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Abstract

The paper assesses the role of taxes on investment in Colombian firms. The research takes advantage of the Colombian context of frequent tax reforms, at least one reform every three years, during the period 2005-2014, and a unique panel data set from financial statements and corporation tax returns at the firm level. The effect of corporate taxation on investment is estimated by first determining the impact of taxation on the user cost of capital by computing the marginal effective tax rates at the firm level. Then, we estimate the impact of the cost of capital on investment. Estimations indicate that the corporate income tax elasticity of investment is on average -0.2 for the analyzed period, which is in the lower range when compared to other studies for developed countries.

Keywords: Corporate taxation, marginal effective tax rates, investment, tax reforms

JEL Classification: H32, H25, C23, D22

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1. Introduction

Corporate taxes play an important role on investment decisions, as they are part of the cost of capital. In turn, decisions of firms affect both economic activity and the country's fiscal accounts (Hanlon and Heitzman, 2010). In Colombia, during the last decade, the National Congress approved different tax reforms that affected the tax burden of companies due to changes in the tax base, statutory tax rate, tax credits and incentives for private investment. Taking advantage of the Colombian context of frequent tax reforms, at least one reform every three years during the last decade, and a of unique panel data set from financial statements and from corporation tax returns at the firm level, the aim of this paper is to measure the effect of changes in the regulation of corporate taxes on investment decisions. To the best of our knowledge, this is the first study for an emerging economy that assesses the relationship between investment and corporate taxation using a compelling data set firm level within a framework of recurrent variations in tax legislation.

Understanding how these changes have affected investment decisions could provide answers on what measures are most effective in promoting investment. All the more, considering that combining several tax cuts and incentives may eventually lead to an increase in the tax burden for companies when they are inconsistent with each other. Since the publication of the seminal papers by Jorgenson (1963), and Hall and Jorgenson (1967), the theoretical and empirical research on the relationship between corporate taxation and investment has been wide. Comprehensive surveys of this research are found in Cummins, Hassett, Hubbard, and Caballero (1994), Auerbach (2002), Hassett and Hubbard (2002), Hines (2007), Hanlon and Heitzman (2010) and Aus dem Moore (2014). Broadly, results indicate a negative relationship between corporate income tax and investment, but a generally accepted consensus has not yet been achieved. This is because empirical literature based on both the user

cost of capital and the *q* theory has faced significant measurement errors in fundamental variables and a cost of capital misspecifications[1].

The empirical strategy is based on the neoclassical approach in which investment is driven by the Jorgenson concept of the cost of capital. According to this framework, firms accumulate capital as long as the return to investment exceeds the cost of finance and depreciation. The effect of corporate taxation on investment is determined into two steps based on De Mooij and Ederveen (2008). First, we measure the effect of corporate taxation on the cost of capital, which depends on the specific tax system since different depreciation allowances schemes or investment tax credits will affect differently the cost of capital. The Marginal Effective Tax Rate (*METR*) defined as the difference in the cost of capital in the presence and the absence of tax, as a percentage of the pre-tax cost of capital, measures this impact (De Mooij and Ederveen, 2008). We compute the *METRs* per firm considering the specific features of the Colombian tax system, the composition of assets, and the tax benefits of each company. In the second step, we estimate the effect of the *METRs* on investment. In this setup, identification is crucial considering that adjustments in the tax structure can affect both investment decisions and *METRs*, for example, through changes in the composition of assets. Thus, a regression model of investment on tax rates might be biased for potential reverse causality. We address this issue by using the approach proposed by Saez, Slemrod, and Giertz (2012), which adopts as instruments the changes in marginal tax rates created by tax reforms. The *METRs* calculated in the first step allow us to calculate these instruments by adjusting the parameters affected by tax reforms. Specifically, we simulate post-reform *METRs* under pre-reform behavior, using the same set of firm characteristics, but allowing tax rules and macroeconomic factors to change.

[1] For a detailed review of the empirical literature on the relation between investment and corporate taxation, see Cummins, et al. (1994) and Hassett and Hubbard (1996).

The use of mechanical changes in *METRs* driven by adjustments in tax laws is used to assess the impact of corporate taxation on investment in a context of frequent tax reforms, using an annual data set of firms. To assess the joint impact of the reforms, we estimate the elasticity within a balance panel data structure for the tax reforms of 2006, 2009 and 2012. To evaluate differences in the investment responses of firms under different tax structures, we estimate the elasticity for each tax reform using cross-sectional estimates. Finally, to assess the cumulative impact of the reforms, we also estimate a cross-sectional specification over the entire analyzed period, considering changes in investment and the *METR*, between a year before the 2006 tax reform and two years after the 2012 tax reform was approved[2].

Results indicate that *METRs* fluctuated on average between 29.1% in 2005 and 13.4% in 2008, which are lower than the statutory corporate tax rates in force in those years, 38.5%, and 33.0%, respectively. The difference is explained by the tax benefits and deductions that companies have, according to the Colombian tax legislation, during the period. *METRs* show great heterogeneity when calculated per firm, which could be due to differences in tax exemptions, the composition of assets and financial restrictions, among other variables. Important differences across economic sectors and firm sizes are also observed. In turn, the corporate income tax elasticity of investment is on average -0.2 for the analyzed period, which is robust and consistent under different specifications. This elasticity is in the lower range when compared to other studies for developed countries, where the empirical literature on the subject is concentrated. For instance, as summarized by Bond and Xing (2015), the elasticity for the US using US firm-level data ranges from -0.3 to 0.7. The lower elasticity might be explained by the effect of the frequency in the tax reforms in the Colombian case in the decisions of the firms. In effect, it is worth point out that the elasticity exhibits important differences when calculated for each tax reform.

[2] We thank an anonymous reviewer for the suggestion to estimate this specification that allows us to evaluate the cumulative impact of the reforms.

This paper is divided into four sections, besides this introduction. The second section describes the Colombian tax system on firms. The third explains the data set used in the analysis. Section fourth describes the empirical strategy, which considers the calculations of *METRs* and the estimation of the effect of the cost of capital on investment. Section five presents the main conclusions of the paper.

2. Some insights of corporate taxation in Colombia

An important feature of the Colombian tax system during the last two decades is the establishment of frequent tax reforms, which modified tax bases and statutory tax rates as well as benefits on taxes that affect business. Indeed, the rate of the corporate income tax registered several modifications, during the last two decades. Until 2006, the statutory tax rate was 35%, with a surtax of 10% between 2002 and 2006, which raised the rate to 38.5%. In 2007, the tax rate was reduced to 34% and then, for the period 2008-2012, stood at 33%. The 2012-tax reform set the tax rate at 25% but simultaneously created an additional tax on corporate income, named *CREE* with a temporary rate of 9% between 2013 and 2015. Then, in 2014, a new tax reform was approved, which maintained the tax rate of 9% until 2016 and established a surtax on the *CREE* of 5% in 2015. The 2016 tax reform eliminated both the *CREE* and its surtax.

The corporate statutory tax rate of Colombia for 2017 is 34%, which, as explained above, could be higher depending on the annual profits of the firm. This rate is equal to the combined *CIT*, 25%, and *CREE*, 9%, statutory tax rate, prevailing in the 2012 and 2014 tax reforms. From an international perspective, this rate is similar to the statutory tax rate of other Latin American countries, such as Argentina, Brazil, and Venezuela, but it is above from the statutory rate of Chile, Panama, and Uruguay. When comparing to the *OECD* countries, the Colombian tax rate of 2017 is higher than most of these countries, although is analogous to the tax rate of France and Belgium (Table 1). It is worth mentioning that the statutory tax rates are not strictly comparable internationally, considering the differences in the corporate income tax

systems across countries. For example, some systems only tax corporate profits, while others share the burden between corporations and the dividends that individuals receive. Furthermore, it is also important to consider that the effective tax burden that companies pay, measured by effective marginal tax rates, could exhibit a different trend due to differences in the tax benefits and exemptions among tax systems.

(Table 1 about here)

Throughout the different tax reforms, the Colombian tax system has provided generous benefits and special regimes to firms, which have affected the tax base of the corporate income tax in different ways. The most generous tax deduction, which operated between 2004 and 2010, allowed investors to deduct from taxable income a percentage between 30% and 40% of the value of the investment on fixed assets. This benefit was intended to increase investment by encouraging firms to buy new tangible assets. This measure was eliminated in the 2010-tax reform. Furthermore, tax legislation allows several exempt incomes. For instance, those generated using new forest plantations, the sale of electricity generated by wind energy, biomass or agricultural residues, and the profit obtained from the sale of land for the development of housing of social interest, among others. The legislation also grants a preferential rate of 9% for hotel services, ecotourism services, publishing companies of scientific and cultural books and journals. It also grants preferential tax rates for economic activities carried out in areas of the country affected by the armed conflict. There is also a special regime for newly incorporated small and medium-sized firms and non-profit organizations as well as a free trade zone regime (Perret and Brys, 2015).

3. Data

The empirical analysis is carried out by using an unbalanced panel data structure for the period 2005-2014. The information used in the analysis is the result of merging two datasets. The first comes from the financial statements of the companies that reported information to the

Superintendencia de Sociedades. Financial statements provide detailed information about taxes, income tax, tax credits and other firm characteristics used in the econometric analysis. This dataset provides precise information on investment in plant and machinery and allows us to calculate financial and economic indicators of firms as well as their tax payments. The dataset also contains an appendix with detailed information about the assets of firms. The second dataset comes from the corporate tax reports of the National Tax Office. For each firm, this data contains comprehensive tax return information, including the payment of corporate taxes, tax deductions, and exemptions, which is relevant to calculate effective marginal rates.

The join database allows us to quantify the *METRs* with observed data and not with hypothetical data as do most of the studies that calculate these rates. The calculation of *METRs* is carried out at the firm level using data from the financial statements and tax return data of firms, of the composition of assets, discounts and tax benefits, indebtedness, among other variables. Bearing in mind that the econometric analysis is conducted by comparing the year before each reform took place and two years after its establishment, *METRs* were calculated for the years before the main tax reforms, 2005, 2008 and 2011. We also calculated *METRs* for 2014, as a benchmark, considering that during this year the last tax reform for the period under study was established. The changes in the *METRs* created by tax reforms are used as instruments in the econometric analysis.

As far as we know, this is the first study, for an emerging economy, that uses this kind of comprehensive firm-level dataset to calculate *METRs* and to evaluate their impact on investment. This detailed information allows us to assess differences at the firm level due to not only to changes in tax parameters but also due to differences in the characteristics of firms such as the composition of assets and their level of indebtedness. Furthermore, in the econometric analysis, the information of the firm's characteristics allows us to control for different characteristics of firms to evaluate the robustness of the results.

4. Empirical Strategy

The effect of corporate taxation on investment is measured in two steps. First, we compute the *METRs*, which measure the impact of taxes on the cost of capital, and secondly, we assess the impact of the cost of capital on the decision to invest by estimating the elasticity of investment to the *METR* for the Colombian tax reforms of 2006, 2009 and 2012, using Two-Stage least squares (*2SLS*) regression analysis.

4.1. Marginal Effective Tax Rates

To study the relationship between corporate taxation and investment, the tax rate employed in the analysis is crucial, since changes in the tax structure might affect the taxable income and consequently, the effective tax rate burdened to firms[3]. For instance, in a tax structure with investment incentives based on the acquisition of assets, as in the Colombian case, the more investment a firm undertakes, the greater the reduction in the effective tax rate. Thus, the measurement of the tax rate used in the analysis is decisive, especially considering the complexity of the Colombian tax structure. In the literature, there is an agreement that the rate that is most suitable to study the relationship between private investment and corporate taxation is the *METR*, which indicates by how much the minimum return on an investment project should be increased to ensure that the rise covers the tax payments. They are based on tax legislation and considers not only tax parameters such as statutory tax rates, tax bases, depreciation allowances, and tax benefits but also macroeconomic parameters including inflation rate and interest rates. To calculate the *METRs*, we adopt the framework of King and Fullerton (1984) and Fullerton (1999), which in turn is based on Hall and Jorgenson (1967). This approach considers the rate of return that equalizes the cost of capital and the expected income in an investment project. As Devereux and Griffith (2003; pp. 107) pointed out, "the basic approach

[3] For more details see Auerbach and Poterba (1987); Graham, Lemmon and Schallheim (1998); Graham (2006); Graham and Mills (2008); and Hanlon and Heitzman (2010).

is to construct a forward-looking hypothetical marginal investment project, for which the impact of tax on the cost of capital can be computed".

METRs can provide evidence about the impact of different tax measures on investment, giving information about which policy or set of them are more effective in stimulating investment. In general, high tax rates discourage investment, while negative ones indicate that the tax system encourages investment projects that are undesirable because they earn a return lower than the opportunity cost. As stated by Elschner et. al. (2014, pp. 6) "If taxation causes the cost of capital to fall below the real market interest rate, it actually favors corporate investment over the financial investment". Otherwise, when taxation increases the cost of capital above the real market rate, taxation plays a negative role in investment.

In the empirical literature, they have been used by Klemm and Van Parys (2009), Abbas and Klemm (2013), Klemm (2010) to evaluate tax burden in different tax structures. *METR*s have also been used to assess the effect of different tax incentives by Klemm (2010 and 2012), and Loretz (2008). International and local tax comparisons by using *METRs* are found in Devereux and Griffith (2003), Nicodème (2001), Bilicka and Devereux (2012) and Chen and Mintz (2013). For developing countries, Abbas and Klemm (2013), and Abramovsky, Klemm, and Philips (2014) calculate corporate taxation trends, using these tax rates. For the case of Colombia, *METRs* have been calculated at the sectoral level, for the 2003 and 2006 tax reforms by Zodrow (2005), and Avila and León (2008), respectively.

In the absence of taxes, the pre-tax return (*GR*), after covering the acquisition cost of the asset package and depreciation, is equal to the after-tax return (*NR*) and the *METR* is zero. When taxes are introduced, the *GR* moves away from the *NR* and pressure is generated to raise expected profits, so that the return on the investment project covers not only the minimum return demanded by sources of financing but also by taxes. This difference expressed as the ratio of the *GR* is a measure of the burden of taxation over the life of the project and it increases with

taxes levied on investment. For instance, if a company wishes to earn a 5% after tax-return on their investments and the *METR* is 60%, they need to earn a pre-tax return of 12.5%. *METRs* are obtained as the difference between the expected return before (gross) and after (net) tax of a marginal investment, expressed as the ratio of the gross return (Fullerton, 1999; Hanlon and Heitzman, 2010; Devereux and Griffith, 1998 and 2003), as follows:

$$METR = \frac{GR-NR}{GR}\% \quad (1)$$

Where $GR = \frac{P}{Q} - \delta$; $NR = r - \pi$

The gross return, *GR*, should be understood as the minimum return of an investment project, *P*, that once covered the acquisition cost of an asset package, Q, and the economic depreciation, δ, it allows the company to pay taxes and cover the expected returns of the funding sources. The net return, *NR*, indicates the real return of the different sources of financing, net of the corporate income tax. It is equivalent to the discount factor of the project, *r*, minus the inflation rate, π[4]. Table 2 illustrates the parameters used in the computation and simulation of the *METRs*.

(Table 2 about here)

METRs calculated for the corporate income tax are on average 29.1% for 2005, 13.4 for 2008, 14.9 for 2011 and 21.4 for 2014. *METR*s are lower than the statutory tax rates prevalent in those years, (e.g. in 2005, 38.5%, in 2009 and 2012, 33%, and in 2014, 25% for *CIT* plus 9% for *CREE*). This could be due to investment projects are strongly affected by the value of allowances and by tax benefits and tax deductions. As mentioned, the Colombian tax legislation approved a deduction in the corporate income tax for investment in productive assets, and different incentives and special regimes (e.g. corporate tax exemption for certain economic activities, tax allowance for research and development and a free trade zone regime). These

[4] The detailed derivation of the *METRs* is found in Avila and León (2008). In the calculations, we distinguish taxes affecting firms only once (in the constitution of the firm or the acquisition of assets), from those taxes levied recurrently on income, sales, and profits.

results suggest the importance to consider the combination of measures in the tax burden actually paid by firms.

In a neutral tax system, the *METRs* should be equal for all assets and therefore for all economic sectors. However, there are economic and tax factors that could distort them, such as the fraction of debt-financed investment, depreciation of assets schemes, the composition of assets, investment tax benefits and the firm's industry. The average *METR*s by the economic sector are shown in Table 3. Results indicate heterogeneity among economic sectors and through tax reforms, which can be explained by differences in financial constraints, asset composition, and tax deductions and exemptions across firms of different industries. The economic sectors that generally record the highest *METRs* are the agriculture, forestry, fishing, and the real estate sector, while the lowest *METRs* are observed in the transportation and storage sector, the construction sector and in the sector of other services.

(Table 3 about here)

Figure 1 shows the distribution of *METRs* calculated at the firm level. They indicate that *METRs* highly varies across firms, for years 2005, 2008, 2011 and 2014. It is also worth noting that for some firms the *METRs* are negative. This could happen when tax benefits are higher than taxes, in net terms. In the Colombian case, the negative *METRs* for some firms are explained by the deduction on productive assets on the corporate income tax. Specifically, the negative result might occur because the deduction favors the investment in productive assets, whereas the corporate income tax levies firm´s profits, which might be relatively small in comparison to the value of the investment in assets.

(Figure 1 about here)

4.2. The effect of the cost of capital on investment

The estimation of the firm's investment determinants, based on the user cost of the capital model (Hall and Jorgenson, 1967) is generally carried out using the following specification:

$$\frac{I_{i,t}}{K_{i,t-1}} = E_{it-1}\left(S_{i,t}\gamma\right) + \epsilon_{it} \quad (2)$$

Where *I* and *K* denote investment and the capital stock, respectively; *S* represents the user cost of capital, which we measure by using the *METRs* calculated in the previous section. Following Cummins, et al. (1994), E_{it-1}, represents the expected operator for firm *i*, conditional on information available at time *t-1*, γ is the coefficient that measures the impact of investment and ϵ_{it} is a white-noise error term.

Following the neoclassical approach, that investment is based on the Jorgenson's concept of the cost of capital, the key issue is that firms accumulate capital as long as the return to investment exceeds the cost of finance and depreciation. In the empirical strategy, we determine the effect of corporate taxation on investment by assessing firstly the impact of the corporate tax on the cost of capital by using the *METRs*, calculated in the previous section. Secondly, we estimate the elasticity of investment. To treat negative values, estimations are conducted using *1-METRs*, which is known in the literature as the net of the marginal effective tax rate and its interpretation is the price of accessing one more unit of income (Gruber and Saez, 2002; Gruber and Rauh, 2007; Dwenger and Steiner, 2012).

4.2.1. Identification and mechanical variation in *METRs*

In the study of the relationship between corporate taxation and investment, the identification is crucial, considering that changes in the tax structure might affect both the taxable income and the tax rate paid by firms. Common factors might determine investment, tax rates, and taxable income, making the estimations on the relationship between investment and tax rates biased and inconsistent. As mentioned, the *METR* and investment are endogenous, which creates a correlation between $METR_{it}$, $\frac{I_{i,t}}{K_{i,t-3}}$ and the error term[5].

[5] The nonlinearity of the tax Colombian system can also be a source of endogeneity, considering that the corporate tax rate is fixed and independent of the firm´s profits. Kink points are likely to be created in a progressive tax system, which is not the Colombian case.

To address the identification problem that could arise in the estimation of the causality effect of changes in corporate taxes on firms' investment, we difference (2) and use the instrumental variables strategy proposed by Gruber and Saez (2002). This methodology proposes as instruments the changes in the marginal tax rates created by tax reforms. This approach has been mainly used to analyze individual's income taxes, which as explained by Gruber and Rauh (2005, p. 21), could be partly due to "the fact that the corporate setting is more complex. They may be more rational or forward-looking about future changes in the tax code than individuals and different marginal tax rates may be more relevant in defining the different margins of corporate behavior that affect corporate taxable income". Recently, Gruber and Rauh (2005) and Dwenger and Steiner (2014) use this approach to evaluate the impact of corporate tax changes on corporate taxable income for *USA* and Germany, respectively.

To compute the mechanical tax changes caused by tax reforms, *METRs* were simulated for two years after each reform by preserving the same characteristics of the firms but introducing the tax parameters of the reform and the macroeconomic factors of that year. Hence, to overcome the endogeneity problem, we construct instruments for the observed *1-METR*, by obtaining the mechanical *1-METRs* changes of $\Delta log(1 - METR_{it})$, driven by changes in tax laws, as:

$$\ln\left(1 - METR_{t+3}(parametres_t)\right) - \ln\left(1 - METR_t(parametres_t)\right) \quad (3)$$

We simulate post-reform marginal tax rates under pre-reform behavior for each firm by using the same set of firm characteristics but allowing tax rules and macroeconomic factors to change. As explained above, differences at time *t* are three-year differences from *t* to *t+3*. The difference in the *METRs* is correlated with the change in *METRs* but is uncorrelated with any change in investment decisions. Tax reforms established in Colombia are a good case of study because of the variation that they show in tax rates and investment, over time and across firms, creating a large identifying variation. These reforms implemented major changes in rates and

tax benefits to encourage investment. Although, some of the changes were fiscal orientated to cover budget deficits, other adjustments such as the special deduction for the investment in productive assets, sought to stimulate investment.

To provide an idea of the identifying variation, Figure 2 depicts the scatter plots between actual and its instrument for the tax reforms of 2006, 2009 and 2012. This is made by comparing the information of the variables one year before each reform was implemented and two years after the reform took place. The scatter plots exhibit great variation for both variables across corporations and tax reforms. Indeed, we find that the combination of changes in tax bases, tax rates, and tax benefits have an increase in the tax rates of several firms but reduce the tax rates of other firms. Variation in the *METRs* indicates that changes in the tax burden of firms depend largely on the combination of tax measures and incentives that yield in the behavior of firms. Indeed, according to the mix of tax policies, measures that apparently could relieve the burden of firms may end up increasing the tax burden[6].

(Figure 2 about here)

4.2.2. Controlling for additional variables

Another identification problem that might arise in the inference for the relationship between taxation and investment is related to the assumption that the potential investment should be uncorrelated with time (Gruber and Rauh, 2005; Gruber and Saez, 2002; Kleven and Schultz, 2014). It is unlikely that this assumption is observed in practice since investment decisions could be affected for reasons other than the changes in tax rules. For instance, real economic growth might create a direct correlation between investment and time. The instruments that we generate in the previous section are exogenous to post-reform investment, but they do depend on the pre-reform characteristics of firms. Therefore, the elasticity estimators could be biased if economic growth is different from year t to year $t+3$, for reasons different from the changes

[6] For a detailed analysis of the effect of different combinations of tax policies see Clark and Klemm (2015).

in tax rates. To address this concern, Gruber and Saez (2002) suggest including pre-reform controls. Hence, any underlying trends correlated with pre-reform characteristics are considered.

Thus, the estimation of the elasticity is based on the following first-difference form of the *log-linear* model:

$$\Delta ln\left(\frac{I_{i,t}}{K_{i,t-3}}\right) = \alpha + e_{1-METR} \cdot \Delta ln(1 - METR_{it}) + \gamma x_{it-3} + \Delta\gamma x_{it} + v_{it} \qquad (4)$$

In the specification, we consider a three-year interval period, which allows us to account "for sluggishness in behavioral adjustments, long enough to capture long-term investment effects, but not longer than that to avoid unnecessarily losing variation and power" Kleven and Schultz (2014, p. 9). In the analysis, we consider only the firms that report information both in year *t* and in $t - 3$, because this year is used to construct pre-reform controls of the firms, γx_{it-3}, including invariant firm's characteristics such as the economic sector and the size of the firm.

Due to the importance of controlling for pre-reform characteristics, we estimate different specifications with different controls. The main pre-reform control that we consider is the logarithm of total assets; given the effect that this variable has on both *METRs* and investment decisions. Additionally, considering the specifications proposed by Kopczuk (2005) to control for non-linearity, we include the ten-piece splines in the logarithm of the total assets, considering that more assets do not necessarily increase or reduce the effect of corporate taxation on investment linearly. In a tax structure with important tax benefits, such as the special deduction for investment in productive assets, companies with more assets could be favored more than those with less amount of assets in their portfolios. The response will depend on other characteristics of the firms to undertake new investment projects, such as the availability of cash flows. We also control for the size of firms, considering that companies of different sizes could have different financial restrictions to invest. Firms are grouped into the small,

medium, and large companies, based on the assets of the firms expressed in minimum legal wages (*MLW*), according to Law 905 of 2004[7]. The categorical variable is large firms. Additionally, we control for the economic sector where the firm operates, using as the categorical variable other services activities.

Furthermore, we control for the changes in other firms' characteristics, that may affect investment decisions, $\Delta\gamma x_{it}$. For instance, as suggested by Edgerton (2010), investment is usually affected by cash flows, since a decline in this variable may lower the effectiveness of tax incentives. Thus, tax incentives may have a lower impact on investment in periods that are most needed. Cash flows together with the taxable status are crucial on the investment decisions of firms, since cash flows may affect the effectiveness of tax incentives. Figure 3 shows that in Colombia corporative losses have been large relative to positive profits during the years of economic slowdowns. This ratio is lower in the years in which the real GDP recorded the lowest growth rates: 2001-2002, 2008-2009, 2014 (red bars), highlighting the importance of controlling for cash flows when evaluating investment decisions of firms and the effectiveness of tax policy.

(Figure 3 about here)

In the empirical literature, different variables have been used to control the cash flows of companies. In this paper, we include indicators to measure the firm's ability to undertake new investment projects. We include the solvency ratio, as it indicates whether the cash flow of the firm is sufficient to meet its short-term and long-term liabilities. Hence, the higher the solvency ratio, the greater the probability that a firm undertakes new investment projects. We also consider the *EBITDA* margin, which measures the earnings before interest rates, taxes, depreciation, and amortization. This is an indicator of a firm's financial health and a measure of the long-term profitability of the firm. We also control for the debt ratio. In general, firms

[7] Firms are classified as small, when they have assets up to 5,000 *MLW*, as medium firms when they have assets between 5,000 and 30,000 *MLW* and large firms when their assets are greater than 30,000 *MLW*.

with more financial constraints are less likely to initiate new investment projects. Furthermore, we control for the return on assets indicator, *ROA*, which is an indicator of the profitability of the firm relative to its assets and therefore might affect the firm´s decision making to invest.

4.2.3. The estimation of the elasticity

Given that from equation (4), we obtain the elasticity of investment with respect to the net of the marginal effective tax rate, e_{1-METR}, and our parameter of interest is the elasticity with respect to the *METR*, e_{METR}, we calculate the point elasticity in the mean of the *METR*, as[8]:

$$e_{METR} = -e_{1-METR}\frac{METR}{1-METR} \quad (5)$$

The estimations of the elasticity are carried out for different specifications using equation (4), where the observed change of the *METR* is instrumented using (3). First, we estimate the elasticity for the tax reforms of 2006, 2009 and 2012, within a balance panel data structure, considering an interval of three years. This estimation allows us to evaluate the joint impact of the three tax reforms, which as explained above involve changes in tax rates and tax benefits for firms. Then, we estimate the elasticity for each tax reform using cross-sectional estimations. Independent repeated samples are useful for assessing differences in the investment responses of companies under different tax structures. For each reform, we compare the pre-reform variables to the information of two years after the approval of the reform. Thus, to estimate the elasticity of the 2006 tax reform, a cross-sectional sample is constructed by comparing the responses between 2005 and 2008. For the 2009 tax reform, we compare the responses between 2008 and 2011, and for the tax reform of 2012, we compare the responses between 2011 and 2014.

[8] From the estimation of $e_{1-\tau}$, the point elasticity e_τ can be obtained as follows. If $e_\tau = \frac{\partial x}{\partial \tau}\frac{\tau}{x}$ and $e_{1-\tau} = \frac{\partial x}{\partial(1-\tau)}\frac{1-\tau}{x}$. Notice that: $\frac{\partial x}{\partial \tau} = -\frac{\partial x}{\partial(1-\tau)} = -e_{1-\tau}\frac{x}{1-\tau}$. Then, the first expression can be written $e_\tau = -e_{1-\tau}\frac{\tau}{1-\tau}$.

Finally, a cross-sectional specification, over the entire analyzed period, is estimated, considering the changes in investment and the *METR*, between a year before the 2006 tax reform and two years after the approval of the 2012 tax reform. This estimation allows us to evaluate the cumulative impact of the reforms, bearing in mind that when analyzing successive tax reforms, their effect might overlap. For instance, if the 2006 reform was not enough to trigger a change in investment by a given firm, but the 2006 reform combined with the 2009 reform leads to sufficiently lower *METR* to trigger investment, the cross-sectional analysis for each reform, cannot capture this effect, which would be all attributed to the last reform[9]. This analysis allows us to estimate the elasticity during a period characterized by three major tax reforms, assessing changes in investment responses due to the combinations of tax measures during the period.

4.3. Results

In this section, we provide the results of the panel structure estimations that consider the tax reforms of 2006, 2009 and 2012, the cross-sectional estimations for each tax reform, and the cross-sectional estimation that assesses the cumulative effect of corporate taxation in the different reforms. The empirical strategy relies on 2SLS regression analysis, using equation (4). From this specification, we estimate the elasticity of investment with respect to the net of the marginal effective tax rate, e_{1-METR}, allowing us to include negative values, considering that the *METRs* can be less than zero when benefits exceed the tax burden. Given that the relevant parameter of interest is e_{METR}, in the table, we also provide the point elasticity computed in the mean of the *METR*, by using equation (5). The dependent variable in every specification is the three-year growth rate of investment and the variable of interest is the three-

[9] We thank an anonymous reviewer for suggesting to us estimate this specification allowing us to assess the cumulative impact of the reforms.

year growth rate in the observed $1 - METR_{it}$, instrumented using the mechanical variation in $1 - METR_{it}$ by simulating $METR_{it}$ under the base-year behavior (equation, 3). In the estimations, standard errors are clustered by firm.

Table 4 provides the results of the estimations for the panel data structure, using different specifications. As a benchmark, the first column reports 2SLS estimation results without control variables. In this case, the elasticity of investment, e_{METR} , is -0.17. When adding the ten-piece *splines* of the logarithm of the pre-reform assets, the elasticity is -0.15, indicating that the non-linearity is statistically not significant in explaining the effect of the *METR* on investment. Results are robust and consistent across different specifications, regardless of the pre-reform controls we include in the regression. This robustness could be derived from the large and compelling identifying variation that the Colombian tax reforms can provide, considering the tax rates and investment grow exhibit great variation, over time and among firms, as shown in Figure 2.

The coefficients of the firm´s characteristics are all statistically significant. On average there is a negative relationship between the pre-reform firm's assets and the growth rate of investment. Solvency ratio and the *EBITDA* margin have a positive impact on investment, suggesting that the more availability of cash flows, the more likely it is that a firm starts a new investment project. On the contrary, the indebtedness ratio and the *ROA* negatively affect investment decisions, indicating that financial restrictions have an impact on the decision to invest. When including size and economic sector dummy variables the elasticity reduces to -0.14, suggesting heterogeneous responses across different types of firms. This could be explained not only by differences in financial restrictions across companies but also by the tax legislation. Indeed, some tax benefits, such as the deduction for investments in fixed assets, could favor more large firms and firms from economic sectors with a high share of fixed assets.

Besides, some incentives and special regimes favor specific economic activities, as explained in the tax reform section.

(Table 4 about here)

Table 5 displays the cross-sectional results for each tax reform and the complete analyzed period. Robust standard errors are shown in all regressions. Results of the first stage, reported in Appendix 1, indicate that the instrument for the observed change in the net of the *METR* is statistically significant, in all cases. The first column of the table reveals the estimation of the elasticity including as a control variable the log of the pre-tax assets in t-3. The second column shows the estimated elasticity including, in addition to the pre-tax assets, other characteristics of firms that could affect the exogeneity of the instrument. The third column presents the elasticity estimations, including as control variables, in addition to the characteristics of the firm's performance, fixed effects of the economic sector and the size of firms.

In general, the estimated elasticity is robust to the different specifications, but it varies significantly across tax reforms. In effect, while the e_{METR} for the 2006 tax reform is positive and around 0.4, for the reform of 2009 is negative and ranges between -0.4 and -0.7, and for the 2012 tax reform, the elasticity is also negative but ranges between -0.7 and -1.2. These results are consistent with the elasticities obtained from the estimations conducted using the OLS method (Appendix 2). Specifically, when using the instrument for $\Delta \ln (1 - METR)$, as the parameter of interest, the elasticities are similar in both cases[10]. Nevertheless, the endogeneity tests for all specifications indicate that the exogeneity hypothesis is rejected and therefore the

[10] A robustness test was carried out by estimating the cross-sectional regressions using an alternative simulated *METRs*. Specifically, we calculated the *METRs* for two years after each tax reform took place by preserving the characteristics of firms and the macroeconomic factors observed one year before each reform but adjusting the tax parameters. With this simulated *METRs*, we construct new instruments for the observed *1-METR*, by obtaining the mechanical changes of $\Delta log(1 - METR_{it})$. Overall, results indicate that the signs and significance of the calculated elasticities are similar to those elasticities calculated with the instruments calculated by adjusting both tax parameters and the macroeconomic variables. It is worth noting that when using the alternative tax rate, results indicate that for the 2006 tax reform, the elasticity, e_{METR}, continue to be positive when controlling for the logarithm of the total assets and the firm's characteristics, and it is no significant when controlling, in addition to these variables, for dummies variables of size and the economic sector where the firm operates.

variable should be treated as endogenous, which confirms that the IV-2SLS methodology is appropriate.

(Table 5 about here)

The results for the 2006 reform indicate that the reduction in the *METR*, observed between 2005 and 2008, mainly as a result of the reduction of the statutory tax rate from 38.5% to 34% and the increase in the percentage of the special deduction for the investment in productive assets from 30% to 40%, did not stimulate investment and instead on average decrease the investment of firms. Although this finding might seem counterintuitive, we offer the following explanations for this result. First, due to the temporary nature of the special deduction measure in the tax reform of 2003, once the measure was announced, the investment decisions of the firms were encouraged significantly right after the implementation of the benefit. Indeed, according to the Law, this deduction could only be used for four years (2004 to 2007), as a result, firms increased investment to guarantee the deduction from the income tax, considering that later in time the benefit will be eliminated. According to the Colombian tax office, the benefit of the special deduction for the investment on fixed assets was widely used by companies, after the benefit was set. For instance, in the year 2004, this benefit was requested by 4,541 firms, and in 2005, by 5,046 firms (Parra, 2006), highlighting the response the measure had after it was announced.

In the 2006 reform, the special deduction was preserved, but investment did not continue to grow at the same rate. This could be due to companies anticipated investment decisions given the temporary nature of this measure and considering the frequent changes in the tax regulations of the country. Indeed, as shown in Figure 4, the country's national investment increased between the period 2003-2007, a period in which the benefit established in 2003 would be in force, but in 2008, two years after the implementation of the 2006 reform, investment was

reduced[11]. The second issue for the positive elasticity of investment is associated with the macroeconomic adjustments linked to the international crisis of 2008, which affected the cost of capital and consequently the decisions to invest. In particular, as a result of the increase in inflation from 4.86% in 2005 to 7.67% in 2008, the net return, NR decreased and as a result, the effective marginal tax rates increased, offsetting the effect of the measures that reduced the corporate tax rates.

Besides, as suggested by Elschner et al. (2014), negative tax rates, as those observed after the approval of the corporate tax stimulus, could encourage investments projects that were undesirable because they earn a return lower than the opportunity cost, decreasing the availability of resources to undertake new investment. Regarding this aspect, it is worth mentioning that contrary to the 2009 and 2012 tax reforms, in the reform of 2006, neither the solvency ratio, nor the return on assets, ROA, were statistically significant in explaining the investment behavior. These results are in line with recent discussions about the effect of corporate tax cuts. Indeed, several authors argue that in many cases, tax cuts have increased corporate profits or encouraged arrangements of the companies' books for tax purposes and are not reflected in increases in investment (Hanlon and Heitzman, 2010; Krugman, 2019).

(Figure 4 about here)

Conversely, for the 2009 reform, investment responded, on average, negatively to an increase in the *METR*. Investment also reduced as a result of the 2014 tax reform, but on average, the reduction was greater than the reduction observed in the 2009 reform. It is worth mentioning that the 2009 reform did not modify the statutory tax rate but reduced the special deduction from 40% to 30%, increasing the tax burden of firms. The 2012 tax reform reduced the income tax rate from 33% to 25%, but established the *CREE* tax, with a tax rate of 9%. For

[11] It is worth mentioning that Galindo and Meléndez (2010) found that the tax reduction policy implemented in Colombia since 2003 did not promote investment. According to their results, investment during the application of the measure were mainly explained by the behavior of macroeconomic variables.

this year, the deduction for investment on assets did not operate, since this measure was completed eliminated in 2010. Results for the cross-sectional specification over the entire period that compares the responses between 2005 and 2014 exhibits similar results to those obtained in the panel data estimations. Indeed, the elasticity, in this case, is around -0.2.

According to the findings, in a tax structure with significant benefits, as the special deduction for the investment in fixed assets, in force in the 2006 reform, on average, investment responded positively and inelastically. Once, this special deduction was eliminated, which for many firms meant an increase in the tax rates, a negative and inelastic effect on investment is found. For the panel data structure and the cross-section for the entire period, the elasticity is negative but smaller to those obtained for the 2009 and 2012 reforms, suggesting that the responses of firms were offset among tax reforms. The results highlight the importance of considering the tax structure and the combination of measures in the response of firms to invest in new projects.

Table 6 presents the results of the last column of Tables 4 and 5. Specifically, the table shows the coefficients of the characteristics of firms and the size and economic sector dummy variables. As mentioned, these variables are included in the estimations to control for characteristics of the firm, considering that changes in investment decisions may affect the instrument. In the estimations, the log of total assets, size, and economic sector dummy variables correspond to the period $t-3$. Results indicate that the solvency ratio and the *EBITDA* margin had a positive impact on investment, in all cases. On the contrary, the debt ratio and the *ROA* had a negative effect, highlighting the role of financial constraints in business investment decisions. It is wort to remark that for the 2006 tax reform, the *ROA* coefficient is the highest, while the coefficient of the indebtedness ratio is not significant, suggesting that the firms were able to resort to different forms of financing, to fund an intensive use of the tax benefit for the investment in fixed assets.

(Table 5 about here)

Regarding size, results indicate there exist heterogeneous effects of changes in the METRs on investment. Indeed, they reveal a stronger negative effect for small firms than for medium and large firms, suggesting that small firms are more vulnerable to adjustments in tax legislation, especially for differences in financial restrictions. In effect, in all specifications, the investment of small and medium corporations responds more negatively than large firms. Likewise, the response of small companies is more negative in comparison to medium-sized ones. These results can be explained by the ability of large companies to respond faster and easier to tax adjustments. Additionally, as suggested by Maffini, Xing and Devereux (2016), small firms could be unable to fully understand a complex tax code and therefore respond differently to large firms, when the tax structure is modified. Large firms might compensate for changes in the tax rate, they can have access to more qualified professionals in the financial area and manage earnings to adjusts the payment of taxes (Hanlon and Heitzman, 2010).

By economic sector, some differences could also be remarked. For instance, in comparison to firms operating in the sector of *other services activities*, the response is higher for firms operating in the sectors of mining and quarrying, manufacturing, accommodation and food, and in the real estate activities. Meanwhile, the response is lower for firms operating in the trade sector. This difference could be explained by the share of fixed assets in the total assets, considering that the tax burden is highly dependent on this variable and for differences in the tax legislation that could favor investment in some economic sectors. It is also worth mentioning that the agriculture and transportations sectors have a positive and significant response only in the 2006 tax reform when the benefits for investment in tangible assets benefits were higher. Conversely, the response of investment in the financial and insurance sector was not significant for the 2006 and 2009 tax reforms, which could be explained by the low use of tangible assets versus intangible assets in this economic sector.

5. Conclusion

The paper assesses the effect of changes in the regulation of corporate taxes on investment decisions, using a panel data set of Colombian firms for the period 2005-2014. The empirical analysis exploits the Colombian context of frequent tax reforms and a unique set of panel data from financial statements and tax return data at the firm level. During this period, the national government established three major tax reforms including changes in the statutory tax rates and incentives for private investment.

The empirical strategy uses two steps to assess the effect of corporate taxation on investment. In the first step, we measure the impact of corporate taxation on the cost of capital, and secondly, we estimate the impact of the cost of capital on investment. To measure the first impact, we calculate the *METRs* per firm, based on the specific features of the Colombian tax system. *METRs* vary between 29.1% in 2005 and 13.4% in 2008, which are lower than the statutory tax rates prevalent in those years, 38.5% and 33%, respectively, the difference can be explained by tax benefits and deductions that firms were able to use. It is worth mentioning that these calculations do not consider evasion that might reduce even more the tax burden paid by firms. Furthermore, results indicate important differences across economic sectors depending on the specific tax legislation of the analyzed year. In general, *METRs* are higher for the mining sector, the real estate and the agriculture forestry and fishing sector. *METRs* also show great heterogeneity when calculated per firm, which could be due to differences in tax exemptions, the composition of assets, financial restrictions, among other firm characteristics. In some years, several firms registered negative *METRs*, suggesting that for those firms, tax benefits were higher than taxes.

In the second step, we estimate the effect of *METRs* on investment. We estimate the elasticity of investment with respect to the net of the *METR* and then calculate the point elasticity in the mean of the *METR*, within a balance panel data structure for the tax reforms of

2006, 2009 and 2012, considering an interval of three years and using cross-sectional estimations for each tax reform and for the entire analyzed period. Independent repeated samples are useful for assessing differences in the investment responses of companies under different tax structures. To overcome the potential endogeneity problems, we use as instruments the changes in the marginal tax rates created by tax reforms.

Results indicate that the corporate income tax elasticity of investment for the analyzed tax reform is around -0.2. This finding is in the lower range when compared to other studies for developed countries, which could be explained by the effect of the frequency of the tax reforms on firm decisions. Results are robust and consistent across different specifications, although some significant differences are found by tax reform, size and the economic sector where the firm is operating. For instance, the elasticity for the 2006 tax reform is positive and around 0.4, for the reform of 2009, the elasticity is negative and ranges between -0.4 and -0.7, and for the 2012 reform, it is also negative but ranges between -0.7 and -1.2. By size of the firm, results indicate a stronger negative effect for small firms than for medium and large firms, suggesting that they are more vulnerable to adjustments in tax legislation. Differences by the economic sector where the firm operates are mainly explained by the share of fixed assets in the total assets, considering that the tax burden is highly dependent on this variable and for differences in the tax legislation that could favor investment in some economic sectors. In particular, the elasticity is higher in the mining, real estate, manufacturing, and accommodation and food sectors.

Overall, the results obtained from the rates and the calculation of the elasticities suggest that the effect of the changes observed in the corporate tax approved in the tax reforms established during the period 2005-2014 increased or decreased the investment of firms, depending on the effect that each tax reform had on the individual firms' tax burden, considering the differences in the characteristics of firms and the tax benefits they received.

The differences observed in the responses for the different tax reforms and for different groups of firms indicate that certain combinations of tax measures may be more effective in stimulating investment than others. Thus, as suggested by Kopczuk (2005), policymakers have a role in finding the combination of measures more suitable for stimulating investment without affecting the public finances of the government.

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Table 1: Corporate income tax rate (%)

País	2005	2010	2014	2017
Argentina	35	35	35	35
Australia	30	30	30	30
Austria	25	25	25	25
Belgium	33.9	33.99	33.99	33.99
Brazil	34	34	34	34
Chile	17	17	20	24
Colombia	38.5	33	34a/	34b/
Denmark	28	25	24.5	22
Finland	26	26	20	20
France	33.33	33.33	33.33	28
Israel	34	25	26.5	25
Italy	37.25	31.4	31.29	31.29
Japan	39.54	39.54	36.99	23.4
Mexico	30	30	30	30
Netherlands	31.5	25.5	25	25
Norway	28	28	27	25
Panamá	30	27.5	25	25
Portugal	27.5	25	23	21
Republic of Korea	27.5	24.2	24.2	22
Spain	35	30	30	25
Sweden	28	26.3	22	22
Switzerland	21.3	21.17	21.15	21.15
United Kingdom	30	28	21	20
United States	40	39.21	39.08	38.92
Uruguay	30	25	25	25

[a/] The tax rate includes the *CREE* for "equality" tax.
[b/] For companies with profits higher than 800 million Colombian pesos (around US$ 2.6 million) per year, the Law set a temporary surcharge of 6% for 2017.
Source: Tax Foundation (https://taxfoundation.org/).

Table 2: Parameters used in the calculation of *METRs* [a/]

Parameter	2006 Reform	2009 Reform	2012 Reform	2014 Reform
Fiscal Parameters				
CIT rate	38.5%	33.0%	33.0%	25.0%
CREE rate	0.0%	0.0%	0.0%	9.0%
Deduction on investment in assets [b/]	30.0%	40.0%	0.0%	0.0%
Macroeconomic variables				
Inflation	4.9%	7.7%	3.7%	3.7%
Interest rate	14.5%	17.2%	11.3%	10.9%
Pre-tax rate of return	4.9%	7.7%	3.7%	3.7%
Shareholder risk premium	5.0%	5.0%	5.0%	5.0%

[a/] The composition of the assets includes observed information of each firm.
[b/] This deduction considerably affects the tax base of the CIT. Tax bases are also affected by different tax exemptions established in the different tax reforms.
Source: Colombian tax legislation for tax parameters and Colombian Central Bank for macroeconomic variables.

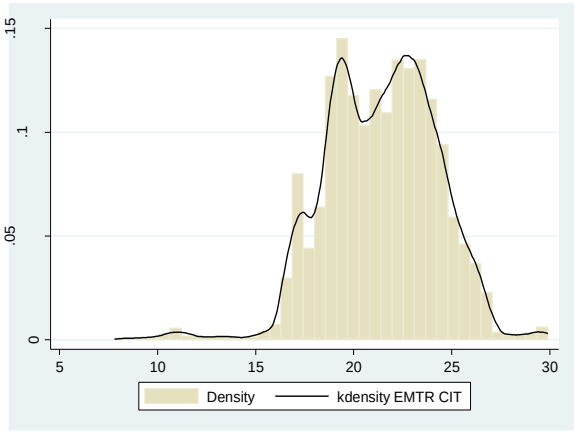
Table 3: *METRs* by economic sector (%)

	2005	2008	2011	2014[a/]
Agriculture, forestry, fishing	33.1	22.2	20.8	23.6
Mining and quarrying	28.1	14.9	15.6	21.6
Manufacturing	26.9	13.1	13.7	20.9
Construction	28.5	10.1	12.9	20.7
Wholesale and retail trade	28.9	12.3	14.2	21.1
Transportation and storage	28.9	7.6	12.3	20.8
Accommodation and food	29.0	14.3	14.1	20.1
Financial, insurance activities	31.2	21.5	20.8	23.9
Real estate sector	34.2	20.7	21.3	24.0
Other services	27.7	6.9	11.3	20.2
Total Sectors	29.1	13.4	14.9	21.4

[a/]This *METR* considers the effect of the *CREE* tax.
Source: Authors' calculations.

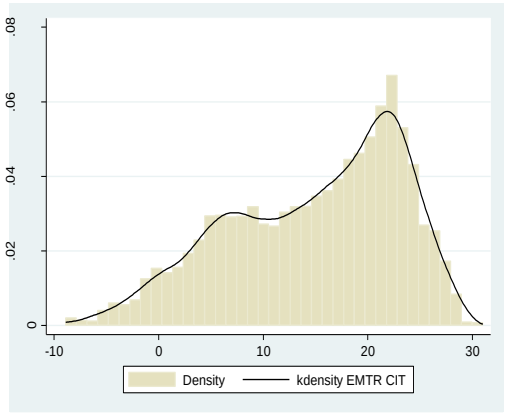
Figure 1: Frequency distributions of *METRs*

METRs: 2014



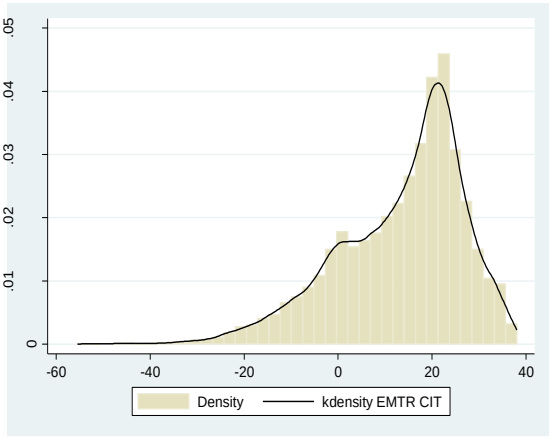
Average: 21.4

METRs: 2011



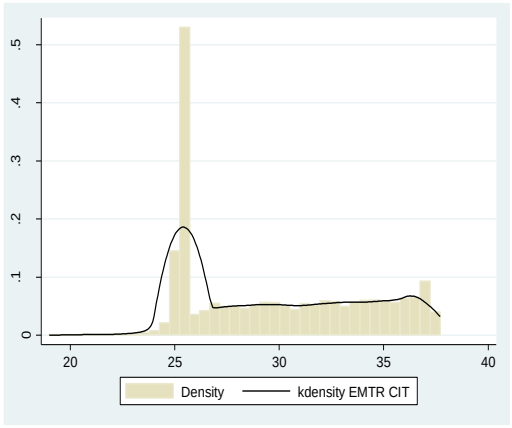
Average: 14.9

METRs: 2008



Average: 13.4

METRs: 2005

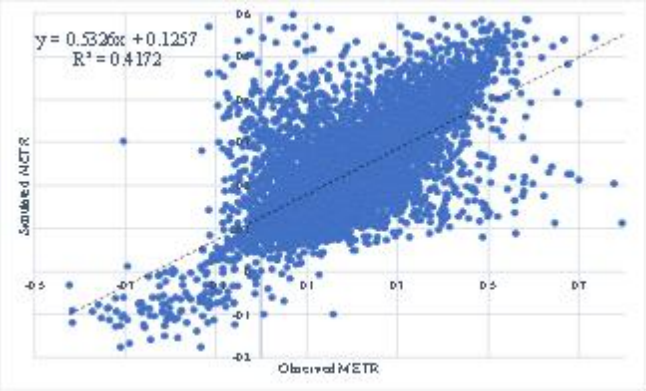


Average: 29.1

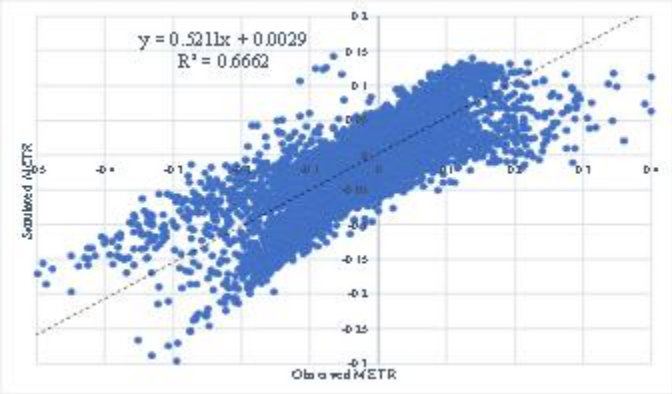
Note: Frequency distributions are plotted by using the information of a balanced panel.
Source: Authors' calculations.

Figure 2: The observed $\Delta \ln (1 - METR)$ and the instrument

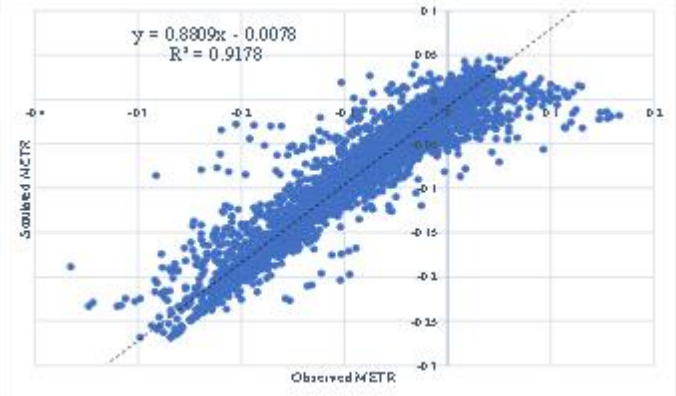
2006 Reform (Changes between 2005-2008)



2009 Reform (Changes between 2008-2011)

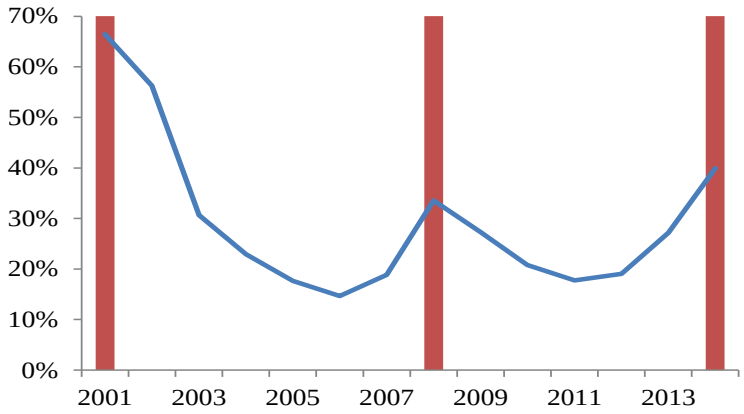


2012 Reform (Changes between 2011-2014)



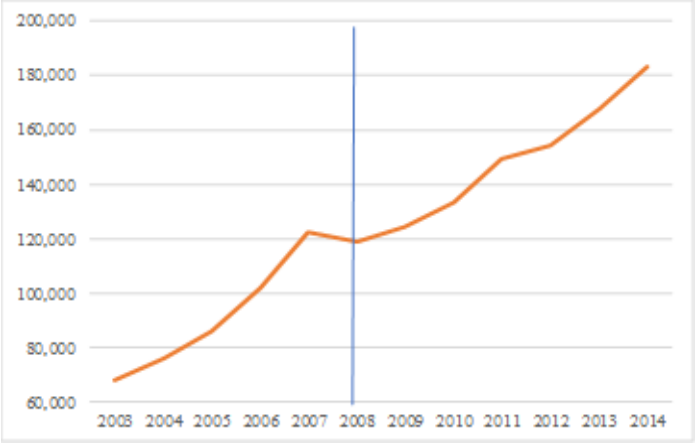
Source: Authors' calculations.

Figure 3: Ratio of corporative losses to positive profits



Note: The numerator in the ratio is the sum of losses across firms and the denominator is the sum of profits across firms that report positive profits.
Source: Authors' calculations based on *Superintendencia de Sociedades.*

Figure 4: National gross fixed capital formation
Billions of Colombian pesos



Source: National Deparment of Statistics, DANE

Table 4: The corporate income tax elasticity of investment

	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{e}_{1-METR}$	0.6819***	0.6210***	0.7783***	0.7402***	0.5680***	0.5809***
	(0.196)	(0.193)	(0.195)	(0.202)	(0.197)	(0.191)
$\boldsymbol{e_{METR}}$	**-0.1669**	**-0.1520**	**-0.1905**	**-0.1811**	**-0.1390**	**-0.1422**
Average *METR*	19.7	19.7	19.7	19.7	19.7	19.7
Controls						
ln (total assets in $t-3$)			-0.0739***	-0.1700***	-0.5095***	-0.5263***
			(0.011)	(0.014)	(0.025)	(0.024)
ΔDebt ratio				-1.0057***	-1.0450***	-0.4479***
				(0.080)	(0.078)	(0.073)
Δ*ROA*				-4.9884***	-4.9034***	-3.9749***
				(1.072)	(1.091)	(0.785)
ΔSolvency ratio				0.3781***	0.3595***	0.4543***
				(0.021)	(0.025)	(0.031)
Δln (*EBITDA* margin)				0.1343***	0.1350***	0.1238***
				(0.011)	(0.011)	(0.011)
Splines ln (total assets in $t-3$)	No	Yes	No	No	No	No
Tax reforms dummies	Yes	Yes	Yes	Yes	Yes	Yes
Size dummies in $t-3$	No	No	No	No	Yes	Yes
Sector dummies in $t-3$	No	No	No	No	No	Yes
Tests of endogeneity	324.358	364.254	360.013	320.166	296.274	328.465
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	23,046	23,046	23,046	20,272	20,272	20,272

Notes: Estimations are based on 2SLS regressions, where standard errors (displayed in parentheses) are clustered by firm. The dependent variable in all specifications is the three-year growth rate of investment. The relevant parameter of interest is e_{METR}, which is calculated from e_{1-METR}, using equation (5). "*Splines*" refer to a flexible piecewise linear functional form with teen components.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Table 5: 2SLS Elasticities cross-sectional specifications

	(1)	(2)	(3)
2006 Tax reform			
$\hat{e}_{1-METR}$	-2.8665***	-2.4827***	-2.1800***
Robust standard error	(0.347)	(0.372)	(0.366)
$\boldsymbol{e_{METR}}$	**0.4428**	**0.3835**	**0.3367**
Average *METR*	13.38	13.38	13.38
Endogeneity test	39.252	38.500	43.146
(Ho: variables are exogenous)	(p = 0.000)	(p = 0.000)	(p = 0.000)
Observations	7,788	6,725	6,725
2009 Tax reform			
$\hat{e}_{1-METR}$	3.7597***	2.2975***	2.2759***
Robust standard error	(0.383)	(0.441)	(0.416)
$\boldsymbol{e_{METR}}$	**-0.6578**	**-0.4019**	**-0.3982**
Average *METR*	14.89	14.89	14.89
Endogeneity test	437.670	280.635	288.120
(Ho: variables are exogenous)	(p = 0.000)	(p = 0.000)	(p = 0.000)
Observations	8,013	7,073	7,073
2012 Tax reform			
$\hat{e}_{1-METR}$	4.2530***	3.0577***	2.7224***
Robust standard error	(0.424)	(0.480)	(0.482)
$\boldsymbol{e_{METR}}$	**-1.1573**	**-0.8320**	**-0.7408**
Average *METR*	21.39	21.39	21.39
Endogeneity test	128.258	98.807	104.205
(Ho: variables are exogenous)	(p = 0.000)	(p = 0.000)	(p = 0.000)
Observations	7,245	6,474	6,474
Cross-sectional specification over the entire period			
$\hat{e}_{1-METR}$	1.5255***	1.1336***	0.4529
Robust standard error	(0.272)	(0.300)	(0.294)
$\boldsymbol{e_{METR}}$	**-0.3733**	**-0.2774**	**-0.1108**
Average *METR*	19.66	19.66	19.66
Endogeneity test	75.115	59.724	56.701
(Ho: variables are exogenous)	(p = 0.000)	(p = 0.000)	(p = 0.000)
Observations	7,240	6,465	6,465
Controls			
$\ln(\text{total assests in } t-3)$	Yes	Yes	Yes
Firm characteristics	No	Yes	Yes
Size dummies in $t-3$	No	No	Yes
Sector dummies in $t-3$	No	No	Yes

Notes: Estimations are based on 2SLS regressions, where standard errors (displayed in parentheses) are clustered by firm. The dependent variable in the cross-sectional estimations for each tax reform is the three-year growth rate of investment. The relevant parameter of interest is e_{METR}, which is calculated from e_{1-METR}, using equation (5). To estimate the elasticity over the entire period, a cross-sectional sample is constructed that compares the responses between 2005 and 2014.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.
Source: Authors' calculations.

Table 6: The Elasticity of Investment

	Panel	2006 tax reform	2009 tax reform	2012 tax reform	Cumulative effect
e_{METR}	**-0.1422**	**0.3367**	**-0.3982**	**-0.7408**	**-0.1108**
Firm Characteristics					
ln (total assets in $t-3$)	-0.5263***	-0.6986***	-0.5247***	-0.4348***	-0.7621***
	(0.024)	(0.039)	(0.033)	(0.038)	(0.034)
ΔDebt ratio	-0.4479***	0.1028	-0.3666***	-0.6141***	-0.5749***
	(0.073)	(0.111)	(0.106)	(0.118)	(0.129)
ΔROA	-3.9749***	-381.817	-55.1922***	-3.3082***	-7.0341
	(0.785)	(292.319)	(17.561)	(0.292)	(4.959)
ΔSolvency ratio	0.4543***	2.7502	29.807	0.5058***	51.4521
	(0.031)	(11.705)	(21.632)	(0.026)	(44.316)
Δln (EBITDA Margin)	0.1238***	0.1601***	0.1321***	0.1429***	0.1881***
	(0.011)	(0.023)	(0.016)	(0.017)	(0.020)
Size of firms in $t-3$					
Medium firms	-1.0380***	-1.2252***	-0.9541***	-0.8036***	-1.4295***
	(0.059)	(0.091)	(0.083)	(0.095)	(0.089)
Small firms	-1.6548***	-1.7779***	-1.4714***	-1.4725***	-2.6085***
	(0.091)	(0.143)	(0.127)	(0.154)	(0.134)
Economic Sector in $t-3$					
Agriculture, forestry, fish.	0.2038**	0.3442***	0.0608	-0.0892	0.0113
	(0.081)	(0.113)	(0.104)	(0.115)	(0.126)
Mining and quarrying	1.1033***	1.1929***	1.1580***	0.7105***	1.0092***
	(0.153)	(0.217)	(0.189)	(0.223)	(0.257)
Manufacturing	0.2432***	0.2375***	0.0792	0.2612***	0.2462**
	(0.060)	(0.076)	(0.076)	(0.086)	(0.098)
Construction	-0.2943***	-0.0785	-0.3944***	-0.4628***	-0.3238**
	(0.090)	(0.118)	(0.117)	(0.128)	(0.148)
Wholesale and retail trade	-0.6584***	-0.6136***	-0.7805***	-0.7388***	-0.6424***
	(0.059)	(0.077)	(0.074)	(0.088)	(0.100)
Transportation and storage	0.0945	0.3076*	0.0681	-0.0354	-0.1277
	(0.142)	(0.169)	(0.180)	(0.200)	(0.222)
Accommodation and food	1.1659***	1.1330***	1.0916***	0.9935***	0.8552***
	(0.111)	(0.148)	(0.132)	(0.162)	(0.186)
Financial, insurance act.	-0.1660	-0.0367	-0.2729	-0.4788**	-0.2880
	(0.151)	(0.198)	(0.201)	(0.214)	(0.256)
Real state sector	1.4116***	1.5610***	1.3530***	1.0621***	1.3242***
	(0.091)	(0.123)	(0.114)	(0.132)	(0.143)
Observations	20,272	6,725	7,073	6,474	6,465

Notes: Estimations are based on 2SLS regressions, where standard errors (displayed in parentheses) are clustered by firm. The dependent variable in the panel data structure and the cross-sectional estimations for each tax reform is the three-year growth rate of investment. The relevant parameter of interest is e_{METR}, which is calculated from e_{1-METR}, using equation (5). To estimate the elasticity over the entire period, a cross-sectional sample is constructed that compares the responses between 2005 and 2014. Firms are classified into small, medium, and large companies, based on the assets of the firms expressed in minimum legal wages (MLW), according to Law 905 of 2004. The categorical variable is large firms. For the economic sector, the categorical variable is other services activities. ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.
Source: Authors' calculations.

Appendix

Appendix 1: First stage of IV 2SLS estimations

Dependent variable: Observed $\Delta \ln(1-\text{METR})$	(1)	(2)	(3)
2006 Tax reform			
Instrumented $\Delta \ln(1-\text{METR})$	0.732***	0.715***	0.704***
	(0.014)	(0.016)	(0.016)
Observations	7,788	6,725	6,725
2009 Tax reform			
Instrumented $\Delta \ln(1-\text{METR})$	1.311***	1.340***	1.365***
	(0.014)	(0.016)	(0.016)
Observations	8,013	7,073	7,073
2012 Tax reform			
Instrumented $\Delta \ln(1-\text{METR})$	1.042***	1.044***	1.053***
	(0.004)	(0.005)	(0.005)
Observations	7,245	6,474	6,474
Cross-sectional specification over the entire period			
Instrumented $\Delta \ln(1-\text{METR})$	1.007***	1.006***	1.009***
	(0.002)	(0.003)	(0.003)
Observations	7,240	6,465	6,465
Controls			
$\ln(\text{total assests in } t-3)$	Yes	Yes	Yes
Firm characteristics	No	Yes	Yes
Size dummies in $t-3$	No	No	Yes
Sector dummies in $t-3$	No	No	Yes

Notes: Estimations correspond to the first stage of the 2SLS regressions, where standard errors (displayed in parentheses) are clustered by firm. The dependent variable in the cross-sectional estimations for each tax reform is the three-year change of the *EMTR*. The relevant parameter of interest is the instrumented change in the *METR*. The cross-sectional specification over the entire period compares the responses between 2005 and 2014.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.
Source: Authors' calculations

Appendix 2: OLS Elasticities cross-sectional specifications

	(1)		(2)		(3)	
	Observed ΔMETR	Instrumented ΔMETR	Observed ΔMETR	Instrumented ΔMETR	Observed ΔMETR	Instrumented ΔMETR
2006 Tax reform						
$\hat{e}_{1-METR}$	−4.613***	-2.099***	-4.305***	-1.776***	-4.099***	-1.535***
	(0.209)	(0.267)	(0.230)	(0.277)	(0.225)	(0.267)
e_{METR}	**0.7136**	**0.3242**	**0.6650**	**0.2743**	**0.6332**	**0.2371**
Average *METR*		13.38		13.38		13.38
Observations		7,788		6,725		6,725
2009 Tax reform						
$\hat{e}_{1-METR}$	-0.659**	4.929***	-1.724***	3.079***	-1.624***	3.106***
	(0.332)	(0.481)	(0.368)	(0.575)	(0.347)	(0.552)
e_{METR}	**0.1153**	**-0.8623**	**0.3016**	**-0.5387**	**0.2841**	**-0.5434**
Average *METR*		14.89		14.89		14.89
Observations		8,013		7,073		7,073
2012 Tax reform						
$\hat{e}_{1-METR}$	2.276***	4.318***	1.063**	3.199***	0.685	2.783***
	(0.455)	(0.425)	(0.511)	(0.486)	(0.513)	(0.488)
e_{METR}	**-0.6193**	**-1.1749**	**-0.2892**	**-0.8705**	**-0.1864**	**-0.7573**
Average *METR*		21.39		21.39		21.39
Observations		7,717		6,474		6,474
Cross-sectional specification over the entire period						
$\hat{e}_{1-METR}$	1.019***	1.488***	0.611***	1.125***	-0.045***	0.3745
	(0.2720)	(0.2638)	(0.3008)	(0.2914)	(0.2955)	(0.2841)
e_{METR}	**-0.2494**	**-0.3641**	**-0.1495**	**-0.2753**	**0.0110**	**-0.0916**
Average *METR*		19,66		19,66		19,66
Observations		7,712		6,886		6,886
Controls						
ln(total assests in $t-3$)	Yes		Yes		Yes	
Firm characteristics	No		Yes		Yes	
Size dummies in $t-3$	No		No		Yes	
Sector dummies in $t-3$	No		No		Yes	

Notes: Estimations are based on OLS regressions, where standard errors (displayed in parentheses) are clustered by firm. The dependent variable in the cross-sectional estimations for each tax reform is the three-year growth rate of investment. The relevant parameter of interest is e_{METR}, which is calculated from e_{1-METR}, using equation (5). To estimate the elasticity over the entire period, a cross-sectional sample is constructed that compares the responses between 2005 and 2014.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.
Source: Authors' calculations