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ORIHARA, Masanori
University of Tsukuba

SUZUKI, Takafumi
Aichi Shukutoku University

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Research Institute of Economy, Trade & Industry, IAA

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Claiming Tax Incentives: Heterogeneous Impacts on Investment and Productivity[1]

Masanori Orihara
University of Tsukuba

Takafumi Suzuki
Aichi Shukutoku University

Abstract

We investigate firms' decisions to claim investment tax incentives following the 2014 tax reform in Japan and assess their impacts on investment and productivity. We use an instrumental variable approach to leverage exogenous variation in tax claim decisions. Frequent claimants were financially less constrained firms and those with fewer tax loss carryforwards. On average, tax claimants increased capital expenditures compared to pre-claim levels but did not achieve productivity gains. Further analysis demonstrates that the effects of tax claiming on investment and productivity vary substantially, depending on firms' financial constraints and tax loss positions. Specifically, financially constrained firms and those with larger tax losses increased productivity upon claiming tax incentives, supporting the effectiveness of countercyclical fiscal policy.

Keywords: Investment tax incentive, Tax claim, financial constraint, Tax loss, Productivity
JEL classification: H25, H32, G31, G38

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1. Introduction

When governments introduce investment tax incentives, firms face a critical decision: to claim these incentives or not. Traditionally, this decision was regarded as relatively straightforward. Established economic theory, dating back to the seminal work of Hall and Jorgenson (1967), presents a simple decision-making model. It suggests that firms should claim the incentives if the reduction in the cost of capital due to these tax incentives outweighs the expected benefits of the additional investments. While this model assumes a frictionless process for claiming tax incentives, recent studies challenge this assumption. They demonstrate that various factors hinder tax claims, such as tax loss positions (Kitchen and Knittel 2016; Cui et al. 2022), tax awareness (Pham 2019), tax complexity (Zwick 2021), and financial constraints (Orihara and Suzuki 2023).

Focusing on actual tax claimants is important for fiscal policy, including both taxation and subsidies, because it allows the classification of firms into three categories: i) tax claimants that increase investment, ii) claimants that do not, and iii) non-tax claimants. The first category fits well with standard theory, which predicts that tax incentives encourage firms to undertake incremental investments they would not have pursued otherwise. The second category includes firms that claim benefits for pre-planned projects that would have proceeded irrespective of the tax incentives. Our research helps the government detect such firms and consider restricting their eligibility for tax benefits. If the third category comprises a substantial number of firms, the government could aim to reduce frictions in the tax-claiming process. Alternatively, it could provide subsidies to firms that could not claim tax benefits due to these frictions. The existing literature, however, generally relies on the intent-to-treat approach and does not distinguish which firms actually claimed the incentives (Zwick and Mahon 2017; Zhang et al. 2018; Liu and Mao 2019; Maffini et al. 2019; Ohrn 2019; Garrett et al. 2020; Fan and Liu 2020; Tuzel and Zhang 2021; Curtis et al. 2022).

We examine the 2014 tax reform in Japan using unique tax return survey data. This reform introduced an investment tax credit and bonus depreciation, effective for nearly three years until the fiscal year ending in 2016. Our data provide information on which firms claimed tax incentives, the years they claimed them, the types of incentives, and the amounts involved. To our knowledge, such detailed information is not available in studies on other countries.

The data reveal two observations. First, 18.8% of firms claimed the tax incentives at least once during the eligible periods. Given that 86.0% of firms reported positive taxable income in our data, most firms had the potential to reduce their tax liability through these incentives. This moderate rate of less than 20% suggests potential frictions in the tax-claiming process. Second, our data demonstrate a clear preference among firms for tax credits over bonus depreciation. This tendency allows for a clearer evaluation of the economic impact of tax incentives because tax credits provide a benefit with a predetermined rate, while the value of bonus depreciation depends on firm-level discount factors that are not readily observable.

A key empirical challenge is the endogeneity in the decision to claim tax incentives. We develop an industry-level instrumental variable that measures the ratio of tax-eligible capital goods costs to total capital goods costs. This variable reflects both the extent of tax eligible expenses and the differences in capital input structures across industries, thereby capturing a plausibly exogenous shift in investment costs caused by the tax reform. Supporting our argument, the first stage of our instrumental variable regression shows that firms in industries more reliant on tax-eligible capital goods claimed these incentives more often.

In the second stage of our estimation, we find that tax claimants increased investments compared to their pre-claim levels. This finding, along with the results from the first stage of the estimation, suggests that tax claimants increased their investments due to the lowered input costs. The magnitude of these estimates is substantially larger than those reported in the literature using the intent-to-treat approach. Our estimation shows that tax claims increased investments by 48.1%, compared to 10.4% to 16.9% in the US (Zwick and Mahon, 2017), 18.0% in the US (Ohrn, 2019), 12.4% to 14.8% in the UK (Maffini et al., 2019), and 38.4% in China (Liu and Mao, 2019). Our larger coefficients result from the observation that actual tax claimants represent a subset of the treated firms in the intent-to-treat analysis; therefore, estimating the local average treatment effect via the instrumental variable estimation of this subset shows more pronounced effects compared to the intent-to-treat estimates in the literature.

We turn our attention to the impact of tax claiming on productivity. This investigation serves as a policy evaluation, since the tax reform requires that firms make investments aimed at enhancing productivity, rather than simply replacing existing capital. However, the actual productivity gains remain uncertain, as the government does not perform ex-post evaluations. We do not observe significant impacts on total factor productivity or labor productivity across all firms on average. This result, at first glance, challenges the effectiveness of the ex-ante requirements intended to encourage firms to invest in productivity-enhancing measures.

It is also possible that the insignificant productivity gains observed on average may obscure the role of firm-level heterogeneity. Supporting this argument, we find that such heterogeneity affects not only the impact of tax claiming on productivity but also on investment and, further, the likelihood of claiming tax incentives. We analyze two aspects of firm-level heterogeneity: financial constraints and tax loss carryforwards.

We find that financially less constrained firms claimed tax incentives more often. However, these firms did not increase investment or improve productivity following their claims. By contrast, financially constrained firms demonstrated significant increases in both investment and productivity upon claiming the incentives. These results imply that while access to finance facilitates the use of tax incentives, they do not guarantee their effective use toward policy objectives.

Moreover, we demonstrate that firms with fewer tax loss carryforwards were more likely to claim tax incentives and showed greater increases in investment following their claims. In contrast, firms with higher tax loss carryforwards showed stronger improvements in productivity. These findings indicate that the type of investments encouraged by tax incentives varies depending on the tax loss positions of firms.

Our paper contributes to the literature in several ways. First, most studies on investment tax incentives apply the intent-to-treat approach, classifying firms into treatment and control groups based on institutional eligibility or expected magnitude of tax benefits (Zwick and Mahon 2017; Zhang et al. 2018; Liu and Mao 2019; Maffini et al. 2019; Ohrn 2019; Garrett et al. 2020; Fan and Liu 2020; Tuzel and Zhang 2021; Curtis et al. 2022). In contrast, we address the actual decisions of firms to claim tax incentives. Our analysis provides a clearer understanding of investment tax incentives, illustrating that some firms claim tax incentives and achieve increases in both investment and productivity, while others claim without demonstrating improvements in either. These findings indicate that more targeted fiscal policies, including the imposition of restrictions, could enhance policy effectiveness.

Second, we advance our understanding of the decision-making process behind claiming tax incentives. While this process was traditionally assumed to be frictionless, recent research addresses the role of frictions as an important element in tax policy design. Our study contrasts with previous research that focuses solely on determinants of claiming tax incentives (Kitchen and Knittel 2016; Pham 2019; Zwick 2021). By examining both the decisions to claim tax incentives and their outcomes, we provide insights into which firms use incentives effectively to achieve policy goals and which do not. Furthermore, our application of an instrumental variable approach to address endogeneity concerns distinguishes our work from Orihara and Suzuki (2023), which studies the same tax reform. Our approach addresses tax claiming decisions driven by an exogenous factor, allowing us to establish causal effects of tax claiming on outcomes for effective policy making and evaluation.

Third, we address productivity. We find an overall insignificant impact on productivity growth, a result that contrasts with the positive effects reported by Liu and Mao (2019) but is in line with the findings of Curtis et al. (2022). One possible explanation is that firm-level heterogeneity plays a significant role; for example, among firms that are financially constrained and have more tax losses, tax claiming improves productivity. These findings have important policy implications: during periods of economic downturn, when financial constraints are more severe, and tax losses are more prevalent, tax policies can help increase productivity. This evidence supports the effectiveness of countercyclical fiscal policies. Moreover, Orihara and Suzuki (2023) do not study productivity.

Fourth, we find that tax losses play a role in both tax claiming and its consequences. Although Cui et al. (2022) have already shown that tax losses hinder tax claims, our study contributes a new finding: firms with fewer tax losses increase investment. This result is consistent with theory, as the value of investment tax incentives is higher for firms with fewer tax losses since they do not reduce their taxable income through tax loss refunds, allowing them to take greater advantage of the incentives. These insights expand our understanding of tax asymmetries (e.g., Auerbach 1986; Altshuler and Auerbach 1990; Devereux et al. 1994; Edgerton 2010), since tax asymmetries and the lack of immediate refunds can reduce the effectiveness of investment tax incentives.

The remainder of this paper is organized as follows. Section 2 provides background information. Section 3 details the data. Section 4 outlines our research design. Section 5 presents the results. Section 6 offers our conclusion.

2. Background

2.1. The 2014 Tax Reform

We study the 2014 tax reform in Japan. The policy targeted productivity growth as its primary goal, rather than simply encouraging more investment. It introduced both a tax credit and bonus depreciation. Firms could claim either for each investment project and had the flexibility to claim a different tax benefit for different investments. This framework differs from most other countries, which typically introduced either a tax credit or bonus depreciation. These tax incentives are structured similarly to those in other countries. A tax credit directly reduces a firm's tax payments, thereby lowering its effective tax rate. Bonus depreciation reduces taxable income rather than directly affecting tax payments, thus not influencing the firm's effective tax rate. These similarities facilitate comparison with studies conducted in other countries.

These tax incentives were temporary and available for nearly three years, from January 2014 to March 2017. In FY2014-15,[1] firms could claim a 5% tax credit, and in FY2016, this credit was set at 4%, both applicable against up to 20% of their corporate tax liabilities. The reform also introduced immediate depreciation in FY2014-15 and a bonus 50% depreciation in FY2016. The cap on corporate tax liabilities did not apply to immediate or bonus depreciation. If firms spent eligible capital expenditures but did not generate necessary taxable income by the end of their fiscal year, they were not allowed to carry forward any unclaimed tax incentive amounts.

Eligibility for tax benefits covers a broad range of capital investment goods, with certain restrictions to ensure alignment with the policy goal of achieving productivity growth. The system categorized eligible investments into two categories: A-type and B-type. A-type investments, representing the most current versions of property, plant, or equipment, are

[1] In Japan, the fiscal year extends from April to March. The tax system became available in January 2014, which falls within FY2013. For simplicity, we refer to the period from January 2014 to March 2016 as FY2014-15, or more succinctly, as 2014-15.

required to show an anticipated annual productivity increase of 1% over the previous version. Industry associations, rather than the firms themselves, were responsible for certifying whether an investment would meet this criterion.[2] They exercised discretion in defining 'productivity growth,' which could include measures such as output per unit of time or energy efficiency. B-type investments were those expected to generate an annual average return of at least 15% over the next three years. Specifically, this return was calculated as the projected average of annual operating earnings and depreciation over three years, increased due to the investment, divided by the capital expenditures. For B-type investments, accountants assessed and certified the feasibility of reaching these projected returns.

Two aspects are noteworthy. First, the government disclosed a list of eligible capital investments for type-A investments. This list helps distinguish between eligible and non-eligible capital expenditures, creating policy-driven variation in the extent of tax benefits. Second, the tax reform required only ex-ante certification that the investment would likely meet specific productivity thresholds. With no government mandate for ex-post evaluations of productivity growth, our research provides insights on whether ex-ante requirements effectively serve as a policy tool for productivity growth.

2.2. The Magnitude of Tax Incentives in Comparison to Other Countries

Given this background, we calculate the economic magnitudes of these tax incentives. As we discuss below, the tax incentives provided benefits that are largely consistent with those in other countries, with somewhat larger magnitudes. The tax incentives applied only to national corporate income taxes and were not applicable to local taxes.[3] Japan had a national corporate income tax rate of 25.5% in 2014. This rate was reduced to 23.9% in 2015 and further to 23.4% for the years 2016–2017. Firms are required to file their tax returns within two months of their fiscal year-end.

The magnitude of the tax incentives varies based on a firm's choice between a tax credit and bonus depreciation. For the tax credit, the benefit is straightforward: a 5% reduction in marginal investment costs for 2014 and 2015, and a 4% reduction in 2016. One caveat is the upper limit, which restricts deductions to 20% of corporate income tax payments. However, our data indicate that less than 5% of firms reached this maximum, which suggests that the limit is not a major concern.

What is the magnitude of tax benefits for firms choosing bonus depreciation? While most firms in our data choose tax credits over bonus depreciation, this calculation is important for comparability with existing studies, which primarily investigate bonus depreciation. Quantifying the exact magnitude is complex, as it depends on the depreciation schedules of the

[2] An example of an industrial association is the Japan Automobile Manufacturers Association, which includes major Japanese car manufacturers like Toyota Motor Corporation.

[3] Exceptions exist for small firms that could reduce local taxes as well. However, this provision did not apply to firms in our sample.

assets and the discount rate. Ohrn (2019) presents an example where, with a $100 investment and a federal tax rate of 35%, 50% bonus depreciation increased the present value of tax savings from $28.79 to $31.89, reducing the after-tax cost by a 3.10 percent point compared to the standard 7-year MACRS schedule in the US. Applying their model to Japan, where the average national tax rate during the eligible periods was 24.05%, we calculate a 3.88 percentage point reduction in investment cost for immediate depreciation. Maffini et al. (2019) report a 3.9% investment cost reduction in their UK setting. In summary, the tax benefits for bonus depreciation in the Japanese setting were broadly comparable to those provided in other countries.

The key difference between our setting and the literature is that firms had the option to select either a tax credit or bonus depreciation. Our data reveals a clear preference for the tax credit. This observation is consistent with the above calculation: 5 or 4 percentage points of tax benefits, exceeding the 3.88 percentage points for bonus depreciation. These arguments provide a rationale for why the majority of Japanese firms chose the tax credit when claiming tax incentives.

3. Data

Our primary data set is tax return survey data, "Survey on Corporate Activities and Tax Liabilities," collected by the Ministry of Economy, Trade, and Industry. It provides information on tax returns, including data on which firms claimed the tax incentives. Such specific data on tax claims is not necessarily available in studies that use data from outside Japan (e.g., Gaggl and Wright 2017). The ministry has sent questionnaires to firms with legal capital exceeding 100 million yen every year since 2011. Legal capital is a component of equity capital as defined in Japanese corporate law. This threshold is a common benchmark of firm size in Japan. As legal capital generally reflects firm size, our survey focuses on relatively large firms.

This tax return survey is subject to certain limitations. First, it excludes small firms, which affects the choice between tax credits and bonus depreciation. Population data aggregated at the industry level from the Ministry of Finance shows that smaller firms rely more on bonus depreciation compared to larger firms. Specifically, small firms, defined as those with legal capital of 100 million yen or below, have a ratio of bonus depreciation claims to total tax incentive claims at 78.1%, while larger firms, with capital above 100 million yen, use it at a much lower rate of 10.4%. We argue that this contrast in tax incentive choices is attributable to differences in discount rates. Bonus depreciation is more effective for firms with higher discount rates, since it reduces after-tax investment costs by allowing earlier deductions, increasing the present value of tax savings through discounting. Smaller firms, often facing financial constraints and higher risks associated with their focused business operations, are likely to have higher discount rates, making bonus depreciation more attractive. In contrast, larger firms could find the immediate savings from tax credits more appealing.

While this limitation presents disadvantages, it also offers potential advantages. The disadvantage is that we cannot directly assess small firms' decisions to claim tax incentives or the consequences of those decisions. However, an advantage is that the majority use of tax credits over bonus depreciation allows for a clearer assessment of the economic impact, because it depends on a fixed credit rate instead of unobservable discount rates. Moreover, larger firms' investments are likely to have a more substantial impact on the overall economy and warrant detailed consideration.

The second limitation of our survey data is that the response rates are around 25 to 30%. This raises the question of whether the responding firms are representative. However, Orihara and Suzuki (2023) show that the percentage of firms claiming incentives in our survey is consistent with the population data reported by the Ministry of Finance for firms within the same size cohort. This consistency suggests that our dataset is indicative of the general patterns of firms regarding tax incentive claims.

For accounting information, we use the Basic Survey of Japanese Business Structure and Activities, also collected by the Ministry of Economy, Trade, and Industry. This survey targets firms with legal capital exceeding 30 million yen and 50 employees. Although these criteria differ from the tax return survey, which requires only a legal capital threshold of 100 million yen, the latter generally encompasses more firms. The response rate for this survey is notably high, around 90%. We merge the tax return survey with this survey to construct a panel dataset. We exclude firms in the finance and utility sectors and winsorize the continuous variables at the 0.5% and 99.5% levels.

In Table 1, we present summary statistics covering the data period from 2010 to 2016, including both pre- and post-tax reform years. The data comprises 36,861 firm-year observations. This table reports that 18.8% of firms claimed tax incentives during one of the eligible years. Tax credits were the dominant choice, with just about 1% of firms exclusively using bonus depreciation during the eligible periods, according to an untabulated table. Given the predominance of tax credits, we do not differentiate between these two types of incentives in our main analysis and refer to them collectively as tax claiming. We observe that 86.0% of the firms report positive taxable income. This observation suggests that tax exhaustion is not a significant obstacle for claiming tax incentives in our data.

4. Research Design

4.1. Instrumental Variable

We seek to assess the causal impact of tax claiming on capital expenditures and productivity. The central challenge arises from the self-selection of firms in choosing to claim tax incentives, leading to endogeneity in their decision-making process. To address this issue, we adopt an instrumental variable approach.

We develop an industry-level instrument to capture the proportion of capital input costs that could be reduced due to tax incentives, relative to the overall capital input costs. We denote the instrument by $Input_j$, where the subscript j refers to the firm's four-digit industry classification. As a component of this instrument, we define $Input_{hj}$ as the cost of capital investment $h \in H$, where H includes all types of capital investments, and h refers to the specific capital investment sold to (and thus purchased by) industry j. To ascertain the amount of capital goods sold to each industry, we rely on the Capital Goods Sales Destination Survey, conducted by the Ministry of Economy, Trade, and Industry, every five years.[4] We use the 2011 survey data to capture pre-tax reform variations. Finally, we define the set $H_T \in H$. It represents capital investments that are eligible for tax incentives, as determined by the list of capital goods disclosed by the government.

Formally, the instrument takes the form $Input_j = \frac{\sum_{h \in H_T} Input_{hj}}{\sum_{h \in H} Input_{hj}}$. The numerator includes H_T, and the denominator includes H, which is the only difference between them. In our dataset, firms report their primary industry, and those operating in multiple sectors can report up to three industries. For such firms, we compute the average of $Input_j$ across the reported industries – for example, $Input_{j1}$ $Input_{j2}$, and $Input_{j3}$ if industries $j1$, $j2$ and $j3$ are reported. This calculation transforms the industry-level instrument into a firm-level instrument, $Input_i$, where refers i to an individual firm. However, we retain the notation $Input_j$ to reflect its basis as an industry-level variable.

The interpretation of the instrument entails caveats. The instrument captures two aspects: the potential magnitude of tax benefits and the ease with which firms claim incentives for pre-planned investments. The first aligns with the policy goal of encouraging additional investment beyond pre-claim levels. The second, however, represents undesirable policy consequences. As our instrument can capture both aspects, it helps us evaluate which implication is more plausible.

Figure 1 presents a box plot to illustrate the considerable variation in our instrument, $Input_j$, across industries classified at the four-digit level within their broader one-digit categories. In the manufacturing sector, the plot displays an interquartile range from approximately 0.65 to 0.90, accompanied by long whiskers. Even outside manufacturing, we

[4] The ministry conducts this survey as part of the process for creating the Industry Input-Output Table. This survey collects data from individual firms, requesting that they report the amount of domestic capital goods sold. The survey targets approximately 1,500 of the largest firms, selected based on production and sales volumes. Firms are required to specify the distribution of these sales across various industries. This industry-level classification enables the mapping of capital goods flows across different sectors of the economy and provides essential input for the construction of the Input-Output Table. First conducted in 1975, the survey is carried out approximately every five years.

also observe a substantial presence of tax-eligible capital expenditures. This figure highlights the substantial and varied potential for firms to benefit from the tax incentives.

Figure 2 presents a preliminary graphical analysis of the relationship between our instrumental variable $Input_j$ and the average tax claim rate $Claim_i$ at the one-digit industry level. The graph shows a positive and almost linear relationship between these two variables. This figure suggests the potential of our instrumental variable to explain corporate decisions regarding tax incentive claims.

4.2. Estimation

We use two-stage least squares for our instrumental variable estimation. In the first stage regression, the outcome variable is the interaction term between the tax claim dummy, $Claim_i$, which takes a value of one if the firm claimed the tax incentives during the eligible periods, and $After_t$, a dummy indicating the post-2014 tax reform period. We often denote this interaction as $Claim_{it}$, representing $Claim_i$ multiplied by $After_t$. Our main regressor is the interaction term between $Input_j$ and $After_t$. This approach examines whether the potential reduction in capital input costs, resulting from tax incentives, leads to more tax claims. We choose control variables X_{it} for the main regression following Maffini et al. (2019): sales growth to capture investment opportunities and lagged cash flow to capture potential cash flow sensitivity of investment due to financial constraints. In some estimations, we include additional control variables in line with Liu and Mao (2019), who also study investment and productivity. Our estimation includes firm-fixed effects[5] and year dummies, with standard errors clustered at the four-digit industry level. We use Equation (1) for the first stage regression.

$$Claim_{it} = \delta_i + \theta Input_j * after_t + \eta X_{it} + \mu_t + \xi_{it} \qquad (1)$$

For the second stage estimation, our outcome variable represents corporate investments or productivity. Specifically, it is either capital expenditures divided by lagged fixed assets, $Capex_{it}/k_{it-1}$, or the natural logarithm of one plus capital expenditure, $Ln\,(capex)_{it}$. To measure productivity, we use labor productivity and total factor productivity. As in the first-stage regression, we incorporate control variables X_{it}, firm-fixed effects, and year dummies into the model. We use Equation (2) for the second stage regression.

$$Outcome_{it} = \alpha_i + \beta Claim_{it} + \gamma X_{it} + \nu_t + \varepsilon_{it} \qquad (2)$$

[5] We also include 2-digit industry dummies. While industry classification can vary within a firm, it tends to be time-invariant and is absorbed by the firm-fixed effect. For simplicity, we omit this dummy from the equation notation.

5. Results

5.1. Investment

5.1.1. Instrumental Variable Approach

In Table 2, we present the first-stage estimation results of our instrumental variable analysis. The table shows that the coefficients for our instrument, $Input_j * after_t$, are positive and significant in all three specifications. Column (1) includes firm fixed effects and year dummies, column (2) adds sales growth and cash flow in line with Maffini et al. (2019), and column (3) incorporates additional covariates following Liu and Mao (2019). The Kleibergen-Paap rk Wald F-statistic for the excluded instrument is over 100 across all columns, comfortably surpassing the standard threshold of 10. These findings support our argument that the tax reform encouraged tax claiming by lowering the cost of input goods.

Table 3 presents the second-stage estimation results. Columns (1) to (3) use $Capex_{it}/k_{it-1}$ and columns (4) to (6) use $Ln\ (capex)_{it}$ as the outcome variable. This table reports that tax claims increased capital expenditures compared to pre-claim levels, as indicated by the positive coefficients on $Claim_{it}$. Alternations in the set of control variables across the columns do not affect our findings. The coefficients on the control variables generally suggest that firms are responsive to investment opportunities, as reflected by sales growth, and demonstrate a positive sensitivity to cash flow in most columns.

The effects of tax claiming on investment are economically significant. Column (5) shows that tax claims increased investments by 48.1%. This estimate is notably larger than those reported in other studies: 10.4% to 16.9% in the US (Zwick and Mahon 2017); 18.0% in the US (Ohrn 2019); 12.4% to 14.8% in the UK (Maffini et al. 2019); and 38.4% in China (Liu and Mao 2019). We calculate changes in the net-of-tax rate due to each tax reform. In Japan, considering the tax credit of 5% tax credit, the net-of-tax rate before the tax reform is 1 - 0.2405 = 0.7595, and after the reform, it is 1 - 0.2405 - 0.05 = 0.7095. The percentage change is 6.58% (0.05/0.7595). Consequently, the implied elasticity is 7.31.

An important factor behind our larger coefficients is that we adopt an instrumental variable approach, while the literature mostly uses intent-to-treat approaches. Our approach estimates the local average treatment effect, which reflects the impact of tax incentives on the subgroup of firms—tax claimants—whose decisions were directly influenced by the instrument. In contrast, the intent-to-treat approach estimates the average treatment effect on the treated, which averages the effect of tax incentives across both tax claimants and non-claimants. Because the average treatment effect on the treated includes non-claimants, which do not respond to the incentives, it could yield a smaller elasticity compared to the effect estimated using our instrumental variable approach.

5.1.2. Intent to Treat Approach

In this subsection, we shift our estimation methodology to the intent-to-treat approach. This change enables us to evaluate the economic significance of our instrumental variable estimates under an identical setting. Comparing these estimates highlights the importance of using our approach to capture the economic behavior of tax claimants.

We use $Input_j$ as the continuous treatment variable in a difference-in-differences framework. This approach essentially compares firms with a higher proportion of tax-eligible capital goods to those with a lower proportion. A key difference from our instrumental variable estimation is that the intent-to-treat approach does not directly account for tax claiming decisions. Instead, it compares changes in investment before and after the tax reform between firms that are more and less affected by the policy. We estimate the parameters of Equation (3).

$$Outcome_{it} = \alpha_i + \beta Input_j * after_t + \gamma X_{it} + \nu_t + \varepsilon_{it} \qquad (3)$$

Table 4 presents coefficients on $Input_j * after_t$ ranging from 0.032 to 0.046 across columns (1) to (3) for the outcome variable $Capex_{it}/k_{it-1}$ and from 0.123 to 0.140 across columns (4) to (6) for $Ln\ (capex)_{it}$. To interpret the economic significance of these estimates, we consider a change in $Input_j$ from zero to one This setting is conceptually similar to the intent-to-treat method, which evaluates differences between tax-eligible and non-eligible firms. From column (5), the tax reform increased capital expenditures by 13.4%. Even under this assumption of full eligibility, our estimates under the intent-to-treat framework are smaller than those from the instrumental variable approach. This finding confirms that instrumental variable estimation captures the actual effects on tax claimants specifically, yielding larger estimates.

5.2. Pre-trend and Graphical Evidence

This subsection explores whether the parallel trend assumption holds between more tax-eligible firms and less eligible firms in the period before the tax reform. We evaluate this assumption using the intent-to-treat approach. We classify firms as more eligible for tax incentives if their $Input_j$values are above the mean plus 0.5 times the standard deviation. Conversely, firms whose values are below the mean minus 0.5 times the standard deviation are considered less eligible.

Figure 3 illustrates that before the tax reform, we do not observe significant differences between more tax-eligible and less eligible firms in investment. This finding is consistent for both the investment ratio, $Capex_{it}/k_{it-1}$, in Panel A and the investment level , $Ln\ (capex)_{it}$, in Panel B. In the periods following the tax reform, we observe significant differences, showing a relative increase in investment among more eligible firms. These results support that there were no pre-existing trends in investment before the tax reform, while also highlighting the impact of the tax incentives in increasing investment for firms that could benefit from reduced input costs.

5.3. Productivity

We shift our focus to productivity. We examine both labor productivity and total factor productivity (TFP). To estimate TFP, we adopt two methodologies: Levinsohn and Petrin (2003), who uses intermediate inputs to handle simultaneity issues in production function estimation, and Wooldridge (2009), who refines the estimation process with a proxy-based approach.

Panel A of Table 5 shows that, on average, tax claiming did not have a significant impact on productivity. While the coefficients across all three columns are positive, none are statistically significant, even at the 10% level.

One possibility is that productivity changes take time to materialize. In Panel B, we examine the long-term effects of tax claiming, extending the analysis to 2019. Specifically, we introduce two variables, $short_t$ and $long_t$, which take a value of one for the periods 2014–2016 and 2017–2019, respectively. In the second-stage regression, the coefficients on $Claim_i * short_t$, which we denote as $Claimshort_{it}$, capture the productivity gains during the eligible period, while those on $Claim_i * long_t$, denoted as $Claimlong_{it}$, reflect the effects in the post-eligible period.

$$Claimshort_{it} = \delta_i + \theta Input_j * short_t + \eta X_{it} + \mu_t + \xi_{it} \quad (4a)$$

$$Claimlong_{it} = \delta_i + \theta Input_j * long_t + \eta X_{it} + \mu_t + \xi_{it} \quad (4b)$$

$$Outcome_{it} = \alpha_i + \beta_1 Claimshort_{it} + \beta_2 Claimlong_{it} + \gamma X_{it} + \nu_t + \varepsilon_{it} \quad (5)$$

Panel B presents the estimation results. None of the coefficients show any effect on productivity, regardless of the measures used or whether the time period is short or long. These results from Panels A and B of Table 5 suggest that, at least on average, the tax reform did not lead to productivity improvements, despite the requirement for firms to provide ex ante evidence of expected gains.

5.4. Firm-level Heterogeneity

Thus far, our analysis has focused on the overall impacts of tax claiming on economic outcomes. We address firm-level heterogeneity in this subsection. This analysis helps understand the mechanisms through which tax incentives operate. Moreover, it allows us to assess whether productivity improvements were absent across all firms or whether certain subsets achieved productivity gains. We explore two types of heterogeneity: financial constraints and the presence of tax loss carryforwards.

5.4.1. Financial Constraints

Table 6 investigates financial constraints, categorizing firms based on size or TSR ratings. We consider smaller firms, based on the median value of sales in 2013, to be more financially constrained than larger firms. The second measure, TSR ratings, is a 100-point scale indicator evaluated by TSR analysts based on firms' financial aspects, such as collateral capacity. We consider firms with ratings of 65 or higher in 2013 to be less financially constrained and those with lower ratings to be more constrained. We choose 65 as the threshold because it represents the point at which analysts evaluate firms as financially safe. A key difference between these two measures is that the former is quantitative, while the latter is more qualitative.

The first two (numerical) rows show first-stage estimation results. We observe positive and significant coefficients on $Input_j * after_t$ in all columns. However, the magnitude for financially less constrained firms in columns (2) and (4) is approximately double those of small firms in columns (1) and (3). These results suggest that firms with fewer financial constraints are more likely to claim tax incentives, even when situated in industries with an equivalent proportion of tax-eligible capital expenditures, as measured by $Imput_j$.

The next two rows present the results on how tax claiming affects capital expenditures, using $\text{Ln}\,(capex)_{it}$ as the measure. More constrained firms show an increase in capital expenditures following tax claims, whereas this change is less pronounced among less constrained counterparts. Specifically, the coefficient for small firms is 0.675 and significant at the 1% level in column (1), while the coefficient for large firms in column (2) is insignificant. We observe a similar comparison for TSR ratings in columns (3) and (4): firms with low ratings increased capex at the 1% level, whereas firms with high ratings show an insignificant effect. These findings are in line with Orihara and Suzuki (2023) who use a simple OLS regression. These results suggest that financially constrained firms face challenges in claiming tax incentives, possibly due to difficulties in financing the investments required to claim them in the first place. However, once they claim tax incentives, constrained firms may have greater investment opportunities, as financial constraints could lead to missed investment prospects. As a result, they increase investment upon claiming the incentives. In contrast, less constrained firms can implement most of their planned investments regardless of tax incentives, meaning their claims may primarily reflect pre-existing investment plans.

The remaining rows use productivity as the outcome variable, measured by TFP based on Levinsohn and Petrin (2003). Columns (5) and (6) examine the effects of tax claims on TFP using data up to the end of the tax-eligible period in 2016. We observe significant impacts only among small firms in column (1). The last two rows examine both short-term effects (2014-2017) and long-term effects (2017-2019). We continue to observe significant effects among small firms in column (1) and now also find significant effects at the 10% level among firms with low TSR ratings. In contrast, we observe insignificant effects among less constrained firms, regardless of the measure, in columns (2) and (4). These results support our interpretation that constrained firms, when able to claim tax incentives, use them to invest in productive opportunities that they would have otherwise missed due to financial constraints.

5.4.2. Tax Losses

In Table 7, we examine tax positions as a form of firm-level heterogeneity. The first two columns report that firms with fewer tax losses in 2013 in column (1) were more likely to claim tax incentives compared to their counterparts with more tax losses in column (2). A rationale is that firms with tax losses could utilize tax deductions for these losses, making them less likely to seek investment tax incentives. Essentially, the availability of another tax reduction option – the deduction for tax losses – could discourage the pursuit of investment tax incentives. We acknowledge the smaller sample size for tax losses as a caveat. To validate the findings, we use the inversed sign of after-tax profits to assets as a proxy and observe similar results in columns (3) and (4).

The next two rows show that firms with fewer tax losses in columns (1) and (3) increased investments relative to pre-claim levels. These findings suggest that the value of investment tax incentives is greater for these firms, since they are less likely to have their taxable income reduced by tax losses, providing more room to benefit from investment tax incentives. In contrast, those with higher losses in columns (2) and (4) did not change their investment levels. This finding is consistent with the argument that higher tax losses limit the effectiveness of tax incentives by reducing taxable income.

The remaining four rows examine productivity and present results that contrast with those for investment changes. Firms with fewer tax losses in columns (1) and (3) show no evidence of productivity gains relative to pre-claim levels. By contrast, firms with higher tax losses in columns (2) and (4) exhibit more consistent indications of productivity improvements, especially over the long term. These findings, combined with those on investment changes, suggest that firms with higher tax losses did not increase their overall investments upon claiming tax incentives but instead shifted their investment focus toward productivity improvements.

6. Conclusion

We investigate the heterogeneous impacts of claiming investment tax incentives on firms' investment and productivity following the 2014 tax reform in Japan. We demonstrate that tax claimants, on average, increased capital expenditures compared to their pre-claim levels. However, significant productivity gains were not observed overall. These findings suggest that while tax incentives effectively reduced the cost of capital and encouraged investment, they did not uniformly translate into productivity improvements. Firm-level heterogeneity, particularly regarding financial constraints and tax loss positions, played a key role in shaping the outcomes of tax claiming.

Our findings contribute to the broader literature on the effectiveness of fiscal policy and provide valuable insights for policymakers. To enhance the impact of investment tax incentives, governments may consider imposing eligibility criteria or designing mechanisms to encourage firms to allocate investments toward productivity-enhancing projects. Additionally, our research underscores the importance of accounting for firm-level heterogeneity in policy evaluation, as aggregate analyses may obscure significant variations in outcomes across firms.

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Figure 1: Distribution of the Instrumental Variable

This figure presents a box plot of our instrumental variable $Input_j$. The instrument measures the ratio of tax-eligible capital input costs to their total costs at the four-digit industry level. This figure shows its distribution across broader one-digit industry classifications. The box represents the interquartile range, from the first to the third quartile, with the median depicted by a line inside the box. The whiskers extend to 1.5 times the interquartile range above the upper quartile and below the lower quartile. Dots beyond the whiskers indicate outliers.

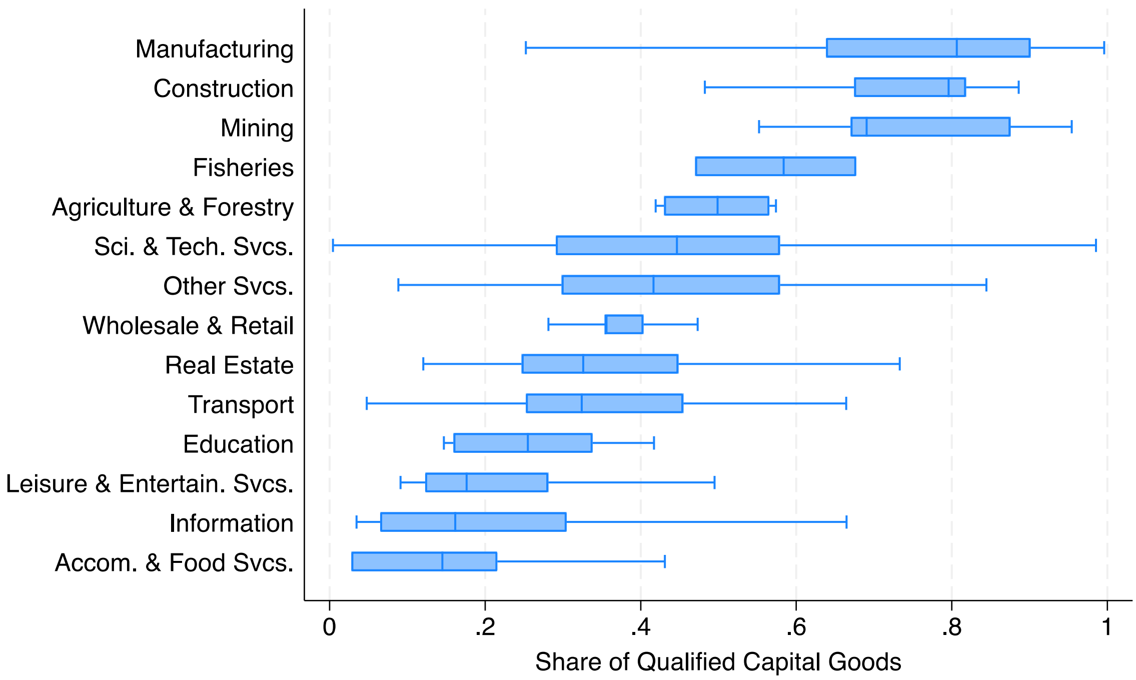


Figure 2: Instrumental Variable and Tax Claiming

This figure shows the relationship between our instrumental variable $Input_j$ and the average tax claim rate $Claim_i$ across firms in the industry. The instrument measures the ratio of tax-eligible capital input costs to their total costs at the four-digit industry level. This figure is presented at the broader one-digit industry level.

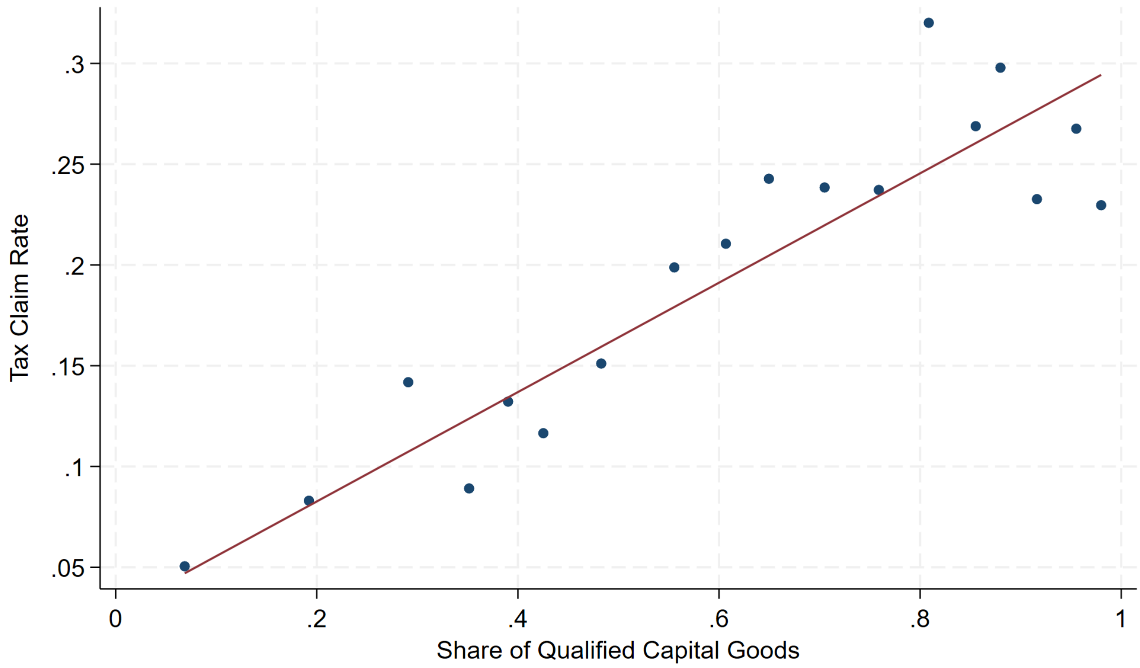
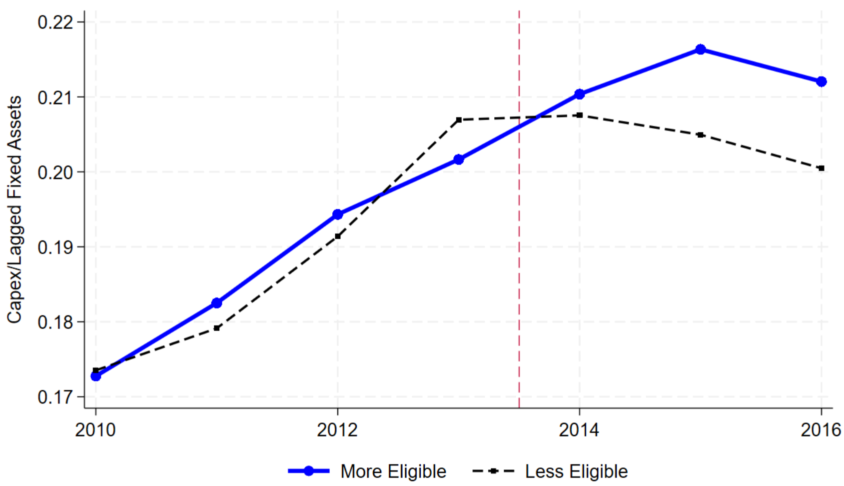


Figure 3: Graphical Evidence

These figures present the changes in capital expenditures from 2010 to 2016. Panel A presents capital expenditures divided by lagged fixed assets, $Capex_{it}/k_{it-1}$. Panel B presents the natural logarithm of one plus capital expenditures, $Ln\ (capex)_{it}$. The vertical dashed line marks the implementation of the 2014 tax reform. We classify firms into more and less tax-eligible groups based on their industry-level tax eligibility intensity. We determine the eligibility by the mean value of $Input_j$, which is an industry-level variable to measure the ratio of tax-eligible capital input costs to their total costs. We consider firms that have values exceeding the mean plus 0.5 times the standard deviation as more eligible for the tax incentives, while we deem firms with values below the mean minus 0.5 times the standard deviation as less tax-eligible. We normalize investment levels by adjusting for pre-2014 mean differences.

Panel A: $Capex_{it}/k_{it-1}$



Panel B: $Ln\ (capex)_{it}$

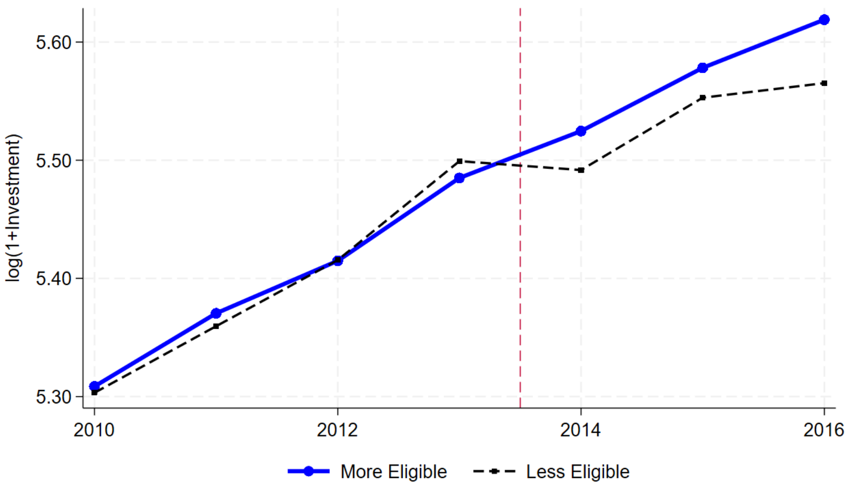


Table 1: Summary Statistics

This table reports summary statistics. We use data from Japanese firms from 2010 to 2016. See the Appendix for the variable definitions.

	Mean	SD	p5	p25	p50	p75	p95	N
$Claim_i$	0.188	0.391	0.000	0.000	0.000	0.000	1.000	36,861
$Capex_{it}/k_{it-1}$	0.196	0.291	0.007	0.042	0.103	0.222	0.692	36,861
$Ln\ (capex)_{it}$	5.479	2.112	1.792	4.094	5.549	6.904	8.952	36,861
$Labor\ productivity_{it}$	11.665	7.455	3.833	7.292	9.875	13.640	25.618	36,257
TFP_LP_{it}	3.483	0.936	2.036	2.860	3.478	4.063	4.990	36,121
$TFP\_Wooldridge_{it}$	3.491	0.915	2.069	2.908	3.465	4.037	4.973	36,121
$Sales\ growth_{it}$	0.028	0.135	-0.162	-0.037	0.017	0.077	0.251	36,861
$Cash\ flow_{it-1}$	0.084	0.063	0.010	0.042	0.072	0.114	0.207	36,861
$Ln(assets)_{it-1}$	9.650	1.421	7.564	8.649	9.506	10.468	12.299	36,861
$Ln(sales)_{it-1}$	9.797	1.409	7.641	8.810	9.686	10.664	12.373	36,861
$Profit\ margin_{it-1}$	0.029	0.048	-0.026	0.007	0.022	0.047	0.111	36,861
$Input_j$	0.579	0.267	0.123	0.355	0.579	0.840	0.972	36,861

Table 2: First Stage Estimation

We examine whether our instrumental variable explains firms' decisions to claim investment tax incentives. We use data from 2010 to 2016 and apply Equation (1): $Claim_{it} = \delta_i + \theta Input_j * after_t + \eta X_{it} + \mu_t + \xi_{it}$. The outcome variable, $Claim_{it}$, represents $Claim_i$ multiplied by $After_t$. $Claim_i$ is a tax claim dummy variable that takes a value of one if the firm has claimed tax incentives. The variable $After_t$ takes a value of one in 2014 and afterward. The instrument, $Input_j$, is an industry-level variable to measure the ratio of tax-eligible capital input costs to their total costs. The matrix X_{it} includes control variables. We include firm- and year-fixed effects and employ a linear model. Standard errors are clustered at the four-digit industry level and reported in parentheses. Significance at the 1%, 5%, 10% levels are denoted by ***, **, and *, respectively. See the Appendix for the variable definitions.

	$Claim_{it}$		
	(1)	(2)	(3)
$Input_j * after_t$	0.278***	0.278***	0.282***
	(0.026)	(0.026)	(0.026)
$Cash\ flow_{it-1}$		0.115***	0.071*
		(0.041)	(0.038)
$Sales\ growth_{it}$		-0.009	
		(0.010)	
$Sales\ growth_{it-1}$			-0.022***
			(0.008)
$Ln(assets)_{it-1}$			0.042**
			(0.017)
$Ln(sales)_{it-1}$			0.049***
			(0.016)
$Profit\ margin_{it-1}$			0.011
			(0.007)
Firm-fixed effects	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
First stage F-stat	117.7	117.4	120.3
Observations	36,861	36,861	36,861

Table 3: Second Stage Estimation

We examine whether tax claiming increases capital expenditures, using an instrumental variable approach. We use data from 2010 to 2016 and apply Equation (2): $Outcome_{it} = \alpha_i + \beta Claim_{it} + \gamma X_{it} + \nu_t + \varepsilon_{it}$. The outcome variable is either capital expenditures divided by lagged fixed assets, $Capex_{it}/k_{it-1}$, in columns (1) to (3), or the natural logarithm of one plus capital expenditures, $Ln\ (capex)_{it}$, in columns (4) to (6). The main regressor, $Claim_{it}$, is the fitted value of the tax claim dummy variable obtained from Equation (1) and Table 2. It represents $Claim_i$ multiplied by $After_t$. $Claim_i$ is a tax claim dummy variable that takes a value of one if the firm has claimed tax incentives. The variable $After_t$ takes a value of one in 2014 and afterward. The matrix X_{it} includes control variables. We include firm- and year-fixed effects and employ a linear model. Standard errors are clustered at the four-digit industry level and reported in parentheses. Significance at the 1%, 5%, 10% levels are denoted by ***, **, and *, respectively. See the Appendix for the variable definitions.

	$Capex_{it}/k_{it-1}$			$Ln\ (capex)_{it}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$Claim_{it}$	0.153***	0.164***	0.115***	0.443***	0.481***	0.497***
	(0.041)	(0.041)	(0.040)	(0.168)	(0.175)	(0.170)
$Cash\ flow_{it-1}$		0.231***	0.097		1.406***	0.614***
		(0.075)	(0.074)		(0.286)	(0.220)
$Sales\ growth_{it}$		0.136***			0.442***	
		(0.019)			(0.059)	
$Sales\ growth_{it-1}$			0.019			0.065*
			(0.015)			(0.038)
$Ln(assets)_{it-1}$			-0.141***			0.146**
			(0.022)			(0.064)
$Ln(sales)_{it-1}$			0.019			0.320***
			(0.020)			(0.062)
$Profit\ margin_{it-1}$			0.082***			0.181***
			(0.028)			(0.052)
Firm-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	36,861	36,861	36,861	36,861	36,861	36,861

Table 4: Intent-to-Treat Approach

We employ the intent-to-treat framework to complement our main findings from Table 3, where we investigate the impact of tax claiming on capital expenditures using the instrumental variable approach. We use data from 2010 to 2016 and apply Equation (3): $Outcome_{it} = \alpha_i + \beta Input_j * after_t + \gamma X_{it} + \nu_t + \varepsilon_{it}$. The outcome variable is either capital expenditures divided by lagged fixed assets, $Capex_{it}/k_{it-1}$, in columns (1) to (3), or the natural logarithm of one plus capital expenditures, Ln $(capex)_{it}$, in columns (4) to (6). The variable $Input_j$ is an industry-level variable to measure the ratio of tax-eligible capital input costs to their total costs. The variable $After_t$ takes a value of one in 2014 and afterward. The matrix X_{it} includes control variables. We include firm- and year-fixed effects and employ a linear model. Standard errors are clustered at the four-digit industry level and reported in parentheses. Significance at the 1%, 5%, 10% levels are denoted by ***, **, and *, respectively. See the Appendix for the variable definitions.

	$Capex_{it}/k_{it-1}$			$Ln\ (capex)_{it}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$Input_j * after_t$	0.043***	0.046***	0.032***	0.123***	0.134***	0.140***
	(0.011)	(0.011)	(0.011)	(0.047)	(0.050)	(0.049)
$Cash\ flow_{it-1}$		0.250***	0.105		1.461***	0.649***
		(0.077)	(0.075)		(0.293)	(0.224)
$Sales\ growth_{it}$		0.135***			0.437***	
		(0.020)			(0.059)	
$Sales\ growth_{it-1}$			0.016			0.054
			(0.014)			(0.035)
$Ln(assets)_{it-1}$			-0.136***			0.166***
			(0.023)			(0.064)
$Ln(sales)_{it-1}$			0.024			0.345***
			(0.020)			(0.062)
$Profit\ margin_{it-1}$			0.083***			0.186***
			(0.028)			(0.054)
Firm-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.322	0.326	0.327	0.826	0.828	0.828
Observations	36,861	36,861	36,861	36,861	36,861	36,861

Table 5: Productivity

We examine whether tax claiming affects productivity, using the instrumental variable approach. We use data from 2010 to 2016 and apply Equation (2) in Panel A: $Outcome_{it} = \alpha_i + \beta Claim_{it} + \gamma X_{it} + \nu_t + \varepsilon_{it}$. We use data from 2010 to 2019 and Equation (5) in Panel B: $Outcome_{it} = \alpha_i + \beta_1 Claimshort_{it} + \beta_2 Claimlong_{it} + \gamma X_{it} + \nu_t + \varepsilon_{it}$. The variable $Outcome_{it}$ represents productivity metrics. In Panel A, the main regressor, $Claim_{it}$, is the fitted value of the tax claim dummy variable obtained from Equation (1) and Table 2. It represents $Claim_i$ multiplied by $After_t$. $Claim_i$ is a tax claim dummy variable that takes a value of one if the firm has claimed tax incentives. The variable $After_t$ takes a value of one in 2014 and afterward. In Panel B, the main regressors, $Claimshort_{it}$ and $Claimlong_{it}$, are the fitted values of the tax claim dummy variable obtained from Equations (4a) and (4b). They represent $Claim_i$ multiplied by $Short_t$ or $Long_t$. The variables $Short_t$ and $Long_t$ take a value of one for the periods 2014–2016 and 2017–2019, respectively. The matrix X_{it} includes control variables. We include firm- and year-fixed effects and employ a linear model. Standard errors are clustered at the four-digit industry level and reported in parentheses. Significance at the 1%, 5%, 10% levels are denoted by ***, **, and *, respectively. See the Appendix for the variable definitions.

Panel A: Base Analysis Using 2010-16 Data

	$Labor\ productivity_{it}$	TFP_LP_{it}	$TFP\_Wooldridge_{it}$
	(1)	(2)	(3)
$Claim_{it}$	1.033	0.071	0.095
	(0.858)	(0.088)	(0.088)
$Cash\ flow_{it-1}$	12.530***	1.159***	1.145***
	(2.057)	(0.192)	(0.190)
$Sales\ growth_{it}$	4.507***	0.466***	0.462***
	(0.360)	(0.030)	(0.030)
Firm-fixed effects	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	36,223	36,087	36,087

Panel B: Short-term (2014-16) and Long-term (2017-19) Analysis Using 2010-19 Data

	$Labor\ productivity_{it}$	TFP_LP_{it}	$TFP\_Wooldridge_{it}$
	(1)	(2)	(3)
$Claimshort_{it}$	1.086	0.100	0.116
	(0.827)	(0.082)	(0.083)
$Claimlong_{it}$	1.410	0.162	0.185
	(1.283)	(0.119)	(0.120)
$Cash\ flow_{it-1}$	16.707***	1.460***	1.451***
	(1.909)	(0.165)	(0.164)
$Sales\ growth_{it}$	4.940***	0.471***	0.470***
	(0.323)	(0.026)	(0.026)
Firm-fixed effects	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	50,519	50,242	50,242

Table 6: Financial Constraints

We examine whether financial constraints, measured by firm size or TSR ratings, affect the relationship between tax claiming and capital expenditures or productivity, using an instrumental variable approach. We estimate separately for financially more and less constrained subsamples according to two measures: i) larger firms with 2013 sales above the median and smaller firms with sales below the median; ii) firms with TSR ratings of 65 or higher and those with lower ratings. The first two rows present the first stage of our instrumental variable estimation, corresponding to column (2) of Table 2. The next two rows show the second-stage results when the outcome is the natural logarithm of one plus capital expenditures, $Ln\ (capex)_{it}$, corresponding to column (5) of Table 3. The following four rows present results for total factor productivity (TFP), measured using the Levinsohn and Petrin (2003) method, TFP_LP_{it}. These four rows report estimates using data up to 2016 in the first half, while the latter half examines both short-term (2014–2016) and long-term (2017–2019) effects, corresponding to column (2) of Panel A and Panel B in Table 5, respectively. We include control variables as well as firm- and year-fixed effects. We employ a linear model. Standard errors are clustered at the four-digit industry level and reported in parentheses. Significance at the 1%, 5%, 10% levels are denoted by ***, **, and *, respectively. See the Appendix for the variable definitions.

	Sales		TSR ratings	
	Small	Large	Low	High
	(1)	(2)	(3)	(4)
	First stage estimation			
$Input_j * after_t$	0.191***	0.387***	0.224***	0.416***
	(0.027)	(0.038)	(0.028)	(0.048)
First stage F-stat	48.72	103.4	63.81	74.86
Observations	17,630	19,231	27,189	9,672
	Second stage estimation when outcome is investment			
$Claim_{it}$	0.675**	0.364	0.586**	0.341
	(0.323)	(0.223)	(0.232)	(0.213)
Observations	17,630	19,231	27,189	9,672
	Second stage estimation when outcome is productivity			
$Claim_{it}$	0.297**	-0.035	0.171	-0.072
	(0.138)	(0.097)	(0.118)	(0.087)
Observations	17,140	18,947	26,556	9,531
	Second stage estimation when outcome is short- and long-term productivity			
$Claimshort_{it}$	0.323**	-0.018	0.191*	-0.063
	(0.134)	(0.094)	(0.114)	(0.086)
$Claimlong_{it}$	0.472**	-0.013	0.300*	-0.071
	(0.196)	(0.126)	(0.158)	(0.129)
Observations	23,695	26,545	36,870	13,372
	Both stages			
Other controls	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes

Table 7: Tax Loss Carryforward

We examine whether tax losses affect the relationship between tax claiming and capital expenditures or productivity, using an instrumental variable approach. We estimate separately for subsamples with more or fewer tax losses according to two measures: i) firms with the average tax loss before 2013 divided by the average assets above the median, and those with ratios below the median; (ii) firms with an after-tax-profit-to-assets ratio (measured with an inverted sign) above the median, and those with ratios below the median. The first two rows present the first stage of our instrumental variable estimation, corresponding to column (2) of Table 2. The next two rows show the second-stage results when the outcome is the natural logarithm of one plus capital expenditures, $Ln\ (capex)_{it}$, corresponding to column (5) of Table 3. The following four rows present results for total factor productivity (TFP), measured using the Levinsohn and Petrin (2003) method, TFP_LP_{it}. These four rows report estimates using data up to 2016 in the first half, while the latter half examines both short-term (2014–2016) and long-term (2017–2019) effects, corresponding to column (2) of Panel A and Panel B in Table 5, respectively. We include control variables as well as firm- and year-fixed effects. We employ a linear model. Standard errors are clustered at the four-digit industry level and reported in parentheses. Significance at the 1%, 5%, 10% levels are denoted by ***, **, and *, respectively. See the Appendix for the variable definitions.

	Tax loss-to-assets		After-tax profit-to-assets (inverted sign)	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
	First stage estimation			
$Input_j * after_t$	0.581***	0.368***	0.385***	0.261***
	(0.068)	(0.074)	(0.039)	(0.040)
First stage F-stat	72.59	24.93	97.38	42.22
Observations	8,209	4,275	13,901	14,075
	Second stage estimation when outcome is investment			
$Claim_{it}$	0.441***	0.244	0.410**	0.335
	(0.151)	(0.419)	(0.184)	(0.301)
Observations	8,209	4,275	13,901	14,075
	Second stage estimation when outcome is productivity			
$Claim_{it}$	0.077	0.138	-0.074	0.266*
	(0.073)	(0.117)	(0.084)	(0.154)
Observations	8,067	4,210	13,677	13,784
	Second stage estimation when outcome is short- and long-term productivity			
$Claimshort_{it}$	0.099	0.168	-0.067	0.317**
	(0.072)	(0.112)	(0.081)	(0.152)
$Claimlong_{it}$	0.095	0.384**	-0.080	0.469**
	(0.101)	(0.156)	(0.111)	(0.198)
Observations	11,243	5,870	19,088	19,183
	Both stages			
Other controls	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes

Appendix: Variable Definition

	Definition
$Claim_i$	A dummy variable that equals one if the firm has claimed a tax credit or bonus depreciation
$Claim_{it}$	$Claim_i$ multiplied by $After_t$, where $After_t$ takes a value of one in 2014 and afterward
$Claimshort_{it}$	$Claim_i$ multiplied by $Short_t$, where $Short_t$ take a value of one for the periods 2014–2016
$Claimlong_{it}$	$Claim_i$ multiplied by $Long_t$, where $Long_t$ take a value of one for the periods 2017–2019
$Capex_{it}/k_{it-1}$	Capital expenditures divided by lagged fixed assets
$Ln\ (capex)_{it}$	The natural logarithm of one plus capital expenditures
$Labor\ productivity_{it}$	Labor productivity, which is value added divided by the number of employees
TFP_LP_{it}	Total factor productivity measured following the Levinsohn and Petrin (2003) method
$TFP\_Wooldridge_{it}$	Total factor productivity measured following the Wooldridge (2009) method
$Sales\ growth_{it}$	The growth rate of sales from the previous year
$Cash\ flow_{it-1}$	Profit before extraordinary items and tax plus depreciation divided by assets
$Ln(assets)_{it-1}$	The natural logarithm of total assets
$Ln(sales)_{it-1}$	The natural logarithm of sales
$Profit\ margin_{it-1}$	Net income divided by sales
$Input_j$	An industry-level variable that measures the ratio of tax-eligible capital input costs to their total costs