the dummy *Crisis*, which we set equal to one if *GDP growth* is negative in $t - 1$. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Dependent Variable: Investment_t</i>	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0022 (0.0020)	0.2995* (0.1532)
<i>Refund</i> × <i>LCB</i> × <i>Crisis</i>	0.0037* (0.0021)	0.1029 (0.1733)
<i>Joint Significance</i>		
<i>Refund</i> × <i>LCB</i> + <i>Refund</i> × <i>LCB</i> × <i>Crisis</i>	0.0058*** (0.0019)	0.4024*** (0.1284)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,602,942	4,602,942
Adj. R ²	0.257	0.257

Table B.13: Tax Refunds and Investments, Robustness to Group Taxation Regimes

This table presents the regression results from 2005–2013. The dependent variable is *Investment*, which is defined as the change in fixed assets before depreciation relative to the prior year's total assets. Column (1) uses a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Column (2) uses a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. We control for firm variables in $t - 1$ and country variables in t and we interact *Refund* with all control variables. In Panel A, we include interaction between *Refund* and *group taxation*, an indicator variable equal to one if the country allows group taxation and if the firm is not stand-alone. In Panel B, we exclude all group firms. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Controlling for <i>Refund</i> × <i>group taxation</i>		
	<i>Dependent Variable: Investment_t</i>	
	<i>Refund</i> =	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0036** (0.0017)	0.3463*** (0.1134)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	4,602,942	4,602,942
Adj. R ²	0.257	0.257
Panel B: Excluding group firms		
	<i>Dependent Variable: Investment_t</i>	
	<i>Refund</i> =	
	<i>Dummy</i>	<i>Cash Equivalent</i>
	(1)	(2)
<i>Refund</i> × <i>LCB</i>	0.0027 (0.0021)	0.2775* (0.1436)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included		
Observations	3,758,216	3,758,216
Adj. R ²	0.261	0.261

Table B.14: Alternative Uses of Funds in $t + 1$ for Excess Cash Firms

Panel A plots the average residual (*Excess Cash*) of estimating cash holdings in t (model definition of Table 7) excluding all *Refund* interactions in a $Refund \times LCB$ matrix. The variable *Refund* represents a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. The residual of this regression (*Excess Cash*) represents the difference between observed and predicted values of cash holdings in t . We observe a positive residual for *Refund* firms in loss carryback countries indicating excess cash holdings of this group of firms. In Panel B, we interact the residual (“*Excess Cash*”) with $Refund \times LCB$ and regress the interaction term on investments in $t + 1$. We report regression results from 2005–2013. The variable *Investment* is defined as the change in fixed assets before depreciation relative to the prior year’s total assets. We control for firm variables in $t - 1$ and country variables in $t + 1$. We interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Residuals of Cash Prediction in t (=Excess Cash)

		<i>LCB</i>	
		0	1
<i>Refund</i>	0	0.00001 (0.00004)	-0.0002 (0.0002)
	1	-0.0001 (0.0001)	0.0017*** (0.0005)

Panel B: Investments in $t + 1$

	<i>Investment</i> _{$t + 1$}
<i>Refund</i> \times <i>LCB</i>	0.0017 (0.0016)
<i>Refund</i> \times <i>LCB</i> \times <i>Excess Cash</i>	0.0254* (0.0151)
<i>Refund</i> \times <i>Excess Cash</i>	-0.0070 (0.0061)
<i>LCB</i> \times <i>Excess Cash</i>	-0.0318*** (0.0116)
<i>Excess Cash</i>	0.0717*** (0.0045)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included	
Observations	3,468,778
Adj. R ²	0.196

Table B.15: Tax Refunds, Productivity, and Exit of Firms (continuous)

This table presents the regression results for exits in 2005–2013. We use *Exit* as our dependent variable, a dummy variable equal to one if the firm exits the market and zero otherwise. *Unproductivity* is equal to *Productivity* multiplied with - 1. We interact *Unproductivity* with *Refund* \times *LCB*. Columns (1) and (2) use a dummy variable to define firms that are eligible for loss carrybacks, that is, firms that report a profit in year $t - 2$ and a loss in $t - 1$. Columns (3) and (4) use a proxy for the tax refund (minimum of the profits in $t - 2$ and the prior year's loss multiplied with the prior year's statutory tax rate) for all eligible loss firms. The main effects are included in the model but are not reported in this table. We control for firm variables in $t - 1$ and country variables in t . We interact *Refund* with all the control variables. We include firm and country–industry–year fixed effects in all the specifications. We report robust standard errors that are clustered at the country–industry level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

<i>Dependent Variable: Exit_t</i>				
Refund =				
	<i>Dummy</i>		<i>Cash Equivalent</i>	
	(1)	(2)	(3)	(4)
<i>Refund</i> \times <i>LCB</i>	-0.0061** (0.0025)	0.0010 (0.0028)	-0.8194*** (0.2228)	-0.3323 (0.2593)
<i>Refund</i> \times <i>Unproductivity</i>		0.0052*** (0.0010)		0.3386*** (0.0836)
<i>Refund</i> \times <i>LCB</i> \times <i>Unproductivity</i>		-0.0117*** (0.0031)		-0.6392*** (0.2329)
<i>LCB</i> \times <i>Unproductivity</i>		-0.0084*** (0.0016)		-0.0086*** (0.0016)
Firm controls in $t - 1$ & <i>Refund</i> interactions with firm- and country-level controls & firm fixed effects & country–industry–year fixed effects included				
Observations	4,532,131	4,532,131	4,532,131	4,532,131
Adj. R ²	0.124	0.124	0.124	0.124

C. Appendix to Chapter 4

C.1 Variable Definitions

Variables	Definition
<i>Firm- and country-level variables</i>	
<i>After</i>	Dummy variable equal to one for periods after 2008.
<i>Cash-to-Assets</i>	Cash holdings relative to total assets.
<i>Leverage</i>	Total liabilities relative to total assets.
<i>Ln (Sales)</i>	Natural logarithm of a firm's sales.
<i>Ln(Fixed Assets)</i>	Natural logarithm of a firm's (tangible and intangible) fixed assets.
<i>Low Tax</i>	Dummy variable equal to one if the firm is located in a country with a <i>STR</i> below 30%.
<i>NO MNE</i>	Dummy variable equal to one if ultimate owner is located in Norway.
<i>Sales growth</i>	Percentage change in sales.
<i>Start-Up</i>	Dummy variable equal to one if the firm was registered for five years or less.
<i>Size</i>	Natural logarithm of total assets.
<i>STR</i>	Average statutory tax rate in 2006–2008 in %.
<i>UK MNE</i>	Dummy variable equal to one if ultimate owner is located in the U.K..
<i>Industry variables</i>	
<i>Entry Ratio</i>	Number of entering firms relative to beginning of the year's total number of firms in the industry (Source: Eurostat).
<i>Exit Ratio</i>	Number of exiting firms relative to beginning of the year's total number of firms in the industry (Source: Eurostat).
<i>MNE Ratio</i>	Percent of market share owned by multinationals (Source: Eurostat).
<i>Net Entry Ratio</i>	Difference in number of entering and exiting firms relative to beginning of the year's total number of firms in the industry (Source: Eurostat).
<i>NO Ratio</i>	Percent of market share owned by Norwegian multinationals (Source: Eurostat).
<i>U.K. Ratio</i>	Percent of market share owned by U.K. multinationals (Source: Eurostat).

C.2 Additional Tables

Table C.1: Sales and Fixed Assets of U.K. Multinationals after the Reform, Firm Controls

This table provides regression results of estimating equation (1) without firm controls using $\ln(\text{Fixed Assets})$ and $\ln(\text{Sales})$ as dependent variables. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We include firm controls as well as firm and country–industry–year fixed effects in all regressions. We report standard errors that are clustered at the parent–subsidiary country level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	$\ln(\text{Fixed Assets})$		$\ln(\text{Sales})$
	<i>High Tax</i>	<i>Low Tax</i>	
<i>UK MNE</i> × <i>After</i>	-0.0969*** (0.0241)	-0.0109 (0.0413)	0.0338*** (0.0121)
<i>Leverage</i> _{t-1}	-0.1746*** (0.0434)	-0.1709*** (0.0232)	0.2714*** (0.0303)
<i>Cash-to-Assets</i> _{t-1}	-0.4763*** (0.0307)	-0.5715*** (0.0247)	-0.0912*** (0.0254)
<i>Start-Up</i>	0.0525** (0.0237)	0.0558*** (0.0125)	-0.0384*** (0.0111)
<i>Sales Growth</i> _{t-1}	0.0050* (0.0030)	0.0016 (0.0033)	0.1332*** (0.0056)
<i>Size</i> _{t-1}	0.5941*** (0.0325)	0.6127*** (0.0239)	0.4921*** (0.0237)
Firm controls & firm fixed effects & country–industry–year fixed effects included			
Observations	536,396	350,057	886,453
Adj. R ²	0.935	0.922	0.937

Table C.2: Sales and Fixed Assets of U.K. Multinationals after the Reform, No Firm Controls

This table provides regression results of estimating equation (1) without firm controls using $\ln(\text{Fixed Assets})$ and $\ln(\text{Sales})$ as dependent variables. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We include firm and country–industry–year fixed effects in all regressions. We report standard errors that are clustered at the parent–subsidiary country level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	$\ln(\text{Fixed Assets})$		$\ln(\text{Sales})$
	<i>High Tax</i>	<i>Low Tax</i>	
<i>UK MNE</i> × <i>After</i>	-0.0859*** (0.0282)	-0.0148 (0.0450)	0.0336** (0.0144)
Firm controls & firm fixed effects & country–industry–year fixed effects included			
Observations	536,396	350,057	886,453
Adj. R ²	0.928	0.914	0.927

Table C.3: Sales and Fixed Assets of U.K. Multinationals after the Reform, Controlling for $MNE \times After$

This table provides regression results of estimating equation (1) using $\ln(Fixed\ Assets)$ and $\ln(Sales)$ as dependent variables. We additionally include $MNE \times After$ to control for the development of foreign MNEs after the reform. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We include firm controls as well as firm and country–industry–year fixed effects in all regressions. We report standard errors that are clustered at the parent–subsidiary country level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Ln (Fixed Assets)</i>		<i>Ln (Sales)</i>
	<i>High Tax</i>	<i>Low Tax</i>	
<i>UK MNE \times After</i>	-0.0527** (0.0236)	0.0103 (0.0437)	0.0135 (0.0120)
<i>MNE \times After</i>	-0.0675*** (0.0117)	-0.0440*** (0.0125)	0.0339*** (0.0104)
Firm controls & firm fixed effects & country–industry–year fixed effects included			
Observations	536,396	350,057	886,453
Adj. R ²	0.935	0.922	0.937

Table C.4: Sales and Fixed Assets of U.K. Multinationals after the Reform, Matching at Firm Level

This table provides regression results of estimating equation (1) using $\ln(Fixed\ Assets)$ and $\ln(Sales)$ as dependent variables using a sample with matched ultimate owners. We apply a one-to-one propensity score matching approach and match ultimate owners based on the industry affiliation and the number of their subsidiaries. *Low Tax (High Tax)* defines countries with a pre-reform average corporate tax rate below (above) 30%. We include firm controls as well as firm and country–industry–year fixed effects in all regressions. We report standard errors that are clustered at the parent–subsidiary country level in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	<i>Ln (Fixed Assets)</i>		<i>Ln (Sales)</i>
	<i>High Tax</i>	<i>Low Tax</i>	
<i>UK MNE \times After</i>	-0.1174*** (0.0294)	-0.0281 (0.0451)	0.0529*** (0.0161)
Firm controls & firm fixed effects & country–industry–year fixed effects included			
Observations	17,600	7,192	24,852
Adj. R ²	0.942	0.939	0.943

Table C.5: Industry Overview

This table provides information on industries used in the analysis of industry dynamics. The last column reports the number of observations with a U.K. Ratio above 5% that varies across industries and countries in percent of the total number of observations in the respective industry.

NACE industry code	Number of observations	U.K. Ratio > 5%
C10-C12	136	0.0%
C13_C14	146	5.5%
C15	100	0.0%
C16	145	0.0%
C19	64	0.0%
C20_C21	129	3.9%
C22	142	9.2%
C23	146	3.4%
C24_C25	138	5.1%
C26_C27	138	0.0%
C28	136	5.9%
C29_C30	125	0.0%
C31_C32	137	0.0%
C33	93	0.0%
G45	146	0.0%
G46	146	10.3%
G47	146	11.0%
H49	145	0.0%
H50	116	6.9%
H51	125	0.0%
H52	137	0.0%
H53	115	0.0%
I55	104	0.0%
I56	104	4.8%
J58	101	20.8%
J59	105	7.6%
J60	99	0.0%
J61	140	33.6%
J62	143	11.9%
J63	99	0.0%
M69	100	0.0%
M70	103	3.9%
M71	104	0.0%
M72	99	4.0%
M73	104	45.2%
M74	103	0.0%
M75	98	0.0%
N77	145	0.0%
N78	143	0.0%
N79	104	18.3%
N80	143	16.1%
N81	107	0.0%
N82	107	7.5%
Total	5,206	100%

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Affirmation – Statutory Declaration

Last Name: Bethmann

First Name: Inga

Affirmation – Statutory Declaration According to § 10 part 1 no. 6 of the Doctoral Studies' Guide Lines (dated 5th March 2008 as amended on the 8th March 2012)

I hereby declare, that the

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submitted to the

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was produced independently and without the aid of sources other than those which have been indicated. All ideas and thoughts coming both directly and indirectly from outside sources have been noted as such.

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The following persons helped me gratuitous / non-gratuitous in the indicated way in selecting and evaluating the used materials:

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Jacob	Martin	Co-author of Bethmann, Jacob, and Müller (2016)	gratuitos
Müller	Maximilian	Co-author of Bethmann, Jacob, and Müller (2017)	gratuitos
Simmler	Martin	Co-author of Bethmann and Simmler (2017)	gratuitos

Further persons have not been involved in the preparation of the presented dissertation as regards contents or in substance. In particular, I have not drawn on the non-gratuitous help of placement or advisory services (doctoral counsels / PhD advisors or other persons). Nobody has received direct or indirect monetary benefits for services that are in connection with the contents of the presented dissertation.

The dissertation does not contain texts or (parts of) chapters that are subject of current or completed dissertation projects.

Place and date of issue: Hamburg, 30.08.2017

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