Tax aggressiveness, R&D spending, and firms' claims for R&D tax deductions

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**NANYANG
TECHNOLOGICAL
UNIVERSITY**

**TAX AGGRESSIVENESS, R&D SPENDING, AND
FIRMS' CLAIMS FOR R&D TAX DEDUCTIONS**

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NANYANG BUSINESS SCHOOL

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Abstract

Using proprietary data obtained from a local tax office in China, I examine how tax aggressiveness affects a firm's incentive to claim for R&D tax deductions and to invest in R&D. I argue that submitting a claim for R&D tax deductions increases the likelihood that a firm will become subject to a tax examination. Therefore, I predict that tax aggressive firms are less likely than non-aggressive firms to submit claims for R&D tax deductions because tax aggressive firms are keen to avoid the oversight of the tax authorities. Further, because tax aggressive firms are less likely than non-aggressive firms to submit claims for R&D tax deductions, I predict that tax aggressive firms have less incentive to invest in R&D. Consistent with these predictions, I find that tax aggressive firms are less likely to claim for R&D tax deductions and they invest less in R&D than non-tax aggressive firms.

Keywords: R&D expenditure; R&D tax deduction policy; tax aggressiveness; tax oversight

1. Introduction

Many countries offer tax breaks to firms that invest in R&D. The economic rationale for tax breaks is that firms would invest too little in R&D in a free market because the information generated by R&D expenditure is a public good (e.g., Nelson, 1959; Arrow, 1962). Empirical studies generally find that firms spend more on R&D when they are provided with stronger tax incentives to invest (Mansfield, 1986; Swenson, 1992; Berger, 1993; Hall, 1993; Klassen et al., 2004).

China enacted its R&D tax deduction policy in 2008 in an effort to stimulate R&D spending. The policy was initiated as part of the China's Medium-Term and Long-Term Program for Science and Technology Development (2006-2020) (hereafter, "the MLP"). The MLP's primary objective is for China's economy to shift away from a dependence on energy consumption, natural resources, and government-oriented investments, toward a greater dependence on firms' innovative capabilities and core competitiveness (The State Council - The People's Republic of China, 2006). The government's reason for this is that "despite the size of our economy, our country is not an economic power, primarily because of our weak innovative capacity" (The State Council - The People's Republic of China, 2006).

This will have a significant impact on the world economy due to China's economic size and growth. In 2011, China is the largest country in exports (US \$1,899 billion) and the second largest country in imports (US \$1,743 billion) (World Trade Organization, 2011). However, a significant portion of China's

trade surplus is derived from counterfeited products (United States International Trade Commission, 2011). The government hopes that by incentivizing firms to invest more in R&D, the piracy problem will be reduced. This would in turn affect firms in other countries. For example, the United States International Trade Commission (2011) estimates that improved intellectual property protection and enforcement in China could result in a 10 – 20 percent increase in sales, royalties and license fees earned by US firms and a 2 – 5 percent increase in employment in the US. Therefore, examining the efficacy of the R&D policy is critical not only to China, but also to the world economy, especially countries with strong trade links to China.¹

While China is attempting to increase R&D spending by offering tax breaks, I argue that the impact of this policy may be muted due to rampant tax aggressiveness in China (Chan et al., 2010). In particular, I argue that a tax aggressive firm has a disincentive to claim for R&D tax deductions and to invest in R&D.² This is because submitting a claim increases the likelihood of a tax examination and tax aggressive firms are keen to avoid such tax oversight. Therefore, tax aggressive firms have incentives not to claim for R&D tax deductions. Moreover, a firm that intends not to claim for the R&D tax breaks

¹ In 2011, China is the largest import market and the third largest export market to the US. US exports to China in 2011 totaled \$103.9 billion, up 539% from 2000. US imports from China totaled \$339.3 billion in 2011, up 299% since 2000 (Office of the United States Trade Representative, 2012).

² As explained later, there exists a mechanical relation between a successful claim for R&D tax deductions and a firm's apparent tax aggressiveness, and this mechanical relation would bias against our predictions if it were not removed. To adjust for this mechanical relation, I take out the effect of R&D tax deductions when measuring a firm's tax aggressiveness. As a result, the term "tax aggressiveness" throughout the paper refers to a firm's *adjusted* tax aggressiveness which is not affected by R&D tax deductions.

has less incentive to invest in R&D. Given that so many firms in China are tax aggressive, this means that the tax breaks offered for R&D spending may not have a substantial impact in terms of stimulating R&D investment.

There are two reasons why the tax authorities are more likely to examine the tax returns of firms that submit claims for R&D tax deductions. First, every firm in China that claims for R&D tax deductions has its claim scrutinized by the tax office before the firm submits its annual comprehensive tax return. The information disclosed in the claim for R&D tax deductions overlaps with other information that is disclosed in the comprehensive tax return. This means that it is less costly for the tax office to conduct a full tax examination on a firm that has already had its R&D tax claim scrutinized than on a firm that has not submitted a R&D tax claim. Therefore, a firm that claims for R&D tax deductions is more likely to be subject to a future tax examination.

Second, the amount that a firm claims to have spent on R&D could be informative about its overall tax aggressiveness. For example, suppose that a firm claims to have spent a lot on R&D and is therefore claiming a substantial tax deduction. If this firm later reports a low taxable income in its comprehensive tax return, the tax office is likely to question why such a firm would be investing so much in R&D. In other words, a lack of consistency between the firm's reported R&D spending and its reported taxable income would be a red flag to the tax office. All things equal, a firm that is investing more in R&D would be expected to be earning higher profits than a firm with less R&D investment. An apparent inconsistency between the two sets of

numbers is likely to raise the suspicions of the tax office and increase the probability of a tax examination.

For these two reasons, I assume that submitting a claim for R&D tax deductions increases the likelihood of a tax examination. Moreover, I provide evidence consistent with this assumption.

I expect that a tax aggressive firm has a stronger incentive to avoid a tax examination compared with a firm that is not tax aggressive. Given that a firm can reduce the likelihood of a tax examination by not submitting a claim for R&D tax deductions, I predict that tax aggressive firms are less likely to claim for R&D tax deductions even when they have eligible R&D expenditures. Moreover, given that a tax aggressive firm is less likely to claim for R&D tax deductions, the tax aggressive firm has less incentive to invest in R&D in the first place. Therefore, I predict that tax aggressive firms in China invest less in R&D.

There is some anecdotal evidence consistent with these predictions even outside of China. For example, Williamson (2011) asserts that some UK firms do not claim for R&D tax breaks even when they are eligible to do so because the firms “simply don’t want HMRC [the UK tax authority] knowing more about their business than absolutely necessary.”³ However, I am unaware of any empirical study showing that tax aggressive firms choose not to claim for R&D tax breaks. Moreover, I am unaware of any evidence that this causes tax aggressive firms to invest less in R&D.

³ Her Majesty’s Revenue & Customs (HMRC) is the Tax Bureau in the United Kingdom.

There are two major obstacles for any study that wishes to test these predictions. First, it is necessary to identify which firms apply for R&D tax deductions and which do not apply. Second, a successful application for R&D tax deductions reduces the amount of tax that a firm is required to pay. Consequently, successful applications for R&D tax deductions would mechanically affect the commonly used measures of tax aggressiveness (i.e., effective tax rates (ETR) and book-tax differences (BTD)). It is therefore necessary to adjust for the impact of a successful R&D tax deduction claim on firms' reported tax liabilities.

My study addresses these two issues using proprietary data obtained from the tax office of a major city in China. The first problem does not arise because the tax office has provided us with information on whether or not a firm submits an application for R&D tax deductions. Therefore, I am able to test the hypothesis that tax aggressive firms are less likely to apply. Second, the tax office has provided us with information on the amount of R&D tax deductions that firms use to reduce their reported tax liabilities in their comprehensive tax returns. This allows us to take out the effect of R&D tax deductions on my tax aggressiveness measures. For example, suppose a firm reports a taxable income of US\$100 and uses the R&D tax deductions of US\$20 in its tax return. To construct this firm's book-tax difference, I add back the R&D tax deduction of US\$20 to the reported taxable income of US\$100 such that the adjusted taxable income is US\$120. My adjusted measures of tax aggressiveness are therefore free of the mechanical impact of R&D tax

deductions on firms' tax liabilities.⁴ Further, the tax office has provided us with information on the firms that were subject to a comprehensive tax audit, which can be viewed as the most severe type of tax examination. This allows us to test my maintained assumption that applying for an R&D tax deduction increases the likelihood of a tax examination. The local tax office provided all these data as part of an agreement to give them research on the efficacy of China's tax policy.⁵

Using my adjusted tax aggressiveness measures and controlling for other determinants of claiming for R&D tax deductions, I find strong robust evidence that firms with R&D spending are significantly less likely to claim for R&D tax deductions when they are more tax aggressive. Further, I find that firms invest significantly less in R&D when they are more tax aggressive. These results are consistent with my conjecture that tax aggressive firms consider the probability of attracting tax oversight when they decide whether or not to submit a claim for R&D tax deductions. And because tax aggressive firms are less likely to claim for tax deductions, they have less incentive to invest in R&D in the first place. The results are not only statistically significant, but economically meaningful as well. For example, as the GAAP ETR drops from the 75th percentile to the 25th percentile, the probability of submitting a claim for R&D

⁴ To assess the importance of these adjustments to the tax variables, I also conduct analyses using the unadjusted measures. Results using the unadjusted tax variables are found to be very different from those obtained using the adjusted ones. Later in the paper, I explain in more details why the adjustments to the tax aggressiveness measures are critical for drawing valid inferences.

⁵ Because the local tax office wishes to remain anonymous, I am unable to disclose its name or location. The proprietary data provided by the tax office has to remain confidential but the tax office has not imposed any other restrictions with respect to disseminating the research findings.

tax deductions declines by 12% and R&D spending falls by 36%.

My study makes two contributions to the literature. First, Hanlon and Heitzman (2010) call for more research on how tax policy affects the real economy. Despite the Chinese government's intention to increase R&D spending by offering tax breaks, my results suggest this policy has had relatively little impact among tax aggressive firms. Such firms are unwilling to apply for R&D tax deductions because they wish to avoid scrutiny by the tax authority. This is important as it provides new insights regarding the use of tax breaks to stimulate R&D spending, particularly in a country like China where tax aggressiveness is rampant (Chan et al., 2010).⁶

Second, my work contributes to a new but fast-growing literature on the consequences of tax enforcement (Dyck and Zingales, 2004; Desai et al., 2007; Guedhami and Pittman, 2008; Ghoul et al., 2011). These studies show that enforcement by the tax authority can increase information transparency and curb rent extraction by managers. My results suggest that tax enforcement can also have real consequences in terms of affecting firms' spending on R&D.

The rest of the paper is organized as follows. Section two reviews the institutional background of the R&D tax deduction policy and the tax system in China. Section three develops two hypotheses. Section four presents the research design. Section five describes the sample and provides descriptive statistics. Section six presents the main results. Section seven contains

⁶ Firms that do not claim for R&D tax deductions not only forgo the concurrent tax benefits, but also lose the potential future profits generated from R&D projects funded by the tax deductions.

additional analyses and robustness checks. Section eight concludes.

2. Institutional background

2.1. The MLP

China enacted its R&D tax deduction policy in 2008, as part of its National Medium-Term and Long-Term Program for Science and Technology Development (2006 – 2020). The MLP was initiated because the Chinese government wants to change China's economic growth model by reducing its dependence on energy, raw resources, and government-oriented investments, and increasing the role of private innovative enterprises. With the R&D tax deduction policy initiated by the MLP in 2006, the Chinese government has set three goals. First, R&D spending needs to increase every year, reaching a target of 2% of GDP by 2010 and 2.5% or above by 2020. Second, by 2020, the contribution of indigenous technologies to GDP will be increased to 60% or more whereas the reliance on imported technologies will be reduced to no more than 30%. Third, by 2020, China will have moved into the top five countries in terms of the number of annual patents awarded and international citations of scientific papers (The State Council - The People's Republic of China, 2006).

Given these ambitious targets, the MLP is seen in the West as the second most important reform since Deng Xiaoping's opening and reform policy in 1979 (United States Chamber of Commerce, 2011). Similarly, the Chinese government describes the MLP as the "grand blueprint of science and

technology development to build an innovation-oriented nation” and to bring about the “great renaissance of the Chinese nation” (The State Council - The People’s Republic of China, 2006). So far, however, the policy has not been attaining its objective. In 2010, R&D spending as a proportion of GDP was 1.4% in China, which is lower than the MLP’s stated target of 2% by 2010. In addition, the 1.4% figure is low when compared with the US (2.7%) and Japan (3.3%) (Battelle.Org, 2011).

Nevertheless, China’s vision could significantly affect the world economy, especially those countries with strong trading relations with China. The main competitive advantage of the US over China lies in its technological superiority. This technological gap is apparent in the trading structure between the US and China. Statistics show that Chinese imports from the US are dominated by high-valued products with sophisticated technology (e.g., aircraft), whereas Chinese exports to the US are mainly small-scale and labor-intensive products or components at the low-end of the value-added chain (The US - China Business Council, 2011). If China is successful in stimulating R&D spending and increasing firms’ innovative capabilities, the competitive advantage of other countries relative to China would be under threat. Thus, investigating the efficacy of China’s R&D policy is of global importance.

2.2. R&D tax policy in China

The Chinese National Tax Office issued instructions for firms’ R&D tax deduction applications in 2008. The instructions specify that, in addition to

R&D expenditures being 100% tax deductible, firms can claim an *extra* tax deduction equal to 50% of their qualified R&D expenditures.⁷ The instructions also define an R&D activity as the one that helps firms obtain new knowledge of science and technology, innovative applications of existing technology, and significant improvements in the technological content and quality of products.

To illustrate how R&D tax deductions reduce firms' tax liabilities, consider a firm that has a qualified R&D expense of RMB 1,000 and pre-tax income of RMB 10,000. The firm can then claim an extra RMB 500 in tax deductions (i.e., 50% of RMB 1,000) and if these are then awarded by the tax office, the claimant firm can use the tax deductions to reduce its reported taxable income to RMB 9,500 (10,000 - 500). With a corporate statutory tax rate of 25%, the firm is then liable for RMB 2,375 ($9,500 \times 25\%$) in taxes, which represents a tax saving of RMB 125 ($500 \times 25\%$).

In China, a firm that wants to enjoy these R&D tax breaks needs to submit its claim for R&D tax deductions before submitting its comprehensive tax return.⁸ This is because the claim must be approved by the tax office before the firm can use the claimed tax deductions to reduce its reported tax liability in the tax return. The instructions require that a firm must submit six documents to the tax office in its application for R&D tax deductions:

1. The prospectus of R&D projects and budgeted R&D expenditures.
2. The job allocations and names of R&D staff.

⁷ Appendix I lists all the R&D expenditures that qualify for the extra R&D tax deduction.

⁸ This is true not only in the city where our sample firms are located, but also throughout China. In contrast, US firms submit their claims for R&D tax breaks at the same time as they submit their comprehensive tax returns.

3. A list of incurred R&D expenditures.
4. Documents signed by top management for the establishment of R&D projects.
5. Contracts or documents signed for joint venture R&D projects.
6. Evaluation reports showing the outcomes of R&D projects.

Upon receiving these documents, the tax office audits the validity of the firm's claimed R&D tax deductions. *Every* claim is audited by the tax office.⁹ The audit is usually conducted jointly with the Science and Technology department of the local government because the tax officers sometimes lack the expertise to deal with the technological issues associated with R&D projects.¹⁰ The tax office may reduce the amount of R&D tax deductions awarded or even impose additional penalties if it finds errors or irregularities during the audit of the R&D tax deduction claim.

2.3. Tax system and tax examination in China

China issued the Law of Enterprise's Income Tax in 2007, which requires firms to pre-pay their taxes on a monthly or quarterly basis. At the end of the fiscal year, firms are required to calculate their annual tax liabilities, which are

⁹ The local tax office that provided us this data told us that they audit all claims for R&D tax deductions for two reasons. First, the amount of R&D tax deductions that firms claim is usually significant and the tax saving from tax deductions is sometimes more than firms' tax payments. Second, the tax office receives relatively few claims in any given year, so the cost of auditing every claim is affordable.

¹⁰ For example, the tax officers may disagree with the outcome of R&D projects stated in the firm's self-submitted evaluation report or find an inconsistency between the expected outcome stated in the prospectus (Document 1) and in the evaluation report. In this case, the tax officers will seek the assistance from the Science and Technology department of the local government, which will then conduct an independent evaluation on the outcome of firms' R&D projects.

then compared with the sum of their pre-paid tax. Firms must pay the extra amount if their annual tax liabilities are more than their pre-paid tax, while they receive refunds if the annual tax liabilities are less than the pre-paid tax. In addition, firms must file their annual financial statements and tax returns with the tax office and the annual financial statements must be audited by an independent audit firm. This process must be completed within five months after the fiscal year end.

Every tax office has a specific audit department, consisting of trained officers whose primary duties are to conduct tax examinations. A tax examination includes a broad range of enforcement activities. At one end of the spectrum, the examination involves simple administrative issues such as checking whether firms file their financial statements and tax returns with the tax office on time. At the other end of the spectrum, the examination could involve a comprehensive audit of the firm's annual tax return. During a comprehensive tax audit, the officers can seek the cooperation of other departments of the tax office, government agencies, banks, and even the police. After completing a comprehensive tax audit, the officers write an outcome report and may forward the files to the police for pursuing the firms' tax liabilities (The Chinese National Tax Office, 1995). The whole process of a comprehensive tax audit can last several months.

Because the tax office has limited resources and personnel, they can only comprehensively audit a limited number of firms' tax returns every year. Therefore, the incidence of a comprehensive tax audit is quite rare. More often,

the tax officers will hold an informal meeting with the firm's accountants when they suspect that the firm is engaged in tax evasion. This will often involve the officers proposing some tax adjustments requiring firms to pay additional tax. Because this kind of tax examination falls short of being a comprehensive tax audit, the tax office does not keep a formal record on its frequency. However, the local tax office has told us that depending on firm size, approximately 10 – 70% of firms in my sample are subject to some form of tax examination. In contrast, only 0.72% of my sample firms are subject to a comprehensive tax audit (see Table 3).

3. Hypotheses development

I argue that the tax office's close scrutiny of firms' claims for R&D tax deductions reduces the incentive of tax aggressive firms to claim for tax deductions and to invest in R&D. This argument is based on the assumption that claiming for R&D tax deductions increases the likelihood that claimant firms will become subject to closer scrutiny by the tax office. There are two reasons for this assumption.

First, every firm in China that claims for R&D tax deductions has its claim audited by the tax office before the firm submits its comprehensive tax return. The information that firms disclose in their claims for R&D tax deductions overlaps with the R&D-related information that firms later disclose in their comprehensive tax returns. Moreover, before auditing the firm's claim for an R&D tax deduction, the tax officers would usually seek a basic understanding

about the claimant firm first. They do so by looking at other information about the firm, such as its foundation year, location, firm size, historical profitability, the number of employees, and ownership structure. This means the tax officers know a claimant firm better than a non-claimant firm. Because the officers who audit R&D tax deduction claims are also responsible for conducting tax examinations on firms' tax returns, the cost of conducting a future tax examination becomes lower after the R&D tax claim audit. Therefore, a firm that claims for R&D tax deductions is more likely to be subject to a future tax examination because part of the preliminary work in a tax examination is done during the prior audit of the firm's R&D tax deduction claim .

Second, the amount that a firm claims to have spent on R&D could be informative about its overall tax aggressiveness. A firm that invests more in R&D usually does so because it has better growth opportunities (Bartram et al., 2012) and is therefore, expected to have better performance. In China, firms' R&D investments are positively associated with their profits. This is true not only for the publicly traded firms (Wen, 2008) but also for the non-publicly traded firms in my sample, as reported in Table 5. Therefore, an inconsistency between a firm's R&D investments and its financial performance is likely to raise the suspicions of the tax office, prompting the tax office to initiate a tax examination against the claimant firm. For example, suppose a firm claims to have invested a lot in R&D and is therefore claiming a substantial tax deduction. If this firm later reports a low taxable income in its comprehensive tax return, the tax office is likely to question the reliability of the firm's

reported profits given the firm's claim that it has already invested so much in R&D. In other words, the tax office would be expecting some consistency between the firm's reported R&D spending and its reported profits. An apparent inconsistency is likely to serve as a red flag thereby increasing the probability and scope of a tax examination.

For these two reasons, I argue that submitting a claim for R&D tax deductions increases the likelihood that claimant firms will be subject to closer scrutiny by the tax authority. A tax aggressive firm has more incentive to avoid scrutiny because tax-aggressive firms are more likely to be penalized by the tax office (Mills, 1998).¹¹ Therefore, a tax aggressive firm has less incentive to submit a claim for R&D tax deductions. Accordingly, my first hypothesis is as follows.

H1: Conditional on investing in R&D, a tax aggressive firm is less likely to claim for R&D tax deductions than is a firm that is less tax aggressive.

A firm's decision to invest in R&D depends on the expected costs and benefits. The expected benefits of R&D investments include the tax deductions that are available if the firm makes a claim and the claim is awarded. In equilibrium, a firm has more incentive to invest in R&D if it anticipates that it will claim for R&D tax deductions, as this will increase the marginal benefit of investing in R&D. Because a tax aggressive firm anticipates that it is less likely to claim for R&D tax deductions, its marginal benefit of investing in R&D is lower, and so it has less incentive to invest in R&D in the first place.

¹¹ In our sample, I find similar results to those reported by Mills (1998). Specifically, tax aggressive firms incur more additional tax payments when they are audited by the tax office.

Accordingly, my second hypothesis is as follows.

H2: Tax aggressive firms invest less in R&D than do firms that are less tax aggressive.

Both hypotheses hinge on the maintained assumption that, by claiming for R&D tax deductions, the claimant firm is more likely to be subject to a future tax examination. In private conversations, the local tax office in China has told us this assumption is valid. To further check the validity of this assumption, the tax office provided us with information on the firms that were subject to a comprehensive tax audit (the most severe form of tax examination). As reported in Section 5, I find that firms claiming for R&D tax deductions are indeed more likely to be selected for a comprehensive tax audit.

To provide a more rigorous analysis of my two hypotheses, I developed a simple analytical model below which endogenizes a firm's decision to claim for R&D tax deductions (H1) and to invest in R&D (H2) as a function of its tax aggressiveness. The predictions generated from the model are consistent with my two hypotheses. The model is as follows.

The firm's profit function, π , is determined by its R&D investment, R , and its decision to claim for R&D tax deductions, e . e is equal to 1 if the firm decides to claim for R&D tax deductions and 0 if it decides not to claim. R and e are determined endogenously by the firm's technology, a , and its tax aggressiveness, T .

I take a simplified Cobb-Douglas production function, $aR^{\frac{1}{2}}$, which has R&D investment as the sole input factor. I assume that R&D investment has the

diminishing marginal return such that $(R^{\frac{1}{2}})' > 0$ and $(R^{\frac{1}{2}})'' < 0$. This means that although a rise in R&D investment can increase the firm's total profit, the marginal benefit on profitability decreases as R&D investment increases. The firm's profit function is stated as follows:

$$\pi(R, e|a, T) = aR^{\frac{1}{2}} - R + (0.5R\tau - \beta T)e \quad (1)$$

τ is the firm's tax rate. For simplicity, I assume that all R&D expenditures qualify for R&D tax deductions. Because firms can claim 50% of their qualified R&D investments as R&D deductions, the expected tax saving of claiming for R&D tax deductions equals $0.5\tau R$; β is a constant and βT denotes the expected cost of a tax examination for a firm that claims an R&D tax deduction.

The firm is facing two choices – claiming or not claiming for R&D tax deductions. If the firm decides to claim for R&D tax deductions, its profit would be as follows:

$$\pi(R, 1|a, T) = aR^{\frac{1}{2}} - R + (0.5\tau R - \beta T) \quad (2)$$

Under the situation that the firm decides to claim for R&D tax deductions, to obtain the firm's optimized R&D investment, I take the first order condition of eq. (2) w.r.t. R and obtain the following equation:

$$0.5aR^{-\frac{1}{2}} - 1 + 0.5\tau = 0 \quad (3)$$

Re-arranging eq. (3), I obtain the optimal R_1 under the “claiming” condition:

$$R_1(e = 1) = \frac{a^2}{4(1 - 0.5\tau)^2} \quad (4)$$

Eqs. (2), (3), and (4) show the firm’s profit and optimal R&D investment when it decides to claim for R&D tax deductions. If the firm decides not to claim for R&D tax deductions, its profit function would be as follows:

$$\pi(R, 0|a, T) = aR^{\frac{1}{2}} - R \quad (5)$$

Under the situation that the firm decides not to claim for R&D tax deductions, the optimal amount of R&D investment is found by taking the first order condition of eq. (5):

$$0.5aR^{-\frac{1}{2}} - 1 = 0 \quad (6)$$

Re-arranging eq. (6), I obtain the optimal R_2 under the “not claiming” condition:

$$R_2(e = 0) = \frac{a^2}{4} \quad (7)$$

Now let's look at the firm's decision to claim for R&D tax deductions. The firm will only submit a claim if claiming gives it a higher profit than not claiming. That is, the firm will only claim for R&D tax deductions if $\pi(R, 1|a, T) > \pi(R, 0|a, T)$. Based on eqs. (2) and (5), we have the following:

$$aR_1^{\frac{1}{2}} - R_1 + (0.5R_1\tau - \beta T) > aR_2^{\frac{1}{2}} - R_2 \quad (8)$$

Substituting R_1 from eq. (4) and R_2 from eq. (7) into eq. (8) above, I obtain the following:

$$\frac{a^2}{2(1 - 0.5\tau)} - \frac{a^2}{4(1 - 0.5\tau)^2} + \frac{\tau a^2}{8(1 - 0.5\tau)^2} - \beta T > \frac{a^2}{2} - \frac{a^2}{4} \quad (9)$$

Re-arranging eq. (9), I obtain the follows:

$$\frac{a^2\tau}{8(1 - 0.5\tau)} - \beta T > 0 \quad (10)$$

Eq. (10) is the condition under which the firm earns higher profit if it submits a claim for R&D tax deductions. We can clearly see that as the firm's tax aggressiveness (T) increases, the left-hand side of eq. (10) is less likely to be

greater than zero, making the firm less likely to claim for R&D tax deductions. This is consistent with my H1 that a firm is less likely to claim for R&D tax deductions if it is more tax aggressive.

Now, let's look at H2. From the discussion above, we know that the firm's optimal R&D investment depends on whether it is going to claim for R&D tax deductions. That is:

$$R(a, T) = \begin{cases} R_1(e = 1) = \frac{a^2}{4(1 - 0.5\tau)^2} & \text{if } \frac{a^2\tau}{8(1 - 0.5\tau)} - \beta T > 0 \\ R_2(e = 0) = \frac{a^2}{4} & \text{if } \frac{a^2\tau}{8(1 - 0.5\tau)} - \beta T < 0 \end{cases}$$

From the equation system above, we can see as the firm's tax aggressiveness (T) increases, $\frac{a^2\tau}{8(1-0.5\tau)} - \beta T$ is more likely to be less than zero. Therefore, the firm's optimal R&D investment is more likely to be R_2 rather than R_1 . Because the firm's tax rate, τ , is in the interval of $[0, 1]$, R_2 is less than R_1 . This demonstrates that the firm's optimal R&D investment becomes smaller as its tax aggressiveness increases. This is consistent with my H2 that a tax aggressive firm invests less in R&D than a firm that is less tax aggressive.

4. Research design

4.1. Measures of tax aggressiveness

There is no consensus in the literature as to how a firm's tax aggressiveness should be measured. To ensure that my results are robust to

using alternative measures of tax aggressiveness, I choose four measures commonly used in the literature (e.g., Chen et al., 2010; Cheng et al., 2012; Desai and Dharmapala, 2006). These are: 1) the GAAP Effective Tax Rate (*GAAP ETR*), 2) the Cash Effective Tax Rate (*Cash ETR*), 3) the Book-Tax Difference (*BT*), and 4) the abnormal Book-Tax Difference (*DBTD*).¹² A higher *GAAP ETR* or *Cash ETR* indicates lower tax aggressiveness, while a higher *BT* or *DBTD* indicates greater tax aggressiveness.

There is a mechanical relation between the unadjusted tax aggressiveness measures used in prior literature and firms' R&D tax deductions. This is because a tax deduction reduces a firm's reported tax liability, resulting in an increase in the firm's tax aggressiveness based on the unadjusted tax measures. Thus, there is a positive mechanical relation between firms' applications for R&D tax deductions and the unadjusted measures of tax aggressiveness. This positive mechanical relation would bias against my prediction in H1 that firms' claims for R&D tax deductions are negatively associated with tax aggressiveness.

To avoid this mechanical relation, I account for the R&D tax deductions that firms use in their tax returns when I construct each of the four measures of tax aggressiveness. Thus, my adjusted tax aggressiveness variables capture the

¹² There are other tax aggressiveness measures that have been used recently in the literature, but due to data constraints, they are not available in our setting. For example, Dyreng et al. (2008) use the sum of ten-year cash tax payments divided by the sum of ten-year pre-tax income to proxy for the firm's long-run tax avoidance. I cannot use this measure as I only have two years of data. Wilson (2009) and Lisowsky (2010) measure the likelihood that a firm engages in a tax shelter. I cannot use this measure either as the predictors in these two studies are based on public firms, but the data supplied to us by the tax office in China is for private firms only.

tax aggressiveness that exists *before* firms decide whether to apply for R&D tax deductions. The four adjusted measures of tax aggressiveness are as follows.

$$1. ADJUSTED_ETR_{it} = (\text{income tax expense} + R\&D \text{ tax deductions} \times \text{actual tax rate}) / \text{pre-tax income}.$$

Where: the definitions of *income tax expense* and *pre-tax income* are the same as in prior US studies (data source: the firm's income statement); *R&D tax deductions* refer to the awarded deductions that claimant firms use to reduce their reported taxable incomes (data source: the firm's tax return); the *actual tax rate* refers to the firm's actual tax rate which can be lower than the statutory rate (data source: the tax office's database).

The definition of $ADJUSTED_ETR_{it}$ is the same as in prior studies except that I add back the awarded R&D tax deductions that firms use to reduce their reported tax liabilities. I use the firm's *actual tax rate*, rather than the statutory tax rate, because firms that engage in certain business activities (e.g., exporting electronic products overseas) receive other tax breaks from the government and are therefore subject to a lower tax rate than the statutory rate. Consistent with prior studies (e.g., Chen et al., 2010; Cheng et al., 2012), I set the $ADJUSTED_ETR_{it}$ as missing if pre-tax income is zero or negative, and I truncate this variable over the interval of [0, 1].

$$2. ADJUSTED_CETR_{it} = (\text{cash tax payment} + R\&D \text{ tax deductions} \times \text{actual tax rate}) / \text{pre-tax income}.$$

Where: *cash tax payment* refers to the amount of tax paid in the fiscal year (data source: the firm's tax return); other variables are as defined previously.

Using the cash tax payment in the tax return is more precise than using the cash tax payment from the cash flow statement, which is the normal approach of studies that use financial statement data rather than data from the tax office.¹³ Just as with the $ADJUSTED_ETR_{it}$ measure, I add back the R&D tax deductions that are used by firms and I use the firm's actual tax rate rather than the statutory rate for the adjustment. Likewise, I set the $ADJUSTED_CETR_{it}$ as missing if pre-tax income is zero or negative, and I truncate this variable over the interval of [0, 1].

$$3. ADJUSTED_BTD_{it} = [pre-tax\ income - (taxable\ income + R\&D\ tax\ deductions)] / total\ assets.$$

Where *taxable incomes* are obtained from firms' tax returns (data source: the firm's tax return), *total assets* are from the firm's balance sheet and the other variables are as defined previously.¹⁴ Again, I adjust for the awarded R&D tax deductions that are used by firms to reduce their tax liabilities.

$$4. ADJUSTED_DDBTD_{it} = \text{the residual } (e_{it}) \text{ from the following OLS regression: } ADJUSTED_BTD_{it} = \beta_1 TACC_{it} + e_{it}.$$

Desai and Dharmapala (2006) argue that a portion of book-tax differences

¹³ When calculating cash ETR, prior studies take the cash tax payment from the firm's cash-flow statement, and divide it by pre-tax income. This creates a potential mismatch between the cash tax payment and pre-tax income due to a timing difference. For example, suppose a firm has a fiscal year from Jan 1 to Dec 31, but pays taxes in cash on March 31 and again on September 30. As a result, the firm's cash tax payment from its cash-flow statement includes three months of taxes from the previous fiscal year and does not include the final three months of the current fiscal year. I avoid this problem by using the cash tax payment recorded in the firm's tax return.

¹⁴ Prior studies estimate firms' taxable incomes using data from the financial statements. In particular, they gross up the current tax expense by the statutory tax rate and then subtract the change in the non-operating loss carryforward. However, the use of financial statement data to measure taxable income introduces measurement errors (e.g., Hanlon, 2003; Hanlon et al., 2005). I avoid this problem by using taxable incomes taken from firms' tax returns.

is attributable to earnings management rather than tax avoidance. To mitigate the impact of earnings management, Desai and Dharmapala (2006) regress the book-tax differences on total accruals and take the residual (e_{it}) as a measure of tax aggressiveness. I follow the same approach.¹⁵ I measure total accruals ($TACC_{it}$) using the balance sheet approach rather than the cash flow statement approach, because the private firms in my sample lack cash flow information. Total accruals are the change in non-cash current assets minus the change in non-debt current liabilities, scaled by lagged total assets.

4.2. Empirical models

To test H1, I estimate the following model:

$$CLAIM_{it} = \beta_1 + \beta_2 TAX_AGGRESSIVENESS_{it} + CONTROLS + \mu_i + \varepsilon_{it} \quad (1)$$

The dependent variable ($CLAIM_{it}$) takes the value one if firm i submits a claim to the tax office for R&D tax deductions in year t , and 0 otherwise. My treatment variable is $TAX_AGGRESSIVENESS_{it}$, which refers to one of the four adjusted measures of tax aggressiveness (as defined above). Eq. 1 is estimated among the firms that have positive R&D expenditures because a firm with zero R&D is not faced with deciding whether to make a claim for R&D tax deductions. To test H1, I estimate both logistic models and panel data models that control for unobserved firm-specific effects (μ_i). Under H1, I predict that

¹⁵ Based on Desai and Dharmapala (2006), Chen et al. (2010) measure the book-tax differences as the sum of the residuals ($u_i + e_{it}$) using a firm-fixed effects model: $BTD_{it} = \beta_1 TACC_{it} + u_i + e_{it}$, where u_i refers to the firm-fixed effect. Cheng et al. (2012) use the same fixed effects model but take e_{it} as the measure of book-tax differences. Our results are qualitatively unchanged if I use these two alternative measures of book-tax differences.

tax aggressive firms are less likely to submit claims for R&D tax deductions. Therefore, I expect to find positive coefficients on the two *ETR* variables and negative coefficients on the two *BTD* variables.

To test H2, I estimate the following model.

$$R\&D_{it} = \partial_1 + \partial_2 TAX_AGGRESSIVENESS_{it} + CONTROLS + \mu_i + \varepsilon_{it} \quad (2)$$

My dependent variable ($R\&D_{it}$) is firm i 's total R&D expenditures scaled by its total assets in year t . The treatment variable is $TAX_AGGRESSIVENESS_{it}$. I estimate both OLS models and panel data models that control for unobserved firm-specific effects (μ_i). Under H2, I predict that firms invest more in R&D when they are less tax aggressive. Therefore, I expect to find positive coefficients on the two *ETR* variables and negative coefficients on the two *BTD* variables.¹⁶

4.3. Control variables in eq. (1)

I am unaware of any prior study examining a firm's decision to claim for R&D tax deductions. Therefore, my choice of control variables is based on economic reasoning and on conversations with the tax office regarding the factors that likely affect firms' decisions to claim for R&D tax deductions.

Firm size is expected to affect the application decision as small firms are less able to afford the costs of making an application. This is consistent with

¹⁶ A limitation of eq. (2) is that I am unable to determine whether a firm's R&D expenditure qualifies for tax deductions. However, this is unlikely to be a serious problem because most types of R&D expenditures in China are qualified for tax deductions (see Appendix I). Although the R&D variable in eq. (2) is not a perfect measure of qualified R&D, I have no reason to believe that the measurement error is systematically correlated with our independent variables.

press comments, which claim that small firms sometimes forgo their R&D tax breaks because the required documentation is complex and they lack the resources to determine whether their R&D expenditures qualify for tax breaks (e.g., Sayler, 1998; Dhanani & Solanji, 2011; Segarra, 2012). Presumably, large firms have more resources and expertise to put together the documentation that is required when applying for an R&D tax deduction. Moreover, the resources and expertise of large firms can help them in their interactions with the tax office. Therefore, I expect firm size has a positive impact on a firm's decision to apply for tax breaks. I control for firm size using the natural logarithm of firm i 's total assets in year t (LTA_{it}).

A claimant that has low financial reporting quality may be targeted by the tax office for a tax examination because of concerns over the integrity of the information supplied by the firm. Therefore, I expect that firms with low financial reporting quality are less likely to apply for R&D tax deductions. I use the absolute value of firm i 's discretionary accruals (DA_{it}) as a proxy for financial reporting quality. I predict that firms with larger absolute discretionary accruals are less likely to submit claims for R&D tax deductions.

A firm with a higher tax rate has more incentive to claim for tax deductions as the marginal benefit of claiming and applying for tax deductions is larger. Because firms in China are subject to a flat tax rate, instead of a progressive tax system, I use the firm's actual tax rate (TAX_RATE_{it}) to control for the marginal benefit of applying for tax deductions. I expect to find a positive coefficient on the TAX_RATE_{it} variable.

A firm has more incentive to claim for tax deductions if it has a positive tax liability against which it can offset tax deduction.¹⁷ The $TAX_LIABILITY_{it}$ variable is defined as the sum of firm i 's taxable income and R&D tax deductions divided by total assets in year t . I expect to find a positive coefficient on the $TAX_LIABILITY_{it}$ variable.

4.4. Control variables in eq. (2)

I control for size using the natural logarithm of firm i 's total assets in year t (LTA_{it}). I do not make a signed prediction because prior studies document mixed results regarding the relation between firm size and R&D spending. On one hand, large firms have more resources to invest in innovative projects and may reap more benefits from R&D (Schumpeter, 1942). Consistent with this view, several studies find a positive relation between firm size and R&D spending (Baysinger and Hoskisson, 1989; Baysinger et al., 1991). On the other hand, larger firms are more likely to have well-established business models and so have less need to invest in R&D. Consistent with this, some studies find a negative association between firm size and R&D spending (e.g., Graves, 1988).

Firms with higher leverage may invest less in R&D in order to report higher earnings and avoid violating the terms of debt covenant agreements. Consistent with this, Bushee (1998) finds a negative association between

¹⁷ A firm can carry forward its unused tax deductions to the next five years if it does not have sufficient tax liability to offset tax deductions. However, the present value of tax deductions reduces if they cannot be used instantaneously.

leverage and R&D spending. In addition, firms with high leverage may be unable to obtain financing to pay for R&D expenditures. The $LEVERAGE_{it}$ variable is equal to firm i 's total debts divided by its total assets in year t .

Strong performance success give managers the confidence to invest more in R&D. Empirically, prior studies typically document a significant positive relation between firm performance and R&D spending (e.g., Klassen et al., 2004). The ROA_{it} variable is equal to firm i 's pre-tax income divided by its total assets in year t .

Firms' financial constraints can directly impact their R&D spending (Cleary, 1999). Firms with ample cash are less likely to be financially constrained and therefore, are more likely to invest in R&D. I use cash and short-term investments to measure the availability of firms' internal funds. The $CASH_{it}$ variable is equal to firm i 's cash plus short-term investments scaled by its total assets in year t .

4.5. Estimation methods

The $CLAIM_{it}$ and $R\&D_{it}$ models are estimated in two ways. My first approach is to use a Seemingly Unrelated Regression (SUR) system (Zellner, 1962). In a SUR system, two or more equations are estimated simultaneously such that the residuals of the equations are allowed to be correlated. In my setting, I expect the residuals to be correlated because when a firm makes its R&D investment decision, it should simultaneously consider whether it will claim for R&D tax deductions, as any successful claim will directly reduce the

expected cost of R&D spending. Therefore, the unobserved factors that affect the firm's decision to apply for R&D tax deductions are likely correlated with the unobserved factors that affect the firm's R&D investment decision. The SUR system takes this into account because the residuals from eqs. (1) and (2) are allowed to be correlated with each other (a recent survey on SUR can be found in Fiebig, 2001). This is the major advantage of estimating a SUR system rather than estimating the equations independently.¹⁸

My second approach is to exploit the fact that I have panel data. This allows us to control for any unobservable firm-specific factors that affect firms' claims for tax deductions and their R&D spending decisions. Unobservable firm-specific characteristics are potentially important to the extent that they are correlated with both the tax aggressiveness measures and the dependent variables (i.e., claims for R&D tax deductions and R&D spending). For example, Dyreng et al. (2010) find that individual executives exhibit strong personal characteristics that affect firms' tax aggressiveness. Further, Barker and Mueller (2002) find that CEO characteristics have a strong impact on firms' R&D spending. Therefore, it could be that unobservable firm-specific characteristics are correlated with both tax aggressiveness and R&D decisions. I control for such unobservable firm-specific effects using panel data methods (Wooldridge, 2005).

There are two types of panel data model: 1) fixed effects, and 2) random effects. When testing H2, I estimate both the fixed effects and random effects

¹⁸ Nevertheless, similar inferences are obtained when the two equations are estimated separately rather than as a SUR system.

specifications. When testing H1, I estimate only the random effects specification because the dependent variable ($CLAIM_{it}$) typically exhibits no time variation for a given firm i and so the fixed effects specification would result in the loss of around 90% of sample observation.¹⁹ The random effects model helps to control for unobservable firm characteristics (Wooldridge, 2005), but without the huge sample attrition that would occur in the fixed effects specification.²⁰

Because my sample comprises a panel with multiple yearly observations on each firm, the standard errors are adjusted for clustering on each firm (Peterson, 2009). I also include year dummies (and industry dummies in the SUR models).

4.6. R&D disclosure in China firms

Following prior studies (Berger, 1993), I assume that any firm that discloses positive R&D expenditure is qualified to claim for R&D tax deductions. This assumption is reasonable in my China setting because most types of R&D expenditure qualify for tax deductions (see Appendix I).

¹⁹ Most firms in our sample either submit claims in every year of the sample period or they submit no claims during any year of the sample period. Such firms would be dropped from the sample in the fixed effects specification because they have no time variation in the $CLAIM_{it}$ variable. As this is the case for around 90% of the firms in our sample, a fixed effects model is not feasible.

²⁰ OLS regression does not control for any unobservable firm-specific characteristics, whereas fixed effects regression completely removes all unobservable firm-specific characteristics. Random effects models are “in between” the OLS and fixed effects models in the sense that they partially eliminate the unobservable firm-specific characteristics. The extent to which the unobservable firm-specific characteristics are eliminated in random effects models depends on the relative magnitude of the variance of u_i and e_{it} in the residual terms and the number of years in the panel. Interested readers are referred to section 14.2 of Wooldridge (2005) for more details.

Similar with the US (Koh and Reeb, 2012), there are many firms in my sample that do not disclose any information about R&D spending. Koh and Reeb (2012) find that some firms hide their R&D spending even if they have invested in R&D. This means that when firms have no R&D disclosure, it is not possible to determine whether they have zero R&D, or they have positive R&D that they chose not to disclose. To follow prior studies (e.g., Bushee, 1998) and avoid the problem of interpreting the cases of no R&D disclosure, I restrict my sample to firms that disclose positive R&D expenditures. (As explained later, my descriptive statistics suggest that few of the non-disclosing firms actually have positive R&D expenditures. Therefore, I evaluate whether my results continue to hold when R&D expenditure is coded as zero for the non-disclosing firms. The results from this robustness test (reported in section seven) are qualitatively unchanged.)

Finally, to the extent that a firm's decision to disclose or not disclose its R&D expenditure is a firm-specific characteristic, this will be controlled for in my panel data models. In fact, I find that only 1.48% of firms disclose positive R&D spending in one year but do not disclose R&D in the other sample year. This is consistent with a firm's R&D disclosure decision being a firm-specific characteristic. Therefore, my panel data models help to alleviate concerns that unobservable factors might affect firms' R&D disclosure decisions.

5. Descriptive statistics

5.1. Sample Selection

While the tax office has provided us with data on private firms, it is not willing to provide data on firms that are publicly traded.²¹ Therefore, my sample consists of private firms only. The firms are mandated to submit their financial statements and tax returns to the tax authorities and all the financial statements are audited by the independent audit firms. The tax office's database contains firms' tax returns and financial statements filed in 2008 and 2009. It also identifies which firms apply for R&D tax deductions and shows the amount of R&D tax deductions that the successful claimant firms use to reduce their reported tax liabilities.

Table 1, Panel A shows the industry composition of the initial sample and the number of observations in which firms disclose positive R&D expenditures.²² Col. 1 shows that manufacturing accounts for 43.45% of the initial sample (26,431 obs.) while firms in the Wholesale and Retail Trade industry account for 43.12% (26,226 obs.). Col. 2 shows that there are 1,186 observations where firms disclose positive R&D expenditures. These 1,186 observations comprise my estimation sample for the tabulated regression results. (Section seven reports untabulated results in which the regressions are estimated using the full sample of 60,828 observations and the non-disclosing firms are assumed to have zero R&D expenditures.) Col. 3 shows the percentage of observations with positive R&D expenditures in each industry. The Information Technology industry has the highest percentage of

²¹ Private firms refer to all the non-publicly traded firms, instead of the non-state owned firms.

²² Industries in China are defined according to the National Bureau of Statistics of China.

observations with positive R&D (10.57%), which is consistent with the innovative nature of the IT industry. In comparison, only 0.80% of observations in the Wholesale and Retail Trade industry and 0.13% of observations in the Social Services industry have positive R&D.

To assess whether the non-disclosing firms have positive R&D expenditures, Panel B of Table 1 breaks the initial sample into four groups. Group 1 comprises observations with undisclosed R&D and no application for R&D tax deductions (Col. 1); Group 2 comprises observations with undisclosed R&D and an application for R&D tax deductions (Col. 2); Group 3 comprises observations with positive disclosed R&D spending and no application for R&D tax deductions (Col. 3); Group 4 comprises observations with positive disclosed R&D spending and an application for tax deductions (Col. 4). The purpose of this breakdown is to determine whether there are many firms that fail to disclose R&D but that nevertheless claim for R&D tax deductions. If there are, then the non-disclosure of positive R&D expenditures is more likely to be a problem.

As shown in Col. 2, there are only 18 observations (out of 59,642 (Col.1 + Col.2)) where firms do not disclose R&D expenditures but claim for R&D tax deductions. In comparison, Col. 4 shows that there are 486 observations where firms claim for R&D tax deductions and also disclose positive R&D expenditures. Given that firms claiming for R&D tax deductions must have positive R&D spending, this indicates that there are likely to be few cases in which firms have positive R&D expenditures but no R&D expenditure is

Table 1
Descriptive Statistics for the full sample (both R&D disclosures and non-disclosures).

Panel A: Number of observations that report positive R&D expenditures

Industry (as defined by China's SIC codes)	Total observations	Observations with positive R&D	% of observations with positive R&D
	(1)	(2)	(3)
Agriculture, Forest, Farming	96	2	2.08%
Mining and Quarrying	88	3	3.41%
Manufacturing	26,431	771	2.92%
Electricity, Gas, Water	76	2	2.63%
Building	454	14	3.08%
Transportation and Warehousing	1,595	19	1.19%
Information Technology	1,438	152	10.57%
Wholesale and Retail Trade	26,226	209	0.8%
Real Estate	305	6	1.97%
Social Services	3,968	5	0.13%
Culture Communication	139	3	2.16%
Others	12	0	0%
Total	60,828	1,186	1.95%

Table 1 (cont.)

Panel B: Firms' R&D disclosures and their applications for R&D tax deductions

Industry (as defined by China's SIC codes)	Undisclosed R&D & no application for tax deduction (1)	Undisclosed R&D & application for tax deduction (2)	Disclosed R&D & no application for tax deduction (3)	Disclosed R&D & application for tax deduction (4)
Agriculture, Forest, Farming	94	0	2	0
Mining and Quarrying	85	0	3	0
Manufacturing	25,648	12	439	332
Electricity, Gas, Water	74	0	2	0
Building	437	3	14	0
Transportation and Warehousing	1,575	1	19	0
Information Technology	1,286	0	49	103
Wholesale and Retail Trade	26,017	0	158	51
Real Estate	299	0	6	0
Social Services	3,963	0	5	0
Culture Communication	134	2	3	0
Others	12	0	0	0
Total	59,624	18	700	486

Panel C: Claimant and non-claimant observations in the sub-sample of observations where R&D expenditures are disclosed (N = 1,186)

	<u>2008</u>	<u>2009</u>	<u>Total</u>
Claimants	184	302	486
Non-Claimants	232	468	700
Total	416	770	1,186

Table 1 (cont.)

Panel D: Industry composition in the sub-sample of observations where R&D expenditures are disclosed and firms claim for tax deductions (N = 486)

<u>Industry</u>	<u>2008</u>	<u>2009</u>	<u>Total</u>
Manufacturing	127	205	332
Information Technology	41	62	103
Wholesale and Retail Trade	16	35	51
Total	184	302	486

Panel E: Industry composition in the sub-sample of observations where R&D expenditures are disclosed but firms do not claim for tax deductions (N = 700)

<u>Industry</u>	<u>2008</u>	<u>2009</u>	<u>Total</u>
Agriculture, Forest, Animal	2	0	2
Mining and Quarrying	1	2	3
Manufacturing	136	303	439
Electricity, Gas, Water	1	1	2
Building	7	7	14
Transportation and Warehousing	9	10	19
Information Technology	21	28	49
Wholesale and Retail Trade	47	111	158
Real Estate	3	3	6
Social Services	3	2	5
Culture Communication	2	1	3
Total	232	468	700

disclosed. In other words, it appears that the majority of firms that invest in R&D also disclose their R&D expenditures.

Table 1, Panel C presents the number of claimants and non-claimants in the restricted sample of firms that disclose positive R&D expenditures. Of the 1,186 observations with disclosed R&D expenditures, 486 submit claims for R&D tax deductions whereas 700 do not submit claims. Panel D shows the number of claims in each industry. All the claims are from either the Manufacturing (N=332), Information Technology (N=103) or the Wholesale and Retail Trade industries (N=51). Panel E shows the number of non-claimants in each industry.

5.2. Descriptive statistics

The initial sample comprises 32,232 firms (60,828 firm-year observations) in 2008 and 2009. Table 2, Panel A shows the descriptive statistics of the full sample. The mean (median) total assets and sales are US\$3,034,357 (\$425,186) and US\$3,399,051 (\$483,811), respectively.²³ Among the 1,186 observations where firms disclose positive R&D expenditures, the mean (median) R&D expenditures are US\$1,691,193 (\$160,738). The mean (median) total assets and sales for these 1,186 observations are US\$22,239,980 (\$4,275,093) and US\$25,814,046 (\$3,568,955).

Table 2, Panel B shows the descriptive statistics for the treatment and control variables. Except for the *ETR* variables which are truncated over the

²³ To convert RMB to US dollar, I take the average exchange rate between RMB and US dollar as 7 : 1 during our sample period 2008 and 2009.

Table 2
Descriptive Statistics

Panel A: Summary statistics of the full sample (the variables are reported in US dollars)

	N	25%	Median	75%	Mean	Standard deviation
Total assets	60,828	193,821	425,186	1,114,810	3,034,357	54,000,000
Sales	60,828	178,918	483,811	1,445,295	3,399,051	46,500,000
R&D expenditures	1,186	34,452	160,738	525,986	1,691,193	19,900,000

Panel B: Summary statistics in the sub-sample of observations where R&D expenditures are disclosed (N = 1,186)

	N	25%	Median	75%	Mean	Standard deviation
R&D _{it}	1,186	0.014	0.027	0.069	0.061	0.090
CLAIM _{it}	1,186	0.000	0.000	1.000	0.410	0.492
ADJUSTED_ETR _{it}	955	0.048	0.110	0.201	0.163	0.195
ADJUSTED_CETR _{it}	955	0.067	0.123	0.195	0.174	0.211
ADJUSTED_BT D _{it}	1,186	-0.042	-0.006	0.012	-0.025	0.105
ADJUSTED_DDBTD _{it}	1,175	-0.013	0.021	0.044	0.005	0.096
LTA _{it}	1,186	15.986	17.214	18.373	17.227	1.696
ROA _{it}	1,186	0.004	0.050	0.155	0.083	0.174
LEVERAGE _{it}	1,186	0.000	0.000	0.025	0.047	0.104
CASH _{it}	1,186	0.053	0.139	0.308	0.214	0.213
DA _{it}	1,175	0.067	0.170	0.329	0.267	0.309
TAX_RATE _{it}	1,186	0.010	0.180	0.200	0.150	0.070
TAX_LIABILITY _{it}	1,186	0.002	0.046	0.150	0.106	0.144

range [0, 1], the continuous variables are winsorized at the 1st and 99th percentiles to mitigate the problem of outliers. The mean $ADJUSTED_ETR_{it}$ is 16.3% and the mean $ADJUSTED_CETR_{it}$ is 17.4%. These are lower than the average statutory tax rate of 19% and the average actual tax rate of 18.3%.²⁴

5.3. Claims for R&D tax deductions and the risk of incurring a tax examination

The key assumption that underlies the two hypotheses is that a firm is more likely to be subject to a tax examination after it submits a claim for R&D tax deductions. If this assumption is true, I would expect to find a positive association between claiming for R&D tax deductions and the incidence of a tax examination.²⁵ As the tax office does not keep records on informal tax examinations, I use the comprehensive tax audit data to test my assumption.

Table 3 shows that among 60,324 firm-year observations where firms did not submit a claim during my sample period, there are 429 cases where firms were subject to a comprehensive tax audit (audit rate = 0.71%). In comparison, among 504 observations where firms submitted a claim, 10 firms were audited by the local tax office (audit rate = 1.98%). A Chi-square test shows that the difference between these audit rates (i.e., 0.71% versus 1.98%) is statistically

²⁴ The city where our sample firms are located is one of the special economic zones in China. Firms in this zone are subject to a lower statutory tax rate than the 25% statutory tax rate in China. The statutory tax rate is 18% in 2008 and 20% in 2009.

²⁵ On the other hand, even if the assumption is correct, the results may not support this prediction due to a self-selection issue, which biases against finding a positive relation between submitting a claim for R&D tax deductions and the incidence of a tax examination. In particular, a firm will not submit a claim if it believes that doing so would result in a tax examination. This self-selection effect means that firms submitting claims for R&D tax deductions are less likely to be examined. Consequently, I may not find a strong positive association between R&D tax claims and tax examinations even if the assumption is true.

significant (p-value < 0.001). This is consistent with my maintained assumption that firms come under greater scrutiny from the tax office when they submit claims for R&D tax deductions.

Table 3

The association between claiming for R&D tax deductions and the incidence of a comprehensive tax audit.

This table tests whether claiming for R&D tax deductions increases the likelihood of incurring a comprehensive tax audit. The sample is based on 60,828 firm-year observations. "Claimants (Non-claimants)" refer to the firms that submitted (did not submit) a claim to the tax office for R&D tax deductions during the sample period. "Tax Audit (No Tax Audit)" refers to the firms that were (not) subject to a comprehensive tax audit during the same period.

	Comprehensive tax audit	No comprehensive tax audit	Frequency of tax audit
Claimants	10	494	1.98%
Non-Claimants	429	59,895	0.71%

Pearson Chi-Square = 11.30
Probability < 0.001

5.4. Univariate tests

Table 4, Panel A presents the univariate results for H1. The analysis shows that claimant firms differ from non-claimant firms in their tax aggressiveness. Specifically, claimant firms have significantly higher effective tax rates and significantly lower book-tax differences than non-claimant firms. This is consistent with my prediction in H1 that tax aggressive firms are less likely to claim for R&D tax deductions.

With respect to the control variables, I find that claimant firms are significantly larger than non-claimant firms. This is consistent with smaller

firms being less able to afford the costs of making a claim for R&D tax deductions. I also find that claimant firms have higher tax rates and tax liabilities, consistent with firms being more likely to claim for R&D tax deductions when the marginal benefit of applying for a tax deduction is larger.

Table 4			
Univariate tests			
The sample comprises 1,186 observations with positive R&D expenditures (see Table 1, Panel C).			
Panel A: Variable means for the claimants and non-claimants (Hypothesis 1)			
	Claimants ($CLAIM_{it} = 1$)	Non-Claimants ($CLAIM_{it} = 0$)	t-statistics for differences in means
$ADJUSTED_ETR_{it}$	0.208	0.126	0.082***
$ADJUSTED_CETR_{it}$	0.237	0.121	0.116***
$ADJUSTED_BTD_{it}$	-0.045	-0.010	-0.035***
$ADJUSTED_DDBTD_{it}$	-0.016	0.019	-0.035***
LTA_{it}	17.871	16.780	1.091***
DA_{it}	0.256	0.275	-0.019
TAX_RATE_{it}	0.159	0.144	0.015***
$TAX_LIABILITY_{it}$	0.178	0.056	0.122***
Panel B: Variable means for the high-R&D and low-R&D (Hypothesis 2)			
	High-R&D ($R\&D_{it} >$ Median)	Low-R&D ($R\&D_{it} <$ Median)	t-statistics for differences in means
$ADJUSTED_ETR_{it}$	0.211	0.109	0.102***
$ADJUSTED_CETR_{it}$	0.233	0.107	0.126***
$ADJUSTED_BTD_{it}$	-0.050	0.001	-0.051***
$ADJUSTED_DDBTD_{it}$	-0.020	0.029	-0.049***
LTA_{it}	17.191	17.263	-0.072
ROA_{it}	0.103	0.063	0.040***
$LEVERAGE_{it}$	0.036	0.058	-0.022***
$CASH_{it}$	0.243	0.186	0.057***

*, **, *** = statistically significant at the 10%, 5%, 1% levels, respectively (two-tailed). See Appendix II for variable definitions.

Table 4, Panel B presents the univariate results for H2. To test whether a

firm's R&D spending is negatively associated with its tax aggressiveness, I split the sample into two groups. The "high-R&D" group refers to firms whose R&D spending is above the median and "low-R&D" refers to firms whose R&D spending is below the median. The analysis shows that high-R&D firms have significantly higher effective tax rates and significantly lower book-tax differences than low-R&D firms. This is consistent with my prediction in H2 that tax aggressive firms invest less in R&D.

With respect to the control variables, I find high-R&D firms are more profitable and have lower leverage than low-R&D firms. High-R&D firms also have more cash and short-term investments than low-R&D firms, consistent with internal funding being a determinant of R&D spending.

Table 5 presents a correlation matrix for all the variables. Correlations that are statistically significant at the 1% level (two-tailed) are highlighted in bold. The matrix shows a significant positive correlation between the two *ETR* variables and the claim probability, and a significant negative correlation between the two *BTD* variables and the claim probability. This is consistent with my first hypothesis that tax aggressive firms are less likely to claim for R&D tax deductions. Similarly, the matrix shows a significant negative correlation between a firm's tax aggressiveness and R&D spending. This is consistent with my second hypothesis that tax aggressive firms invest less in R&D.

Turning to the four measures of tax aggressiveness, I find that the correlation between the adjusted *GAAP ETR* and *Cash ETR* is 0.750, which is

Table 5
Pearson Correlation Matrix
The sample comprises 1,186 observations with positive R&D expenditures (see Table 1, Panel C).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. $R\&D_{it}$	1.000												
2. $CLAIM_{it}$	0.433	1.000											
3. $ADJUSTED_ETR_{it}$	0.287	0.211	1.000										
4. $ADJUSTED_CETR_{it}$	0.260	0.276	0.750	1.000									
5. $ADJUSTED_BTD_{it}$	-0.274	-0.166	-0.266	-0.433	1.000								
6. $ADJUSTED_DDBTD_{it}$	-0.289	-0.176	-0.257	-0.430	0.987	1.000							
7. LTA_{it}	-0.131	0.317	-0.079	-0.000	0.085	0.076	1.000						
8. ROA_{it}	0.132	0.251	-0.201	-0.202	0.551	0.490	0.203	1.000					
9. $LEVERAGE_{it}$	-0.107	-0.015	-0.013	0.020	0.018	-0.003	0.305	-0.088	1.000				
10. $CASH_{it}$	0.127	0.064	0.044	0.037	-0.004	0.021	-0.163	0.201	-0.173	1.000			
11. DA_{it}	0.064	-0.030	-0.064	-0.102	0.042	-0.003	-0.031	0.181	0.056	0.082	1.000		
12. TAX_RATE_{it}	0.112	0.106	0.479	0.453	-0.097	-0.072	-0.097	-0.185	-0.000	0.077	-0.023	1.000	
13. $TAX_LIABILITY_{it}$	0.354	0.416	-0.061	0.020	-0.051	-0.103	0.186	0.796	-0.116	0.244	0.175	-0.156	1.000

Correlations that are statistically significant at the 1% level (two-tailed) are highlighted in **bold**.
See Appendix II for variable definitions.

close to the 0.779 correlation documented in Cheng et al. (2012). The correlations between the adjusted *GAAP ETR* and the adjusted *BTD* and *DDBTD* are -0.266 and -0.257, respectively. These are similar to the correlations of -0.361 and -0.242 documented in Chen et al. (2010). Overall, the correlations among the four adjusted tax aggressiveness measures are similar to prior studies with respect to both their signs and magnitudes.

6. Main results

6.1. Results for H1

Table 6 presents the results for my first hypothesis regarding the firm's decision to claim for R&D tax deductions. In Panel A, the models are estimated using the SUR system. In Panel B, the models are estimated using the random effects specification.²⁶ Under H1, I predict that tax aggressive firms are less likely to claim for R&D tax deductions. Therefore, I expect to find positive coefficients on the *ETR* variables and negative coefficients on the *BTD* variables.

Consistent with H1, I find that the coefficients on the *ADJUSTED_ETR_{it}* variables are positive and statistically significant at better than the 1% level (z-stats. = 6.20). The coefficients are not only statistically significant, but economically meaningful as well. My estimates indicate that increasing the *ADJUSTED_ETR_{it}* from 4.8% (the 25th percentile) to 20.1% (the 75th percentile) increases the claim probability by 12% (from 39% to 51%). Similarly, the

²⁶ As noted earlier, it is not feasible to estimate equation (1) using a firm fixed effects specification because the dependent variable does not vary over time for the vast majority of firms.

$ADJUSTED_CETR_{it}$ variable has positive and statistically significant coefficients (z-stats. = 5.93). Increasing the $ADJUSTED_CETR_{it}$ from 6.7% (the 25th percentile) to 19.5% (the 75th percentile) increases the claim probability by 10% (from 40% to 50%). These results are consistent with my expectation that tax aggressive firms are significantly less likely to claim for R&D tax deductions.

Table 6

The relation between a firm's tax aggressiveness and its decision to claim for R&D tax deductions (Hypothesis 1). The dependent variable indicates whether the firm submits a claim to the tax office for R&D tax deductions ($CLAIM_{it}$). The sample comprises observations with positive R&D expenditures (see Table 1, Panel C). z-statistics are reported in the parentheses.

Panel A: Seemingly Unrelated Regression

$ADJUSTED_ETR_{it}$	1.893*** (6.20)			
$ADJUSTED_CETR_{it}$		1.859*** (5.93)		
$ADJUSTED_BTD_{it}$			-3.198*** (-5.98)	
$ADJUSTED_DDBTD_{it}$				-3.546*** (-6.15)
LTA_{it}	0.198*** (4.70)	0.181*** (4.15)	0.205*** (5.23)	0.209*** (5.35)
DA_{it}	-0.342*** (-2.67)	-0.309** (-2.48)	-0.387*** (-3.20)	-0.389*** (-3.15)
TAX_RATE_{it}	1.525* (1.93)	1.299* (1.91)	3.074*** (4.28)	3.105*** (4.31)
$TAX_LIABILITY_{it}$	3.852*** (6.78)	3.739*** (6.92)	4.409*** (7.81)	4.302*** (7.64)
$INTERCEPT_{it}$	-4.544*** (-5.76)	-4.223*** (-5.22)	-4.687*** (-6.18)	-4.658*** (-6.18)
<i>Year Dummy</i>	Yes	Yes	Yes	Yes
<i>Industries Dummies</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	949	949	1,175	1,175
<i>Pseudo R²</i>	25.39%	25.90%	28.60%	28.89%

Panel B: Random effects models

<i>ADJUSTED_ETR_{it}</i>	4.357*** (4.85)			
<i>ADJUSTED_CETR_{it}</i>		7.933*** (5.26)		
<i>ADJUSTED_BT D_{it}</i>			-9.726*** (-5.74)	
<i>ADJUSTED_DDBTD_{it}</i>				-11.336*** (-6.03)
<i>LTA_{it}</i>	0.982*** (6.52)	1.278*** (6.83)	1.436*** (7.95)	1.445*** (7.95)
<i>DA_{it}</i>	-1.502*** (-2.67)	-1.698** (-2.42)	-2.182*** (-3.59)	-2.409*** (-3.92)
<i>TAX_RATE_{it}</i>	10.871*** (3.40)	12.123*** (3.22)	27.196*** (7.46)	27.270*** (7.49)
<i>TAX_LIABILITY_{it}</i>	15.974*** (7.86)	20.067*** (9.01)	25.576*** (11.86)	25.545*** (11.78)
<i>INTERCEPT_{it}</i>	-21.809*** (-7.20)	-28.370*** (-7.78)	-33.032*** (-9.47)	-32.940*** (-9.41)
<i>Year Dummy</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	955	955	1,175	1,175

*, **, *** = statistically significant at the 10%, 5%, 1% levels, respectively (two-tailed). See Appendix II for variable definitions.

Consistent with H1, I also find negative and significant coefficients on the *ADJUSTED_BT D_{it}* and *ADJUSTED_DDBTD_{it}* variables. This again suggests that tax aggressive firms are less likely to claim for R&D tax deductions. Increasing the *ADJUSTED_BT D_{it}* from the 25th percentile the 75th percentile lowers the claim probability by 7% (from 45% to 38%). Similarly, increasing the *ADJUSTED_DDBTD_{it}* from the 25th percentile to the 75th percentile reduces the claim probability by 8% (from 45% to 37%).

For the control variables, I find a significant positive relation between

firm size and the application probability. This is consistent with large firms being more likely to claim for R&D tax deductions because they have more resources and expertise to handle the claim process. I also find a significant negative coefficient on the absolute discretionary accruals variable (DA_{it}). This is consistent with firms having stronger incentives to avoid the tax office scrutiny when they have lower financial reporting quality. I find a positive relation between the firm's actual tax rate (TAX_RATE_{it}) and its claim probability. This is consistent with firms having a stronger incentive to claim for R&D tax deductions when they are subject to a higher tax rate. I also find a significant positive coefficient on the firm's tax liability ($TAX_LIABILITY_{it}$). This is consistent with my prediction that firms are more likely to claim for R&D tax deductions when they have sufficient positive tax liabilities to offset the tax deductions.²⁷

Panel B presents the random effects models. The results are consistent with those using the SUR system in Panel A. The $ADJUSTED_ETR_{it}$ and $ADJUSTED_CETR_{it}$ variables have positive and statistically significant coefficients. Likewise, the coefficients on the $ADJUSTED_BTD_{it}$ and $ADJUSTED_DDBTD_{it}$ variables are negative and statistically significant. For

²⁷ Loss firms may have less incentive to claim for R&D tax deductions because they cannot use the tax deductions concurrently. However, the R&D tax deduction policy in China allows loss firms to carry forward the unused R&D tax deductions to the next five years. Therefore, loss firms still have the incentives to make a claim. In addition, the $TAX_LIABILITY_{it}$ variable controls for the firm's tax liability, and thereby partially addresses this issue.

Moreover, I do restrict the sample to firms with positive pre-tax income when constructing the two ETR variables. (Following prior studies, the $ADJUSTED_ETR_{it}$ and $ADJUSTED_CETR_{it}$ variables are coded as missing if the pre-tax income is zero or negative.) I further checked the robustness of our results by restricting the two BTD models to firms with positive pre-tax income. The results are qualitatively unchanged.

the control variables, I continue to find significant positive coefficients on firm size (LTA_{it}), actual tax rate (TAX_RATE_{it}) and tax liability ($TAX_LIABILITY_{it}$), and significant negative coefficients on absolute discretionary accruals (DA_{it}).

Overall, the results in Table 6 are consistent with tax aggressive firms being less likely to claim for R&D tax deductions (H1).

6.2. Results for H2

Table 7 presents the results for my second hypothesis regarding firms' R&D investments. The SUR results are reported in Panel A, the random effects models are given in Panel B, and the fixed effects models are shown in Panel C. Under H2, I predict that tax aggressive firms invest less in R&D. Therefore, I expect to find positive coefficients on the *ETR* variables and negative coefficients on the *BTD* variables.

Consistent with H2, both the $ADJUSTED_ETR_{it}$ and $ADJUSTED_CETR_{it}$ variables have positive and statistically significant coefficients (t-stats. = 6.40, 6.28). Therefore, tax aggressiveness is negatively associated with R&D spending. Economically, as the $ADJUSTED_ETR_{it}$ variable increases from 4.8% (the 25th percentile in my data) to 20.1% (the 75th percentile), there is an increase in R&D spending of US\$601,000, which accounts for 36% of the average R&D spending of my sample firms (US\$1.69 million). Similarly, an increase in the $ADJUSTED_CETR_{it}$ from 6.7% (the 25th percentile) to 19.5% (the

Table 7

The relation between a firm's tax aggressiveness and its spending on R&D (Hypothesis 2). The dependent variable is R&D spending ($R\&D_{it}$). The sample comprises observations with positive R&D expenditures (see Table 1, Panel C). t-statistics are reported in parentheses.

Panel A: Seemingly Unrelated Regression

$ADJUSTED_ETR_{it}$	0.157*** (6.40)			
$ADJUSTED_CETR_{it}$		0.137*** (6.28)		
$ADJUSTED_BTD_{it}$			-0.404*** (-7.80)	
$ADJUSTED_DDBTD_{it}$				-0.413*** (-7.82)
LTA_{it}	-0.008*** (-3.53)	-0.010*** (-3.97)	-0.010*** (-4.83)	-0.009*** (-4.62)
$LEVERAGE_{it}$	0.024 (0.88)	0.024 (0.87)	0.027 (1.25)	0.019 (0.89)
ROA_{it}	0.186*** (5.81)	0.182*** (5.67)	0.202*** (5.97)	0.183*** (5.84)
$CASH_{it}$	0.003 (0.20)	0.003 (0.19)	0.005 (0.38)	0.009 (0.72)
$INTERCEPT_{it}$	0.146*** (3.75)	0.173*** (4.28)	0.187*** (5.63)	0.191*** (5.71)
<i>Year Dummy</i>	Yes	Yes	Yes	Yes
<i>Industry Dummies</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	955	955	1,186	1,175
<i>Adjusted R²</i>	21.00%	19.97%	23.93%	23.46%

Panel B: Random effects models

$ADJUSTED_ETR_{it}$	0.143*** (10.90)			
$ADJUSTED_CETR_{it}$		0.117*** (9.55)		
$ADJUSTED_BTD_{it}$			-0.345*** (-13.90)	
$ADJUSTED_DDBTD_{it}$				-0.350*** (-13.62)
LTA_{it}	-0.009***	-0.010***	-0.009***	-0.009***

	(-4.57)	(-5.15)	(-5.61)	(-5.18)
<i>LEVERAGE_{it}</i>	-0.012	-0.011	-0.006	-0.015
	(-0.44)	(-0.40)	(-0.24)	(-0.64)
<i>ROA_{it}</i>	0.162***	0.162***	0.197***	0.177***
	(8.42)	(8.24)	(11.42)	(10.67)
<i>CASH_{it}</i>	0.000	-0.001	0.003	0.010
	(0.01)	(-0.09)	(0.21)	(0.80)
<i>INTERCEPT_{it}</i>	0.169***	0.194***	0.196***	0.194***
	(5.01)	(5.72)	(6.73)	(6.64)
<i>Year Dummy</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	949	949	1,186	1,175
<i>R² (within-effect)</i>	6.58%	3.27%	3.57%	3.00%

Panel C: Fixed effects models

<i>ADJUSTED_ETR_{it}</i>	0.090***			
	(4.23)			
<i>ADJUSTED_CETR_{it}</i>		0.051***		
		(2.68)		
<i>ADJUSTED_BT D_{it}</i>			-0.108***	
			(-2.87)	
<i>ADJUSTED_DDBTD_{it}</i>				-0.102***
				(-2.62)
<i>LTA_{it}</i>	-0.028***	-0.031***	-0.015*	-0.015*
	(-2.74)	(-2.92)	(-1.78)	(-1.74)
<i>LEVERAGE_{it}</i>	0.001	0.002	-0.018	-0.016
	(0.01)	(0.04)	(-0.47)	(-0.42)
<i>ROA_{it}</i>	0.035	0.026	0.020	0.006
	(1.05)	(0.74)	(0.65)	(0.21)
<i>CASH_{it}</i>	-0.018	-0.023	-0.019	-0.014
	(-0.72)	(-0.88)	(-0.80)	(-0.62)
<i>INTERCEPT_{it}</i>	0.541***	0.590***	0.309**	0.327**
	(2.99)	(3.21)	(2.18)	(2.16)
<i>Year Dummy</i>	Yes	Yes	Yes	Yes
<i>Observations</i>	949	949	1,186	1,175
<i>R² (within-effect)</i>	9.93%	6.46%	5.80%	5.41%

*, **, *** = statistically significant at the 10%, 5%, 1% levels, respectively (two-tailed). See Appendix II for variable definitions.

75th percentile) is associated with an increase of US\$448,000 in R&D spending,

which is 27% of the average R&D spending in my sample.

Further, the $ADJUSTED_BTD_{it}$ and $ADJUSTED_DDBTD_{it}$ variables have negative and statistically significant coefficients (t-stats. = -7.80, -7.82). Increasing the $ADJUSTED_BTD_{it}$ from the 25th percentile to the 75th percentile is associated with a decrease of approximately US\$491,000 (i.e., 29%) in R&D spending. Similarly, increasing the $ADJUSTED_DDBTD_{it}$ from the 25th percentile to the 75th percentile reduces R&D spending by approximately US\$530,000 (i.e., 31%).

For the control variables, I find that firm size (LTA_{it}) is negatively associated with R&D spending. I find positive and significant coefficients on performance (ROA_{it}), indicating that profitable firms invest more in R&D. The coefficients are insignificant for leverage ($LEVERAGE_{it}$) and internal funds ($CASH_{it}$). In addition, the SUR results reveal a significant positive correlation between the residuals in the $CLAIM_{it}$ and $R\&D_{it}$ models (mean correlation = 0.136, the level of significance < 0.01). This is consistent with my conjecture that the unobserved factors that affect the firm's decision to apply for R&D tax deductions are correlated with the unobserved factors that affect the firm's R&D investment decision. In other words, the two decisions are not independent of each other.

Table 7, Panel B presents the random effects models. The results are highly consistent with those using the SUR system in Panel A. The coefficients on the $ADJUSTED_ETR_{it}$ and $ADJUSTED_CETR_{it}$ variables are positive and statistically significant, while the coefficients on the $ADJUSTED_BTD_{it}$ and

$ADJUSTED_DDBTD_{it}$ variables are negative and statistically significant. Panel C presents the fixed effects models. Again, the results are consistent with Panels A and B. All of the adjusted tax aggressiveness measures have the predicted signs and are statistically significant.

Overall, I find strong evidence that tax aggressive firms invest significantly less in R&D, as predicted under H2.

7. Additional analyses

7.1. Undisclosed R&D expenditures

My main analyses are conducted on the firms that disclose positive R&D spending. On the other hand, the descriptive statistics in Table 1 suggest that most of the non-disclosing firms likely have zero R&D as very few of the non-disclosing firms apply for R&D tax deductions. Therefore, I assess the robustness of the results for H2 by replacing the non-disclosed R&D as zero and including all of the 60,828 observations from the original sample. I continue to find that tax aggressive firms invest significantly less in R&D. All of the adjusted tax aggressiveness variables are statistically significant with the predicted signs.

7.2. Zero or negative pre-tax income

I follow the majority of prior studies by setting the $ADJUSTED_ETR_{it}$ and $ADJUSTED_CETR_{it}$ variables as missing if pre-tax income is zero or negative. However, Robinson et al. (2010) code a firm's effective tax rate as 1 if the firm

has positive income tax expense or cash tax payment but zero or negative pre-tax income. When I follow their approach, my results are qualitatively unchanged.

8. Conclusions

In this paper, I examine how tax aggressiveness interacts with the availability of R&D tax deductions to affect a firm's incentive to invest in R&D in China. Because of the institutional setting in China, I expect that tax aggressive firms are less likely to claim for R&D tax deductions because they wish to avoid the close scrutiny of the tax authority. This means that R&D is a less attractive proposition for tax aggressive firms and so they invest less in R&D. I therefore predict that tax aggressive firms are significantly less likely to ask the tax office for R&D tax deductions and they invest less in R&D accordingly. The results obtained using various estimation methods are highly consistent with both hypotheses.

My work provides new insights on the implementation of R&D tax policy in China. The main conclusion is that R&D tax breaks are less effective in stimulating R&D investments when firms are tax aggressive. Given the widespread tax aggressiveness in China and its current emphasis on stimulating innovation, the findings of this study are likely to be of global interest as they provide one reason why China has been unable to meet its targets for greater R&D spending.

References

- Arrow, K., 1962. Economic welfare and the allocation of resources for invention, NBER Chapters, in: *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pages 609-626 National Bureau of Economic Research, Inc.
- Barker, V.L., Mueller, G.C., 2002. CEO characteristics and firm R&D spending. *Management Science* 48, 782-801.
- Bartram, S.M., Brown, G., Stulz, R.M., 2012. Why are U.S. stocks more volatile? *Journal of Finance* 67, 1329-1370.
- Battelle.Org., 2011. 2012 Global R&D Funding Forecast.
- Baysinger, B., Hoskisson, R.E., 1989. Diversification strategy and R&D intensity in multiproduct firms. *Academy of Management Journal* 32, 310-332.
- Baysinger, B., Kosnik, R.D., Turk, T.A., 1991. Effects of board and ownership structure on corporate R&D strategy. *Academy of Management Journal* 34, 205-214.
- Berger, P., 1993. Explicit and implicit effects of the R&D tax credit. *Journal of Accounting Research* 31, 131-171.
- Bushee, B., 1998. The influence of institutional investors on myopic R&D investment behavior. *The Accounting Review* 73, 305-333.
- Chan, K.H., Lin, K.Z., Mo, P.L., 2010. Will a departure from tax-based accounting encourage tax noncompliance? Archival evidence from a transition economy. *Journal of Accounting and Economics* 50, 58-73.
- Chen, S., Chen, X., Cheng, Q., Shevlin, T., 2010. Are family firms more tax aggressive than non-family firms? *Journal of Financial Economics* 95, 41-61.
- Cheng, A., Huang, H., Ying, L., Stanfield, J., 2012. The effect of hedge fund activism on corporate tax avoidance? *The Accounting Review* 87, 1493 - 1526.
- Cleary, S., 1999. The relationship between firm investment and financial status. *Journal of Finance* 54, 673-692.
- Desai, M., Dharmapala, D., 2006. Corporate tax avoidance and high-powered incentives. *Journal of Financial Economics* 79, 145-179.

- Desai, M., Dyck, A., Zingales, L., 2007. Theft and taxes. *Journal of Financial Economics* 84, 591–623.
- Dhanani, S., Solanji, K., 2011. R&D tax credit: direct benefits to small & mid-market companies. *Business View*.
<http://www-view.com/finance/r-d-tax-credit-direct-benefits-to-small-mid-market-companies.htm>.
- Dyck, A., Zingales, L., 2004. Private benefits of control: an international comparison. *Journal of Finance* 59, 537–600.
- Dyreng, S., Hanlon, M., Maydew, E., 2008. Long-run corporate tax avoidance. *The Accounting Review* 83, 61–82.
- Fiebig, D.G., 2001. Seemingly unrelated regression, Chapter 5 in Baltagi, B.H. (ed.), *A Companion to Theoretical Econometrics*, Blackwell Publisher, 0101–121.
- Ghoul, S., Guedhami, O., Pittman, J., 2011. The role of IRS monitoring in equity pricing in public firms. *Contemporary Accounting Research* 28, 643 – 674.
- Graves, S., 1988. Institutional ownership and corporate R&D in the computer industry. *The Academy of Management Journal* 31, 417–428.
- Guedhami, O., Pittman, J., 2008. The importance of IRS monitoring to debt pricing in private firms. *Journal of Financial Economics* 90, 38–58.
- Hall, B., 1993. R&D tax policy during the eighties: success or failure? *Tax Policy and the Economy* 7, 1–36.
- Hanlon, M., 2003. What can we infer about a firm's taxable income from its financial statements? *National Tax Journal* 56, 831–63.
- Hanlon, M., Heitzman, S., 2010. A review of tax research, *Journal of Accounting and Economics* 50, 127–178.
- Hanlon, M., Laplante, S.K., Shevlin, T., 2005. Evidence for the possible information loss of conforming book income and taxable income. *Journal of Law and Economics* 48, 407–442.
- Klassen, K., Pittman, J., Reed, M., 2004. A cross-national comparison of R&D expenditure decisions: tax incentives and financial constraints. *Contemporary Accounting Research* 21, 639–680.

- Koh, P-S., Reeb, D., 2012. R&D disclosure bias. Working paper.
- Liowsky, P., 2010. Seeking shelter: empirically modeling tax shelters using financial statement information. *The Accounting Review* 85, 1693-1720.
- Mansfield, E., 1986. The R&D tax credit and other technology policy issues. *American Economic Review* 76, 190-194.
- Mills, L., 1998. Book-tax differences and internal revenue service adjustments. *Journal of Accounting Research* 36, 343-356.
- Nelson, R., 1959. The Simple Economics of Basic Scientific Research. *Journal of Political Economy* 67, 297-306.
- Office of the United States Trade Representative, 2012. U.S. - China Trade Facts.
- Peterson, M., 2009. Estimating standard errors in finance panel data sets: comparing approaches. *Review of Financial Studies* 22, 435-480.
- Robinson, J., Skies, S., Weaver, C., 2010. Performance measurement of corporate tax departments. *The Accounting Review* 85, 1035-1064.
- Sayler, A., 1998. R&E Tax Credit. American Association of Engineering Societies.
www.aaes.org/public_policy/6_16_98.asp.
- Schumpeter, J.A., 1942. *Capitalism, Socialism and Democracy*. Harper and Row, New York.
- Segarra, M., 2012. Three overlooked small-business tax breaks. *CFO Magazine*.
www3.cfo.com/article/2012/2/tax_3-tax-breaks-small-businesses-overlook.
- Swenson, C.W., 1992. Some tests of the incentive effects of the research and experimentation tax credit. *Journal of Public Economics* 49, 203-218.
- The Chinese National Tax Office, 1995. *The Tax Audit Procedures*.
- The Chinese National Tax Office, 2008. *Instructions for the enterprise's R&D tax deduction application*.
- The State Council - The People's Republic of China, 2006. *The National Medium-Term and Long-Term Program for Science and Technology Development (2006-2020)*.

- The US – China Business Council, 2012. US – China trade statistics and China's world trade statistics.
- United States Chamber of Commerce, 2011. China's Drive for "Indigenous Innovation" – A Web of Industrial Policies.
- United States International Trade Commission, 2011. China: Effects of Intellectual Property Infringement and Indigenous Innovation Policies on the U.S. Economy.
- Wen, F., 2008. The determinants and consequences of R&D investments in Chinese publicly traded firms. Working paper.
- Williamson, B., 2011. Why don't more UK companies take advantage of R&D tax credits? Business7.Co.UK.
<http://www.business7.co.uk/business-news/business-view-and-comment/2011/10/07/why-don-t-more-uk-companies-take-advantage-of-r-d-tax-credits-106408-23473280/>.
- Wilson, R., 2009. An examination of corporate tax shelter participants. The Accounting Review 84, 969–999.
- Wooldridge, J., 2005. Introductory Econometrics: A Modern Approach. South-Western College Pub; 3rd edition.
- World Trade Organization, 2011. Trade growth to slow in 2012 after strong deceleration in 2011.
- Zellner, A., 1962. An Efficient Method of Estimating Seemingly Unrelated Regression Equations and Tests of Aggregation Bias. Journal of the American Statistical Association 57, 500-509.

Appendix I: R&D expenditures that are qualified for R&D tax deductions

The Chinese National Tax Office issued “Instructions for the enterprise’s R&D tax deduction application” in 2008. The instructions specify the following R&D expenditures as being qualified for R&D tax deductions:

1. Costs of designing new products, setting new technology standards, and purchasing R&D-related books and documents.
2. Costs of raw material and fuel consumption during the R&D process.
3. Salaries, bonuses and subsidies of R&D staff.
4. Depreciation or rental of fixed assets that are used during the R&D process.
5. Amortization of intangible assets such as software, patents and intangible technology that are used during the R&D process.
6. Costs of making new moulds and tools for the purpose of experimentation and manufacturing trial products.
7. Costs of exploration and survey during the R&D process.
8. Costs of demonstrating and evaluating R&D output.

Appendix II: Variable definitions

<u>Variable name</u>	<u>Variable definition</u>
$R\&D_{it}$	Firm i 's total research and development expenditures divided by total assets in year t .
$CLAIM_{it}$	A binary variable which takes value 1 if firm i claims for R&D tax deductions in year t and 0 otherwise.
$ADJUSTED_ETR_{it}$	$(Income\ tax\ expense + R\&D\ tax\ deductions \times actual\ tax\ rate) / pre-tax\ income$. (This variable is set as missing if pre-tax income is zero or negative. In addition, this variable is truncated over the interval of $[0, 1]$).
$ADJUSTED_CETR_{it}$	$(Cash\ tax\ payment + R\&D\ tax\ deductions \times actual\ tax\ rate) / pre-tax\ income$. (This variable is set as missing if pre-tax income is zero or negative. In addition, this variable is truncated over the interval of $[0, 1]$).
$ADJUSTED_BTD_{it}$	$[Pre-tax\ income - (taxable\ income + R\&D\ tax\ deductions)] / total\ assets$.
$ADJUSTED_DDBTD_{it}$	The residual (e_{it}) from the following OLS regression: $ADJUSTED_BTD_{it} = TACC_{it} + e_{it}$ (where $TACC_{it}$ refers to the firm's total accruals and is calculated using the balance sheet method).
LTA_{it}	The natural logarithm of firm i 's total assets in year t .
DA_{it}	Firm i 's absolute value of discretionary accruals in year t , estimated using modified Jones model.
TAX_RATE_{it}	Firm i 's actual tax rate in year t .
$TAX_LIABILITY_{it}$	$(Taxable\ income + R\&D\ tax\ deductions) / total\ assets$.
ROA_{it}	Firm i 's pre-tax income divided by total assets in year t .
$LEVERAGE_{it}$	Firm i 's total debts divided by total assets in year t .
$CASH_{it}$	Firm i 's cash plus short-term investments divided by total assets in year t .