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The effect of corporate taxes on investment: Evidence from the Colombian firms[♣]

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Abstract

The paper assesses the role of taxes on investment in Colombian firms. The analysis is carried out at the firm level for the period 2003-2014. During this period, the national government set five different tax reforms, including changes in the statutory tax rates, tax credits and incentives for corporate investment. The effect of corporate taxation on investment is estimated by first determining the impact of taxation on the cost of capital by computing the effective marginal tax rates (*EMTRs*) at firm level. Then, we estimate the impact of the cost of capital on investment through a panel data regression. Endogeneity is controlled by an instrumental variable approach, simulating post-reform effective marginal tax rates under pre-reform firm characteristics. Results are robust with different control variables, although some significant differences by size and economic sector of the firm are found.

Key words: Corporate taxes, Marginal effective tax rate, Investment, cash flows

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, firm´s decision-making affect both the economic activity and the country's fiscal accounts (Hanlon and Heitzman, 2010). In Colombia, during the last decade the national government established six different tax reforms including changes in statutory tax rates, tax credits incentives for private investment and the creation of a wealth tax paid by companies. Despite the different tax reforms, several experts have argued that the tax burden faced by companies is high and distortionary, and in case of an eventual tax reform it should moderate corporate taxes due to their impact on investment and economic growth.

Taking advantage of the Colombian context of frequent tax reforms, at least one 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, using an annual panel data set of firms for the period 2003-2014. To the best of our knowledge, this is the first study for an emerging economy that asses the relation between investment and corporate taxation using a compelling dataset at the firm-level in a framework of recurrent variations in tax legislation. Understanding how these changes have affected investment decisions could provide answers on which measures are most effective in promoting investment. All the more that it has been argued that combining several tax cuts and incentives may eventually lead to an increase of the tax burden for companies when they are inconsistent with each other.

Since the publication of the seminal papers by Jorgenson (1963) and Jorgenson and Hall (1967), the theoretical and empirical research on the relation 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]. In the study of the relationship between

[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).

corporate taxation and investment, the identification is crucial, considering that changes in the tax structure might affect tax rates as well as investment decisions of firms. To address the identification problem, we consider the instrumental variables strategy proposed by Gruber and Saez (2002), which propose to adopt as instruments the changes in the marginal tax rates created by tax reforms[2]. As far as we know, the use of mechanical changes in *EMTRs* driven by adjustments in tax laws is used for the first time to assess the impact of corporate taxation on investment in a context of frequent tax reforms.

Our 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 impact of corporate taxation on the cost of capital, and secondly, we estimate the impact of the cost of capital on investment. The first effect depends on the specific tax system, since different depreciation allowances schemes or investment tax credits will impact differently the cost of capital. The Effective Marginal Tax Rate (*EMTR*) defined as the difference in the cost of capital in the presence and in the absence of tax, in percentage of the pre-tax cost of capital, measures this impact (De Mooij and Ederveen, 2008). We compute the *EMTRs* per firm considering the specific features of the Colombian tax system and using real data rather than hypothetical information for the composition of assets, discounts and tax benefits. It is worth noting that *EMTRs* provide a different perspective of corporate tax burden compared to calculations obtained using average effective rates and other definitions of tax rates[3].

In the second step, we estimate the effect of *EMTRs* on investment. In this setup, identification is crucial considering that adjustments in the tax structure can affect both investment decisions and the *EMTRs*, 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 Gruber and Saez

[2] As indicated by Saez, Slemrod and Giertz (2012), although this methodology has been mainly used to estimate the behavioral response to individual income taxes, the methodology can be applied to any tax base.

[3] For instance, the marginal effective tax rate is different from the marginal tax rate used in corporate finance, which is the firm-specific present value of tax on an additional dollar of income. It is also different from the average effective tax rate of a particular industry, which is the ratio of the tax expense to pre-tax earnings reported in the firm's accounting statements.

(2002), which adopts as instruments the changes in marginal tax rates created by tax reforms. The *ETMRs* calculated in the first step allow us to calculate these instruments by adjusting the parameters affected by tax reforms. Specifically, we simulate post-reform *EMTRs* under pre-reform behavior, using the same set of firm characteristics, but allowing tax rules and macroeconomic factors to change. Thus, considering the tax reforms established during the last decade, we computed mechanical *EMTRs* variations for the reforms of 2006, 2009 and 2012, by comparing the year before and two years after each reform was established[4].

An important aspect to consider in the analysis is that investment decisions are usually affected by cash flows (Edgerton, 2010). In effect, declines in cash flows may decrease the effectiveness of tax incentives, thus tax incentives may have the least impact on investment in periods that are most needed. These aspects are taken into account in the empirical analysis by controlling for different measures of cash flows. Furthermore, considering that tax credits and the compositions of assets may differ by industry and other firm's characteristics, we will also evaluate differences by size and by the economic sector where the firm belongs. The analysis is carried out at the firm-level, using a panel data set rather than aggregate time series data, allowing us to exploit the cross-sectional variation on investment, capital stock and cash flows across firms. Moreover, the use of a panel data structure allows us to assess the impact on investment decisions under different tax structures.

Results indicate that *EMTRs* fluctuated between 22% in 2014 and 28% in 2005, which are lower than the statutory corporate rates prevalent in those years, 38.5% and 33%, respectively because of tax benefits and deductions of the Colombian tax legislation. Overall, *EMTRs* suggest that the combination of tax measures of the reforms established during the period under analysis are reflected on average in a decreasing pattern of the rates over time. Nevertheless, important differences across economic sectors and firm sizes are observed. *EMTRs* also show great heterogeneity when calculated per firm which could be due to differences in tax exemptions, composition of assets and financial restrictions, among other variables. In turn, the corporate income tax elasticity of investment is -0.2, which is robust and consistent under different specifications. Some significant differences are found by size, tax reform and the economic sector where the firm is operating. This elasticity is in the lower range when compared to other studies for developed countries, where the empirical literature

[4] In the analysis, we consider, three-year interval, which is long enough to capture firm´s investment decisions.

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.

This paper is divided into four sections, besides this introduction. The second section describes the Colombian tax system on firms. Section three describes the data set used in the analysis. In section four we present the empirical strategy, which considers the calculations of *EMTRs* 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

From the point of view of different experts, the Colombian tax system on firms is high and complex compared to other countries, considering the different national and local taxes that firms should pay[5]. Within the national taxes, on which this study focuses, in addition to the corporate income tax, firms must pay a tax on wealth[6]. In turn, the most representative local taxes are the property and the industrial and business taxes[7]. An important feature of the Colombian tax system during the last two decades is the establishment of frequent tax reforms. As we explain in the summary below, tax reforms modified tax bases and statutory tax rates as well as benefits on taxes that affect business (Table 1)[8].

Regarding the corporate income tax rate, the reform approved at the end of 2016 (Law 1819 of 2016), classifies the companies into two types of regimes. Under the ordinary regime, the corporate income tax rate is 34% in 2017 and 33% in 2018. However, 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 and 4% for 2018, which means that the rate actually rises to 40% in the first year and to 37% in the second. From 2019, all companies must pay a 33% tax rate. The special regime, which has a rate of 20%, is for companies operating in free zones, cooperatives and non-profit organizations.

[5] See for example, Comisión de expertos (2015a and 2015b) and Perret and Brys (2015).

[6] The 2016 reform established a tax on dividends, with rates ranging from 5% to 10% depending on the amount distributed.

[7] The tax on industry and bussines is settled on the ordinary and extraordinary income received with rates ranging from 0.2% to 0.7%, for industrial enterprises and 0.2% and 1% for commercial and service fimrs. The property tax is settled on the cadastral value of the property, with a rate that oscillates between 0.5% and 1.6%.

[8] For details of Colombian tax reforms, see Ávila and León (2008), and Cárdenas and Mercer-Blackman (2005).

Table 1: The Colombian tax reforms

Tax change	Tax reform 2003 (Law 863)	Tax reform 2006 (Law 1111)	Tax reform 2009 (Law 1370)	Tax reform 2012 (Law 1607)	Tax reform 2014 (Law 1739)
Corporate Income tax rate	35% Surtax of 10% between 2004 and 2006	34% from 2007 and 33% from 2008	33%	25%	25%
Income tax for equality (*CREE*)				Tax rate: 9% A new income tax for equity, *CREE*, was established. *CREE* base unlike *CIT* does not have exceptions	Tax rate 9% Surtax of 5% in 2015
Tax benefits	A special deduction of 30% in the *CIT* for the investment in productive assets was included.	The deduction in the *CIT* for investment in productive assets increased to 40%	The deduction in the *CIT* for investment in productive was reduced to 30%	* The special deduction was eliminated in 2010.	Firms are refunded 2 percentage points of the 16% VAT paid on capital goods, through a tax credit in the *CIT*.
Wealth Tax	Tax rate: 0.3%. For firms with liquid patrimony above 3,000 million COP (around US$ 1 million).	Tax rate: 1.2%. For firms with liquid patrimony above 3,000 million COP.	Tax rate: 2.4%. For firms with liquid patrimony between 3,000 and 5,000 million COP and 4.8% for firms with liquid patrimony above 5,000 million COP in January 2011.		A wealth tax for firms with gross patrimony minus debt equal to or greater than $ 1,000 million COP. Tax rates in 2015 vary between 0.2% and 1.15%, depending on wealth.

Sources: Authors' summary based on Colombian tax reforms.

The rate of the corporate income tax registered several modifications, during the last two decades. Until 2006, it was 35%, with a surcharge of 10% between 2002 and 2006, which raised this percentage to 38.5%. In 2007, the 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, 6% in 2016, 8% in 2017 and 9% in 2018. The 2016 tax reform eliminated both the *CREE* and its surtax. 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 investment on fixed assets. The aim of the National Government with this measure was 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 by the use of 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 special regime for newly incorporated small and medium-sized firms and non-profit organizations and a free trade zone regime (Perret and Brys, 2015).

The corporate statutory tax rate of Colombia for 2017 is 34%, which, as explained above, it 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 some 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 2). Nevertheless, it is worth mentioning that the statutory tax rates are not

strictly comparable, 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, as we explain in the next section, that the effective tax burden that companies actually 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 2: 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***	***34***[1/]	***34***[2/]
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
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

[1/] The tax rate includes the *CREE* for "equality" tax.
[2/] 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: KPMG, Deloitte, Tax foundation.

Regarding the wealth tax, the current legislation foresees its elimination from 2017. This tax was restored in Colombia by Law 863 of 2003 for firms with liquid patrimony exceeding 3,000 million Colombian pesos (around US$ 1 million) and a tax rate less than 1%. The Law allows firms to make the payment through periodic installments. Subsequently, the reforms of 2006, 2009, 2010 and 2014 revised the requirements to declare and pay this tax and modified the tax rate.

Firms are also subject to other taxes and contributions that affect their income and sales, such as a tax on financial transitions and different contributions to the social security system. The tax on financial transactions was created transitorily in 1998 under the declaration of a state of economic emergency, with a rate of 0.2% on bank withdrawals. Law 633 of 2000 raised the rate to 0.3% and left the tax permanent. Subsequently, Law 863 of 2003 increased the rate to 0.4% and maintained the tax for the period 2004-2007. Law 1111 of 2006 extended its validity until 2013, and then Laws 1393 of 2010 and 1739 of 2014 ordered their gradual dismantling. Law 1819 of 2016 again settled the permanent character of the tax and maintained the rate of 0.4%.

Contributions to social security include the payments made to the health system, which corresponds to 12.5% on wages; 4% is assumed by the worker and 8.5% by the employer. It is worth mentioning that employers are exempt for those workers whose remuneration is less than ten minimum wages. The contributions to the pension system correspond to 16% on wages; 4% is assumed by workers and 12% by employers. When salaries are higher than four minimum wages, employees must cancel an additional 1%. Additionally, on the payroll value, employers are required to pay 4% to the Family Compensation Funds, 3% to the Colombian Institute of Family Welfare, *ICBF*, and 2% to the National Learning Service, *SENA*. Employers are exempt from these contributions, when they have workers with salaries below ten minimum wages. Finally, it is also important to mention that the value-added tax (VAT) paid on the acquisition of fixed assets can only be deducted from corporate income since the 2016 reform. According to the reform of 2014, firms were refunded 2 percentage points of the 16% VAT paid on capital goods. Before this tax reform, firms were not refunded for the VAT paid on fixed assets, which was an additional burden for firms[9].

[9] As explained by Perret and Brys (2015), Colombia was different from most countries, considering that in most of them, VAT on fixed assets is only levied on final consumption. Businesses that purchase goods and services pay VAT but receive a refund for the VAT paid on their inputs.

In view of the debate that high and complex tax burden on firms could affect private investment in the country, we carry out an exercise that calculates *EMTRs* and their effect on investment not only for corporate taxation and wealth taxes, but also for what we name ahead "*the total burden of taxes*" that consider the impact of taxes on financial transactions, tariffs on imports, and VAT, bearing in mind that they are not completely deducted for the corporate income tax. Local taxes on property and industry and commerce tax, which could also have an impact on the tax burden of firms, are not comprised in the analysis.

3. Data

The empirical analysis will be carried out by using an unbalanced panel data structure for the period 2003-2014. 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 from the *Superintendencia de Sociedades* provide detailed information about taxes, income tax, tax credits and other firm characteristics used in the econometric analysis. This dataset provide precise information on investment in plant and machinery and allow us to calculate financial and economic indicators of firms as well as their tax payments of firms. Furthermore, this dataset provides an appendix with detailed and classified information about the different assets of companies. This information allows us to quantify at firm level the *EMTRs* with observed data and not with hypothetical data as do most of the studies that calculate these rates. It is important to note that the number of firms that report information varies over time (Table 3).

Table 3: Number of firms included in the analysis

Year	Number of Companies	Year	Number of Companies
2003	9,227	2009	25,277
2004	10,840	2010	23,892
2005	19,174	2011	27,461
2006	22,894	2012	26,163
2007	21,906	2013	21,230
2008	23,063	2014	25,515

Source: *Superintendencia de Sociedades*

The second dataset comes from the corporate tax reports of the National Tax Office. For each firm, this data contains detailed tax return information, including the payment of corporate taxes, wealth taxes, tax deductions and exemptions, along with information about the payment of social security and *parafiscal* contributions, which is relevant to calculate the effective marginal rates. Specifically, for the calculation of *EMTR*s we merge the dataset from the financial statements of the firms and the tax return data. The changes in the *EMTRs* 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 *EMTRs* and to evaluate their impact on investment. The detail of the information allows us to assess differences at the firm level due to not only 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 firm's characteristics allows controlling for different characteristics of the firm in order to evaluate the robustness of the results.

4. Empirical Strategy

The effect of corporate taxation on investment is measures in two steps. First, we compute *EMTRs*, which measure the impact of taxes on the cost of capital, and secondly we estimate the impact of the cost of capital on investment.

4.1. Effective marginal tax rates

For studying the relation between corporate taxation and investment, the tax rate employed in the analysis is crucial, considering that changes of the tax structure might affect the taxable income and consequently the effective tax rate burdened to firms[10]. For instance, in a tax system with investment incentives based on the acquisition of assets, such in the Colombian case, the more investment the firm carries out, the greater the reduction in the effective tax rate. Thus, the measurement of the tax term to be used in the analysis is decisive, especially considering the complexity of the Colombian tax structure.

[10] For more details see Auerbach and Poterba (1987); Graham (1996a, 1996b); Graham, Lemmon and Schallheim (1998); Graham (2006); Graham and Mills (2008); Edgerton (2010); Hanlon and Heitzman (2010).

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 *EMTR*, which represents the relative percentage in which the minimum return on an investment project should be increased in order to ensure that the rise covers the payment of taxes. They are based on tax legislation and takes into account not only tax parameters such as statutory tax rates, tax bases, investment tax credits, depreciation allowances and tax deductions but also macroeconomic parameters including inflation rate and interest rates. To calculate the *EMTRs*, we adopt the framework of King and Fullerton (1984) and Fullerton (1999), which in turn is based on Hall and Jorgenson (1967)[11]. This approach considers the rate of return that equalizes the cost of capital and the expected income in any investment project. As Devereux y Griffith (2003; pp. 107) pointed out, "the basic approach is to construct a forward-looking hypothetical marginal investment project, for which the impact of tax on the cost of capital can be computed".

The calculation of *EMTRs* is carried out at firm level using real data rather than hypothetical information for the composition of assets, discounts and tax benefits, indebtedness, among other variables, as explained in detail in Appendix A. In a neutral tax system, the *EMTRs* 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, composition of assets, investment tax benefits and upon the industry of the firm. In general, high tax rates discourage investment, while negative ones indicate that the tax system encourages investments projects that are undesirable because they earn a return lower than the opportunity cost. As stated by Elschner at 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 on investment.

Specifically, *EMTRs* 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:

[11] Devereux and Griffith (1998, 2003) proposed some changes to the original methodology to calculate *EMTR*s and introduced the concept of effective average tax rates.

$$EMTR = \frac{GR - NR}{GR}\%$$

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

The gross return, *GR*, is the pre-tax required rate of an investment project that is sufficient to compete with an alternative investment. It 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.

In the absence of taxes, *GR*, after covering the acquisition cost of the asset package and depreciation, is equal to the *NR* and the *EMTR* is zero. When taxes are introduced, the *GR* rises 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[12]. For instance, if a company wishes to earn a 5% after tax-return (*NR*) on their investments and the *EMTR* is 60%, they need to earn a pre-tax return (*GR*) of 12.5%.

EMTRs 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 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. The *EMTR*s have also been used to assess the effect of different tax incentives by Klemm (2010 and 2012), Devereux, Griffith and Klemm (2002) and Loretz (2008), among other papers. International and local tax comparisons by using *EMTRs* 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.

[12] See Appendix A for a detailed derivation of *EMTRs*, considering the Colombian specific tax legislation.

Bearing in mind that the econometric analysis is conducted by comparing the year before each reform took place and two years after its establishment, *EMTRs* were calculated for the years prior to the main tax reforms, 2005, 2008 and 2011. We also calculated *EMTRs* for 2014, as a benchmark, considering that during this year the last tax reform for the period under study was established. To compute the mechanical tax changes caused by tax reforms, *EMTRs* 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. Table 4 illustrates the tax and macroeconomic parameters used in the computation and simulation of *EMTRs*. It is worth mention that since *EMTRs* were calculated at firm level by using information from the financial statements and tax return data of firms, we used the assets value and the sources of finance observed for each firm.

Table 4: Parameters used in the calculation of *EMTRs*

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%
Rate on wealth tax [1/]	1.2%, w >3	2.4%, w: 3 -5 4.8%, w >5		0.2%, w: 1-2 0.35%, w: 2-3 0.75%, w: 3-5 1.15%, w> 5
Deduct. on investment in assets[2/]	30.0%	40.0%	0.0%	0.0%
Rate on financial transactions (FT)	0.3%	0.4%	0.4%	0.4%
Deduction of FT on CIT	0.0%	25.0%	25.0%	50.0%
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%

[1/]The tax rate of the wealth tax is established by the total wealth of the firm. The values are expressed in billions of Colombian pesos.

[2/]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.

According to Fullerton (1999), the methodology to compute *EMTRs* might include only the effect of corporate income taxes, or they may also consider other taxes that affect the cost of capital. For the case of Colombia, *EMTRs for the total burden of taxes* have been calculated at sectorial level, for the 2003 and 2006 tax reforms by Zodrow (2005), and Avila and Leon (2008), respectively. As mentioned above, we calculate *EMTRs* not only for corporate taxation and wealth taxes but also for "*the total burden of taxes*". In these calculations, we distinguish taxes affecting firms only once (in the constitution of the firm or in the acquisition of assets), from those taxes levied recurrently on income, sales and profits (Appendix A). Although social security and *parafiscal* contributions are taken into account in the analysis, (when corresponds, they are included as deductions from the corporate income tax). Results of these rates are presented in Appendix B.

EMTRs were also computed by economic sector, as firms of different industries might face diverse financial constraints, and due to tax benefits could affect them in a different way, because of the differences in the composition of assets and tax deductions and exemptions. *EMTRs* by economic sector are calculated by aggregating the assets of the firms of each economic sector and according to the methodology explained in Appendix A. Results shown in Table 5 indicate heterogeneity among economic sectors and through tax reforms. Indeed, *EMTRs* calculated for the corporate income tax fluctuate between 28.3% in the year 2005 and 22.0% for the year 2014, recording a decrease over time, despite the elimination of the special deduction on the income tax for investment in productive assets in 2010.

It is worth to remark that *EMTR*s do not necessarily replicate the pattern of the statutory rates. They are lower than statutory tax rates prevalent in the different years, (e.g. in 2014, 25% for *CIT* plus 9% for *CREE* and in 2005 38.5%)[13]. 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 includes 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 results suggest the importance of the combination of measures in the tax burden actually paid by companies.

[13] It is important to mention that *EMTRs* do not consider tax evasion. *EMTRs* measure the tax burden of an asset packet considering taxes that a firm need to paid based on the tax legislation.

Table 5: *EMTRs* by economic sector

	2005		2008		2011		2014	
	CIT	*CIT* and *wealth* tax[1/]	*CIT*	*CIT* and *wealth* tax[1/]	*CIT*	*CIT* and *wealth* tax[1/]	*CIT*[2/]	*CIT* and *wealth* tax[1/]
Agriculture, forestry, fishing	20.2	20.2	27.1	31.5	25.3	30.4	23.8	29.1
Mining and quarrying	27.5	27.5	20.4	25.8	23.6	30.1	22.0	28.4
Manufacturing	23.6	23.6	18.9	22.9	22.5	26.6	22.3	27.0
Construction	30.9	31.0	17.9	20.6	21.5	24.7	20.0	23.4
Wholesale and retail trade	29.6	29.6	21.0	23.7	24.0	27.6	22.2	26.0
Accommodation and food	34.2	34.3	23.3	27.1	20.8	25.2	19.6	23.7
Transportation and storage	29.2	29.3	16.7	20.9	22.0	25.9	21.3	28.1
Financial, insurance activities	25.8	25.8	29.6	37.8	26.3	34.7	24.2	34.1
Other services	35.5	35.6	29.9	36.2	23.3	28.8	22.6	26.7
Artistic activities	28.1	28.2	15.0	17.8	21.1	23.4	21.2	24.8
Total Sectors	**28.3**	**28.3**	**25.7**	**30.3**	**23.4**	**28.1**	**22.0**	**27.1**

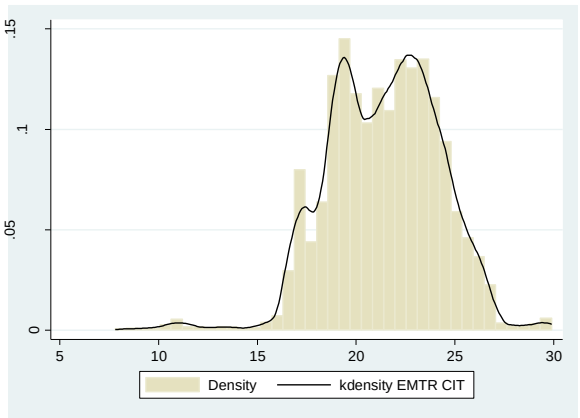
[1/]This *EMTR* includes the combined effect of CIT and the wealth tax.
[2/]This *EMTR* considers the effect of the *CREE* tax.
Source: Authors' calculations.

When the wealth tax is added to the analysis, *EMTRs* increase by around 4.7% in 2008 and in 2011 and by 5.7% in 2014[14]. The burden per economic sector varies depending on the specific tax legislation of the analyzed year and considering the composition of assets. The economic sectors that generally record the highest *EMTRs* in both cases are the mining and quarrying, the agriculture, forestry, fishing and the financial, insurance activities.

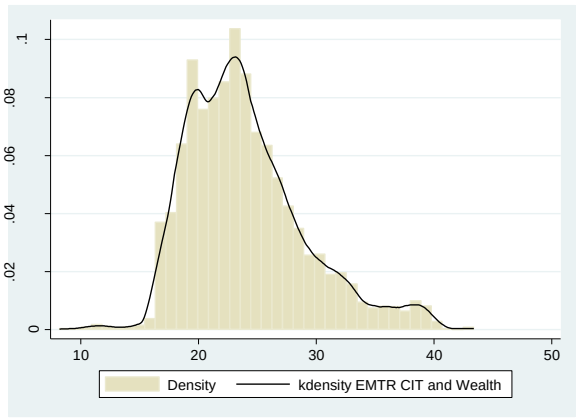
Taking advantage of the information available in the data set, explained above, *EMTRs* were also calculated at firm level, by considering the observed assets of each company and following the methodology shown in Appendix A. Figure 1 indicates that *EMTRs* highly varies across firms, for years 2005, 2008, 2011 and 2014, which as explained above, it could be due to differences in the composition of assets, in financial restrictions, in tax exemptions etc. It is also worth noting that for some firms *EMTRs* are negative. This could happen when in net terms; tax benefits are higher than taxes. In the Colombian case, the negative *EMTR* for some firms could be explained by the deduction on productive assets on the corporate income tax. Specifically, the negative result might occur because the deduction benefits the investment in assets whereas the corporate income tax levies the profits of the firm that might be relatively small in comparison to the value of investment in productive assets of the firm. In general, when the wealth tax is considered in the analysis, the dispersion of the *EMTRs* increase due to this tax only affects a group of firms according to their patrimony.

Figure 1: Frequency distributions of *EMTRs*

EMTRs: 2014



EMTR CIT: 22.0

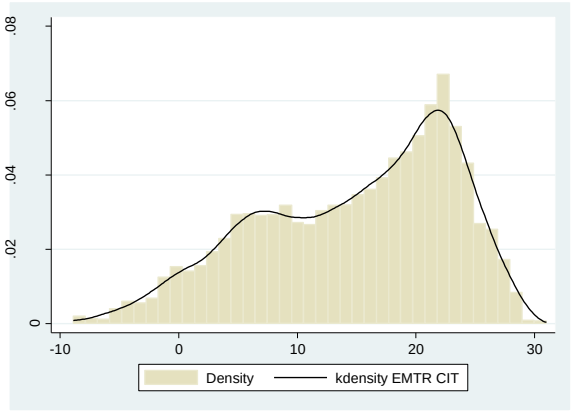


EMTR CIT and wealth: 27.1

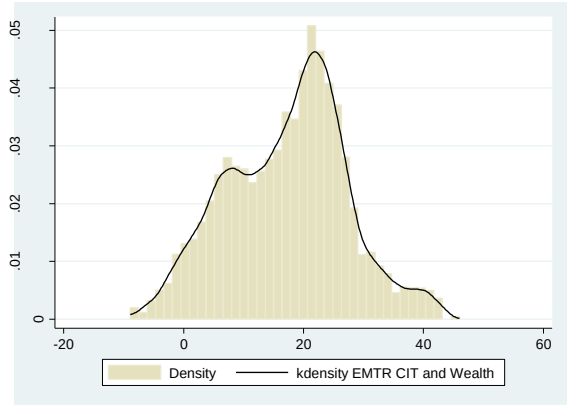
[14] *EMTRs* calculated for the total burden of taxes fluctuate between 40% in the year 2005 and 53.5% for the year 2011 (see Appendix B, Table B1, Figure B1).

Figure 1: Frequency distributions of *EMTRs* (Cont.)

EMTRs: 2011

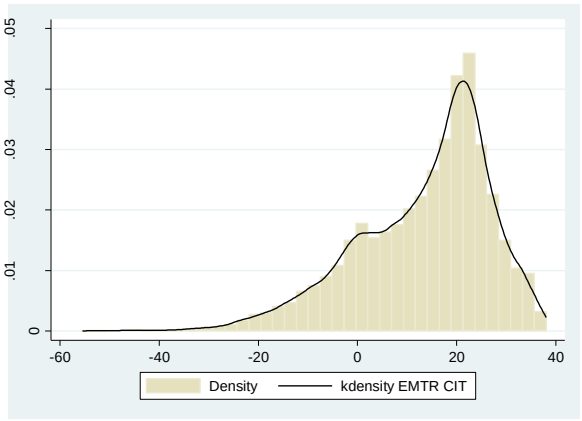


EMTR CIT: 23.4

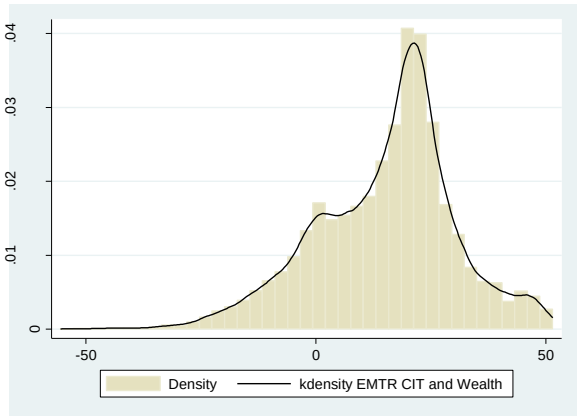


EMTR CIT and wealth: 28.1

EMTRs: 2008

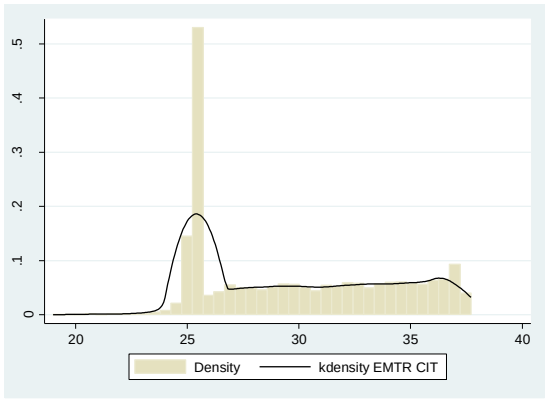


EMTR CIT: 25.7

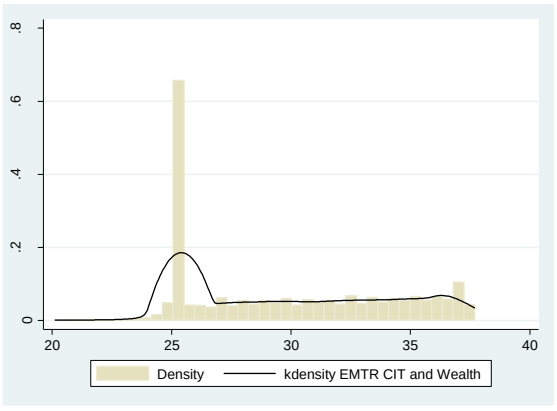


EMTR CIT and wealth: 28.1

EMTRs: 2005



EMTR CIT: 28.3



EMTR CIT and wealth: 28.3

Note: Figure 1 shows the EMTRs calculated at the company level for the CIT and for the combined effect of CIT and the wealth tax. Frequency distributions are plotted by using information of a balanced panel, in order to compare the same firms in the different years.
Source: Authors' calculations

4.2.The effect of the cost of capital on investment

4.2.1. Theoretical framework

The estimation of the firm's investment determinants, based on the user cost of capital model (Hall and Jorgenson, 1967) [15] is generally carried out using the following specification:

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

Where *I* and *K* denote investment and the capital stock, respectively; *S* represents the user cost of capital, which we measure by using the *EMTRs* 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*[16], 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 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 and, secondly by estimating the impact of the cost of capital on investment. *EMTRs* that reflect the first impact were calculated in the previous section. For the second effect, we estimate the elasticity of investment by specifying a *log-linear* model, as follows:

$$log\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \alpha + e \cdot log(emtr_{it}) + \gamma_t x_i + \gamma x_{it} + \mu_{it} + v_{it} \quad (2)$$

The relevant parameter is the elasticity with respect to the *EMTR*, e. This parameter quantifies the effect of a one percent change in *EMTRs* on the percent change of investment. A coefficient close to zero indicates that investment does not respond to changes in *EMTRs* and a coefficient of *-1* indicates that for every percent increase in *EMTRs*, investment decrease by one percent. In the specification, we control for characteristics of the firm and we distinguish invariant firm's characteristics such the economic sector.

[15] In this model, corporate taxes on profits increase the cost of investment, while allowances for depreciation and investment tax credits reduce it.

[16] In the empirical strategy, we use the mechanical variation in *EM*TRs that simulates post-reform marginal tax rates under pre-reform behavior.

The first-difference form of the model can be written as:

$$\Delta log\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \alpha + e \cdot \Delta log(emtr_{it}) + \gamma_t x_i + \Delta\gamma x_{it} + \Delta\mu_{it} + v_{it} \quad (3)$$

In this specification, difference at time *t* is the three-year differences from *t* to *t-3*. The three-year interval period 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 include only firms that are also observed in year *t − 1*, because this year is used to construct the pre-reform income controls. Thus, we employ a balanced panel data set to analyze the tax reforms of 2006, 2009 and 2012.

4.2.2. Identification and mechanical variation in EMTRs

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 effective investment, tax rates and taxable income, making the estimations on the relationship between investment and tax rates biased and inconsistent (Gruber and Rauh, 2005). As mentioned, because of the nonlinearity of the tax Colombian system, the *EMTR* and investment are endogenous, which creates a correlation between $\Delta log(emtr_{it})$, $\Delta log\left(\frac{I_{i,t}}{K_{i,t-1}}\right)$ and the error term. To address the identification problem that could arise in the estimation of the causality effect of changes in corporate taxes on firms' investment, we consider 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), it 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".

The methodology proposed by Gruber and Saez (2002) has been mainly used to analyze individual's income taxes[17]. Gruber and Rauh (2005) and Dwenger and Steiner (2012) use this approach to evaluate the impact of corporate tax changes on corporate taxable income for *USA* and Germany, respectively. On the relation of investment and taxation, recently, Aus dem Moore (2014) used a difference-in-differences approach to a quasi-experimental setting of Belgium corporations. For the identification strategy, the paper uses the indirect effect of taxes on investment via their impact on cash-flows. Maffini, Xing and Devereux (2016) assess the effect of tax incentives in the form of depreciation allowances on firm's investment for United Kingdom by using a quasi-experimental setting where the control group is composed by firms that did not qualify to capital allowances. Devereux and Liu (2014) estimate the causal effect of corporation taxation on investment of small firms by evaluating the impact of the 2006/07 tax reform in the UK, using a difference-in-differences design.

Hence, to overcome the endogeneity problem we construct instruments for the observed *EMTR*, by obtaining the mechanical *EMTRs* changes $\Delta log(emtr_{it})$, driven by changes in tax laws, as:

$$\text{Log}\big(EMTR_{t+3}(parametres_t)\big) - \text{Log}\big(EMTR_t(parametres_t)\big) \qquad (4)$$

As explained above, differences at time *t* are three-year differences from *t* to *t+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. The difference in the *EMTRs* is correlated with the change in *EMTRs*, 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 both rates and tax bases, over time and across firms, creating a large identifying variation. These reforms implemented major changes in rates and tax bases, as well as in tax benefits for investment[18]. Although, some of the changes were fiscal orientated to cover fiscal deficits, other changes such us the special deduction in the income tax for the investment in productive assets, sought to stimulate investment by encouraging firms to buy new tangibles assets. To give an idea of the identifying variation, Figure 2 shows the mechanical variation in *EMTRs* (the variation in the instrument) for the tax

[17] For example, Kleven and Shultz (2014) evaluate the behavioral responses to Danish income tax reforms over the period 1984 to 2005 adopting the mechanical tax changes as instruments to overcome endogeneity.

[18] It is important to mention that changes in the tax base come mainly from changes in the different tax benefits for the CIT that the tax reforms established.

reforms of 2006, 2009 and 2012 by comparing the observed *EMTR* for one year before the reform was implemented and the simulated *EMTR* for two years after the reform took place.

In Figure 2, each panel shows the three-year variation between the observe *EMTR* before the reform and the simulated *EMTR* after the reform for the corporate income tax and for the combined effect of corporate income and wealth taxes[19]. In each analyzed year, companies are classified into three groups according to the value of the investment (each group comprises 33% of the firms). Then, to assess changes in investment, the sample is split into seven groups using the three year difference in the classification of firms: (i) firms that are in the bottom bracket (33% of firms with the lowest investment) both before and after the reform, (ii) firms moving from the middle to the bottom bracket, (iii) firms moving from the bottom to the middle bracket, (iv) firms that are in the middle bracket both before and after the reform, (v) firms moving from the top to the middle bracket, (vi) firms that move from the middle to the top bracket, and (vii) firms that are in the top bracket (33% of firms with the highest investment) both before and after the reform. The figure also illustrates the share of firms in each group considered in the analysis.

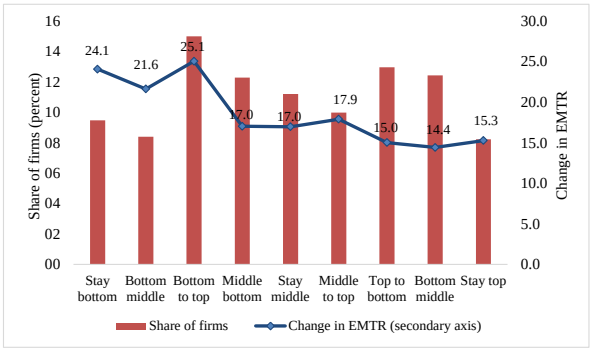
Results indicate that there are large and strongly heterogeneous tax changes across firms in the different analyzed tax reforms. For the 2006 tax-reform, the mechanical variation in *EMTRs* for the corporate income tax ranges from -24% to -13%. These findings could be explained by the reduction of the 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%. Both measures significantly contribute to reduce the tax burden of firms associate to corporate income tax. For the 2009 reform, mechanical changes are much smaller, ranging from -1.5% to 3.8%. It is worth mentioning that this reform did not modify the statutory tax rate but reduced the special deduction for the investment in productive assets from 40% to 30%, increasing the tax burden, although at firm level the variation depends to a large extent on the composition of its assets. Regarding mechanical changes for the 2012 tax-reform, results indicate the *EMTRs* variation oscillated between 4.3% and 10.2%. This tax reform reduced the income tax rate from 33% to 25%, but established the *CREE* tax, with a tax rate of 9%. For this year the especial deduction for investment on assets was not operating.

[19] Appendix B (Figure B2) shows the three-year variation between the observe *EMTR* before the reform and the simulated *EMTR* for *the total burden of taxes.*

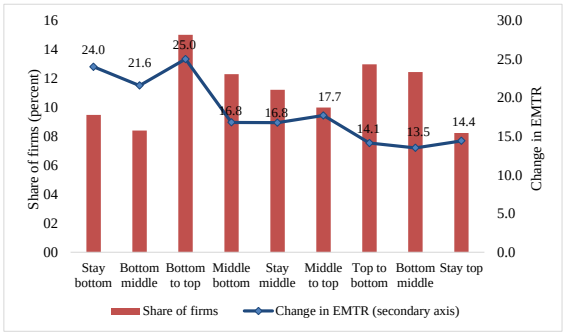
Figure 2: Mechanical variation in EMTR

2006 Reform: (2005-2008 Difference)

CIT

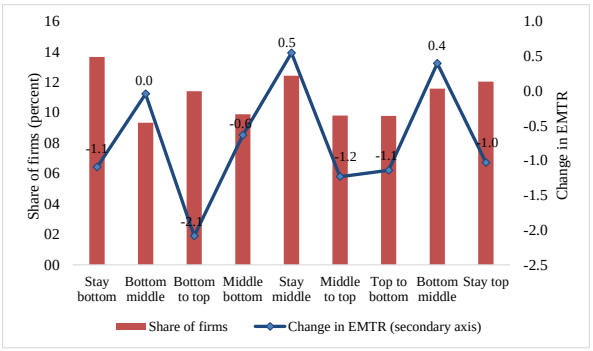


CIT and wealth tax

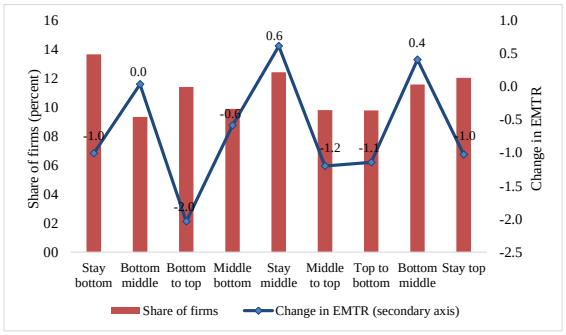


2009 Reform: (2008-2011 Difference)

CIT

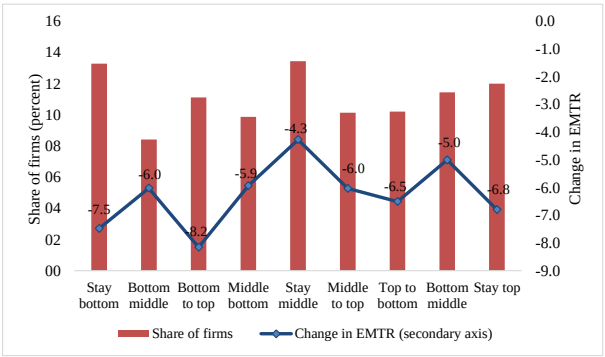


CIT and wealth tax

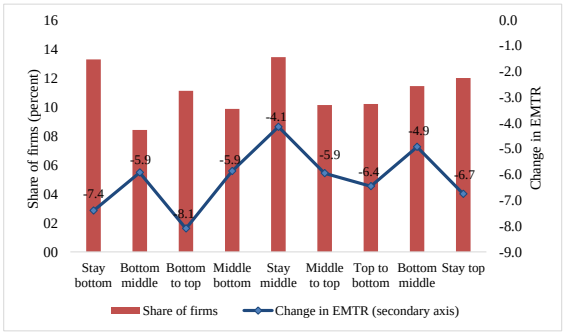


2012 Reform: (2011-2014 difference)

CIT



CIT and wealth tax



Notes: Figure 2 shows the mechanical variation in *EMTRs* (blue lines) due to the 2006-tax reform, the 2009-tax reform and 2012-tax reform, calculated for the CIT and the CIT and the wealth tax, respectively. Each panel shows the three-year differences in *EMTRs*. The sample of firms is split into seven groups using the three year difference in the classification of firms according to their investment (i) firms that are in the bottom bracket both before and after the reform, (ii) firms moving from the middle to the bottom bracket, (iii) firms moving from the bottom to the middle bracket, (iv) firms that are in the middle bracket both before and after, (v) firms that pass from the top to the middle bracket, (vi) firms that pass from the middle to the top bracket, and (vii) firms that are in the top bracket both before and after the reform. The figure also illustrates the share of firms in each group (red bars).
Source: Authors' calculations.

In general, the mechanical variation in *EMTRs* indicates that changes in the tax burden of firms depend largely on the combination of tax measures and the incentives that these produce in the behavior of firms. Depending on the mix of tax policies, measures that can apparently could relieve the burden of firms may end up increasing the tax burden[20]. As found by Kleven and Schultz (2014) for the behavioral responses to various Danish income tax reforms over the period 1984 to 2005, using data at individual level, we also found for the Colombian reforms, that combination of changes in tax bases, tax rates, tax benefits and the bracket cutoffs push some firms from a lower to a higher bracket (e.g. bottom to middle, middle to top) and simultaneously push other taxpayers in the opposite direction (e.g. middle to bottom, top to middle). Furthermore, the classification of firms in the figure is useful for the identifying strategy. Although the tax changes in the tax reform of 2006 register the greatest variation in the sample, there is large variation in the analyzed tax reforms.

4.2.3. Controlling for additional variables

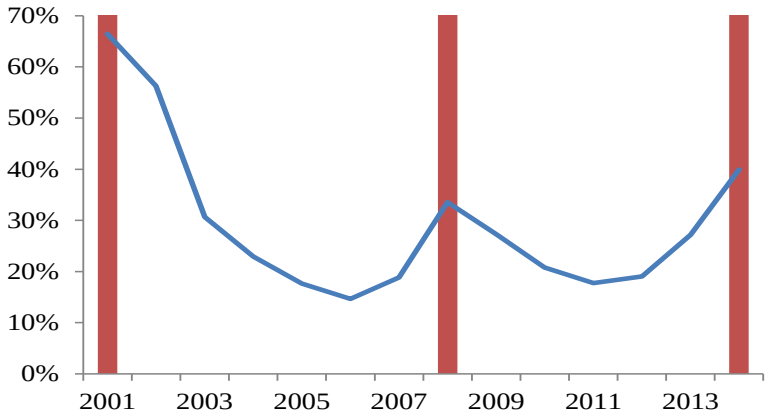
Another identification problem that might arise in the inference for the relationship between taxation and investment is related to the assumption that potential investment should be uncorrelated with time (Gruber and Rauh, 2005; Gruber and Saez, 2002; Kleven and Schultz, 2014). This assumption is unlikely to be hold in practice since investment of firms 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 pre-reform incomes. Therefore, the elasticity estimators could be biased if economic growth is different from year t to year $t+3$, for reasons different to the changes in *EMTRs*. To address this concern, Gruber and Saez (2002) suggest including pre-reform controls. Hence, any underlying trends correlated with pre-reform characteristics will be considered.

Due to the importance of controlling for pre-reform characteristics, we include different specifications with different controls. The main pre-reform control that we consider is the log-total assets; given the effect that this variable has on both *EMTRs* and investment decisions. Additionally, taking into account the specifications proposed by Kopczuk (2005) to control for non-linearity of the variables, we include the ten-piece *splines* in the logarithm of the total assets; considering that more assets does not necessarily increase or reduce the effect of the

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

EMTR on the investment of the firm linearly. Furthermore, as suggested by Edgerton (2010) one important aspect to consider in the analysis is that investment decisions of firms are usually affected by cash flows. Thus, declines in cash flows may lower the effectiveness of tax incentives, thus tax incentives may have the least 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 impact the effectiveness of tax incentives (Edgerton, 2010). For instance, 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) highlighting the importance of controlling for cash flows when evaluating investment decisions of firms and the effectiveness of tax policy.

Figure 3: Ratio of corporative losses to positive profits
in the Colombian firms



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

In the empirical literature, different variables have been use to control for cash flows of firms. 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. The solvency ratio in comparison to other indicators is a comprehensive measure of solvency, since it measures the cash flow capacity in relation to all liabilities, and not only with respect to debt. Hence, the higher the solvency ratio, the greater the probability that a firm undertake new investment projects. We also consider the *EBITDA* margin, which measure 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. More profitable companies are likely to invest more. We also control for the debt ratio. In general, firms 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 profitability of the firm relative to its assets and therefore might affect the firm´s decision making to invest.

We also control for the size of firms, considering that companies of different sizes could have different financial restrictions to invest and as stated by Maffini, Xing and Deverues (2016, p. 5), "small and medium firms may not be able to fully understand a complex tax code and therefore, the tax incentives may be less salient for them". Firms are grouped 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. Firms are classified as small, when they have assets up to 5,000 *MLW,* as medium when they have assets between 5,000 and 30,000 *MLW* and large firms when their assets are greater than 30,000 *MLW*. 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.

4.2.4. Results

In this section, we present the results from the panel regressions based on the tax reforms of 2006, 2009 and 2012. The empirical strategy relies on 2SLS estimations of equation (3) using mechanical tax changes as instruments. We present separate estimations for *EMTRs* calculate for the corporate income tax and for the corporate income and wealth taxes[21]. The dependent variable in every specification is the three-year growth rate of investment and the relevant variable is the three-year growth rate in the *EMTR*, instrumented using the three-year growth rate by simulating *EMTRs* under the base-year behavior. In the estimations, standard errors are clustered by firm.

Table 6 presents the results for the corporate income. As a benchmark, the first column reports 2SLS estimation results without control variables. In this case, the estimate elasticity

[21] Appendix B (Table B2) presents estimations for *EMTRs* calculate for the total burden of taxes. Results indicate that the elasticity of investment without control variables is -0.59. The estimated tax burden is levied virtually unchanged in around -0.45, when adding pre-reform controls of the firm including debt ratio, ROA, solvency ratio, and the EBITDA margin, indicating that results are robust and consistent to different specifications.

of investment is -0.21. When adding the ten-piece *splines* of the logarithm of the pre-reform assets, the elasticity is -0.22, indicating that nonlinearity is not significant in explaining the effect of the *EMTR* on investment. When adding pre-reform controls of the firm, results are extremely robust to the specification, with a consistently estimated elasticity around -0.20, regardless of the pre-reform controls we include in the regression, indicating that an increase of 1 percent in the *EMTR* reduces on average the investment in about 0.2 percent. It is worth to highlight the robustness of the results, which unlike previous studies are robust and consistent across different specifications. This robustness could be derived from the large and compelling identifying variation that the Colombian tax reforms can provide, considering the fluctuation that they show in both tax rates and bases, over time and across firms.

Results indicate that the first-stage regressions are always very strong, as can been seen from the *R-square* and the pre-reform control variables are all statistically significant. The pre-reform solvency ratio and the *EBITDA* margin have a positive impact on investment, suggesting that the more cash flows the firm has; the more likely it is to start new investment projects. On the contrary, the pre-reform debt ratio and *ROA* have a negative impact on the firms' investment decisions, indicating that financial restrictions negatively affect the decision to invest. Results for the join corporate income and wealth tax elasticity of investment are similar to those that evaluate only the corporate income tax elasticity, but now the estimated elasticity is -0.21 across the specifications (Table 7).

In the last column of Tables 6 and 7, we include in the specification size and economic sector dummy variables, as well as dummy variables for the year that the tax reform took place. The elasticity reduces for the corporate income tax to -0.17 and for the corporate income and wealth taxes to -0.18, suggesting some heterogeneity of the elasticity response across different types of firms. This could be explained not only by differences in financial restrictions of firms from different economic sectors and of different size, but also by tax legislation. Indeed, some tax benefits, such as the deduction for investments in fixed assets could benefit more certain types of firms; for example, large firms and firms from economic sectors with large share of fixed assets. In addition, some incentives and special regimes favors specific economic activities as explained in the tax reform section.

Table 6: The corporate income tax elasticity of investment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Elasticity	-0.2057***	-0.2249***	-0.2299***	-0.1967***	-0.1973***	-0.1983***	-0.1987***	-0.1829***	-0.1655***
	(0.028)	(0.028)	(0.027)	(0.027)	(0.027)	(0.028)	(0.029)	(0.028)	(0.028)
Pre-reform controls									
Splines of *log*-total assets	No	yes	no	no	no	no	no	no	no
Log-total Assets			-0.0784***	-0.0874***	-0.0873***	-0.0872***	-0.1729***	-0.4647***	-0.4737***
			(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.257)	(0.025)
Debt ratio				-0.9184***	-0.9169***	-0.9153***	-0.9576***	-1.0125***	-0.3699***
				(0.084)	(0.084)	(0.084)	(0.088)	(0.085)	(0.083)
ROA					-4.0057***	-4.0053***	-4.4513***	-4.3634***	-3.6954***
					(0.925)	(0.926)	(0.6057)	(0.6243)	(0.507)
Solvency ratio						0.4947***	0.4175***	0.3949***	0.4862***
						(0.019)	(0.229)	(0.026)	(0.0317)
Log-EBITDA margin							0.1347***	0.1373***	0.1253***
							(0.012)	(0.012)	(0.011)
Tax reforms dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Size dummies	No	no	no	no	no	no	no	yes	yes
Sector dummies	No	no	no	no	no	no	no	no	yes
Tests of endogeneity	127.587	153.319	146.103	137.261	137.194	137.465	115.192	108.095	110.619
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared (1-step)	0.712	0.714	0.713	0.713	0.713	0.713	0.707	0.707	0.701
Observations	19,292	19,292	19,292	19,292	19,288	19,287	17,038	17,038	17,038

Notes: Estimates 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 variable of interest is the three-year growth rate in the EMTR, instrumented using the three-year growth rate of $\text{Log}\left(\text{EMTR}_{t+3}(\text{parametres}_t)\right) - \text{Log}\left(\text{EMTR}_t(\text{parametres}_t)\right)$ "Splines" refer to a flexible piecewise linear functional from with teen components.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Table 7: The Corporate income and wealth taxes elasticity of investment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Elasticity	-0.2183***	-0.2346***	-0.2405***	-0.2114***	-0.2120***	-0.2130***	-0.2128***	-0.1992***	-0.1803***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.028)	(0.028)	(0.027)
Pre-reform controls									
Splines of *log*-total assets	no	yes	no	no	no	no	no	no	no
Log-total assets			-0.0798***	-0.0891***	-0.0889***	-0.0888***	-0.1755***	-0.4681***	-0.4771***
			(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.026)	(0.025)
Debt ratio				-0.9202***	-0.9187***	-0.9171***	-0.9573***	-1.011***	-0.3619***
				(0.084)	(0.084)	(0.084)	(0.088)	(0.085)	(0.083)
ROA					-4.0819***	-4.0815***	-4.5611***	-4.4485***	-3.7763***
					(0.994)	(0.995)	(0.995)	(0.713)	(0.591)
Solvency ratio						0.5018***	0.4237***	0.4019***	0.4953***
						(0.019)	(0.024)	(0.027)	(0.032)
Log-EBITDA margin							0.1367***	0.1390***	0.1269***
							(0.012)	(0.012)	(0.011)
Tax reforms dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Size dummies	no	no	no	no	no	no	no	no	yes
Sector dummies	no	no	no	no	no	no	no	no	yes
Tests of endogeneity	158.03	199.33	183.908	172.700	172.622	172.952	146.543	139.774	138.598
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared (first step)	0.682	0.685	0.684	0.684	0.683	0.684	0.675	0.677	0.678
Observations	19,421	19,421	19,421	19,421	19,417	19,416	17,157	17,157	17,157

Notes: Estimates 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 variable of interest is the three-year growth rate in the EMTR, instrumented using the three-year growth rate of $\mathrm{Log}(\mathrm{EMTR}_{t+3}(\mathrm{parametres}_t)) - \mathrm{Log}(\mathrm{EMTR}_t(\mathrm{parametres}_t))$ "Splines" refer to a flexible piecewise linear functional from with teen components.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Table 8 presents the results of last column of Tables 6 and 7 by showing the coefficients of the different dummy variables. In all cases, the impact for the 2009 and 2012 reform in compare to the 2006 tax reform is more negative, indicating that the combination of different tax measures matters for the response of firms to invest in new projects. For instance, it can be highlight that although the statutory corporate income tax rate of 2006, 38.5%, was higher than the 2009 and 2012 tax rate, 33%, the deduction for investment in fixed assets did not operate in 2012, since it was eliminated in 2010, indicating the importance of this measure in stimulating investment of firms. In turn, in 2006, the tax on financial transactions was not deductible from the corporate income tax, while in 2009 and 2012, 25% of the payment of this tax was deductible.

Regarding size, regressions results reveal that the response is more negative for medium and small firms in compare to large firms, which as explained above could due to differences in financial restrictions and because as suggested by Maffini, Xing and Deverues (2016, p. 5), they could not be able to "fully understand a complex tax code and therefore, the tax incentives may be less salient for them". By economic sector, there are also some differences that could be remarked. For instance, in compare 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 wholesale and retail 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.

Additionally, in order to capture any differential response among different groups of firms, we estimate different specifications by adding to the basic specification interactions of the EMTRs with the dummy variables of firm size, as well as for those of the different tax reforms. The interaction term, calculated as the product between the dummy variable and the simulated EMTR for the corporate income tax and for the corporate income and wealth taxes, is added one at a time. In each specification, we control for the pre-reform variables and the standard errors are clustered by firm. We also calculate the rate between the coefficient of the interaction term and the total elasticity, in order to assess the variation of the elasticity for the different analyzed groups. A negative rate indicates a more negative elasticity.

Table 8: The Elasticity of Investment

	CIT		*CIT and wealth*	
Elasticity	-0.1898***	-0.1668***	-0.2010***	-0.1785***
	(0.030)	(0.029)	(0.029)	(0.029)
Dummies for tax reforms				
2009 Reform	-0.3902***	-0.3828***	-0.4031***	-0.3935***
	(0.037)	(0.036)	(0.036)	(0.035)
2012 Reform	-0.6599***	-0.6255***	-0.6755***	-0.6379***
	(0.047)	(0.046)	(0.044)	(0.043)
Dummies for Size of firms				
Medium firms	-0.9109***	-0.9135***	-0.9110***	-0.9141***
	(0.063)	(0.061)	(0.063)	(0.061)
Small firms	-1.5341***	-1.5283***	-1.5356***	-1.5312***
	(0.100)	(0.097)	(0.101)	(0.098)
Dummies for the economic sector of the firm				
Agriculture, forestry, fishing		0.0691		0.0859
		(0.089)		(0.089)
Mining and Quarrying		0.8585***		0.8735***
		(0.155)		(0.155)
Manufacturing		0.1814***		0.1830***
		(0.064)		(0.064)
Construction		-0.1601*		-0.1716*
		(0.095)		(0.095)
Wholesale and retail trade		-0.6161***		-0.6137***
		(0.065)		(0.065)
Transportation and storage		0.1039		0.0648
		(0.154)		(0.161)
Accommodation and food		0.9434***		0.9595***
		(0.121)		(0.121)
Financial, insurance activities		0.1214		0.1320
		(0.168)		(0.167)
Real estate Activities		1.3025***		1.3206***
		(0.095)		(0.095)
Pre-reform controls	yes	yes	yes	Yes
Tests of endogeneity	108.585	107.221	137.191	133.006
	(0.000)	(0.000)	(0.000)	(0.000)
R-squared (1 step)	0.700	0.700	0.670	0.670
Observations	14,716	14,716	14,818	14,818

Notes: Estimates are based on 2SLS regressions, where standard errors (shown in parentheses) are clustered by firm. The dependent variable in all specifications is the three-year growth rate of investment. The independent variable of interest is the three-year growth rate in the effective marginal tax rate, instrumented using the three-year growth rate in the simulated effective marginal tax rate under base-year behavior. Firms are classified grouped 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. Firms are classified into small firms (assets up to 5000 MLW) medium (assets between 5000 and 30.000 MLW) large firms (assets greater than 30.000 MLW. 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.

Results in Table 9 indicate heterogeneous effects of *EMTRs* on investment, consistent with the previous results[22]. They reveal a stronger tax negative effect for small firms than for medium and large firms for the corporate income tax, suggesting that they are more vulnerable to changes in tax legislation[23]. In fact, while the rate between the coefficient of the interaction term and the total elasticity for small firms is 1.6, for large firms is 1.0 and for medium firm is 0.6. As expected, when the wealth tax is included, the coefficient for small firms is not significant. Regarding tax reforms, the 2012 reform shows the strongest negative effect on investment for both *EMTR*s, with a rate between the coefficient of the interaction term and the total elasticity of 3.0. On the contrary, the 2009 tax reform had the less negative impact on investment, which can be explained by the effect of the deduction for the acquisition of fixed assets, which for this year reached 40%. It is worth to remember that the *EMTR*s of an important group of firms were negative with the tax parameters of this tax reform.

Table 9: Heterogeneous responses to tax rates

Interaction terms	*CIT*		*CIT and wealth*	
	coefficient	rate	coefficient	Rate
EMTR x 2012 reform	-0.2120***	3.036	-0.2201***	2.819
	(0.059)		(0.059)	
EMTR x 2009 reform	0.1860***	0.233	0.1510***	0.397
	(0.065)		(0.065)	
EMTR x 2006 reform	0.0462	0.795	0.0640*	0.743
	(0.040)		(0.042)	
EMTR x large firms	-0.0063	1.032	-0.0837***	1.425
	(0.042)		(0.045)	
EMTR x medium firms	0.0860***	0.635	0.1068**	0.586
	(0.036)		(0.036)	
EMTR x small firms	-0.0843***	1.569	-0.0572	-0.222
	(0.038)		(0.209)	
Pre-reform controls	yes		yes	

Notes: Estimates are based on 2SLS regressions, where standard errors (shown in parentheses) are clustered by firm. The dependent variable is the three-year growth rate of investment. The interaction term is calculated as the product between the dummy variable and the simulated *EMTR*. The rate is calculated between the coefficient of the interaction term and the total elasticity (the sum of the elasticity in each regression and the interaction term). A negative rate indicates a more negative elasticity.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

[22] Results for the *total burden of taxes* shown in Table B3, indicate that 2006 tax reform registered the lowest negative sensitivity to invest.

[23] An additional exercise that estimated the responses of the interaction between the different reforms, the size of the firm and the *EMTRs* indicates that investment of small firms is the most negatively affected in all the analysed tax reforms.

5. Conclusions and Final remarks

The paper assesses the causality effect of changes in the regulation of corporate taxes on investment decisions, using a panel data set of Colombian firms for the period 2003-2014. The empirical analysis exploits the Colombia context of frequent tax reforms and a of unique panel data set from financial statements and tax return data at firm level. During this period, the national government established five different tax reforms including changes in statutory tax rates and tax credits incentives for private investment. During this period, the corporate Colombian tax system has been high and complex. This is mainly because of the combined effect of the corporate income tax, the corporate "equity tax", (*CREE*), the net wealth tax on business assets and the value-added tax (VAT) on fixed assets that were not deducted from corporate income during the analyzed period. However, the tax system also counts with generous tax benefits and important tax deductions.

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 *EMTRs* per firm, based on the specific features of the Colombian tax system. Results indicate that calculated for the corporate income tax vary between 22% in 2014 and 28.3 in 2005 that are lower than the statutory tax rates prevalent in those years, 38.5% and 33%, respectively, the difference can be explained by the tax benefits and deductions that the tax legislation has. When the wealth tax is considered in the analysis, *EMTRs* increase around 4.7% in 2008 and 2011, and 5.7% in 2014. It is worth mentioning that these calculations do not consider evasion that might reduce the effective tax burden paid by firms. In general, the *EMTRs* calculations for the corporate income tax suggest a decreasing pattern through the different tax reforms.

Furthermore, results indicate important differences across economic sectors depending on the specific tax legislation of the analyzed year. In general, *EMTRs* are higher for the mining and quarrying sector, the agriculture forestry and fishing sector and the financial and insure activities. *EMTRs* also show great heterogeneity when calculated per firm which could be due to differences in tax exemptions, composition of assets, financial restrictions, among other firm characteristics. In some years, several firms registered negative *EMTRs*, suggesting that for those firms, tax benefits were higher than taxes.

In the second step, we estimate the effect of *EMTRs* on investment using a panel data approach. 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 is -0.2. This result is robust and consistent across different specifications, although some significant differences are found by size, tax reform and the economic sector where the firm is operating. For instance, the sensitivity of investment to taxes is more negative for small than for medium and large firms. Meanwhile, the strongest negative effect on investment is registered for the 2012 tax reform and the less negative effect for the 2009 tax reform. Coefficients of the control variables indicate that the pre-reform solvency ratio and the *EBITDA* margin have a positive impact on investment, and that the pre-reform debt ratio and *ROA* have a negative impact on the firms' investment decisions, indicating the importance of these variables in the investment of firms.

Overall, results obtained from the *EMTRs* and from the calculation of the elasticities suggest that taxation has negatively affected the investment of Colombian firms during the analyzed period. Nevertheless, 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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Appendix A:

Methodology for the calculation of the *EMTRs*

This appendix describes in detail the assumptions and procedures followed in the calculating of *EMTRs*, considering the specific structure of the Colombian tax system. The description includes the total burden of taxes that affect investment. However, calculations for corporate income taxation and corporate income taxation and wealth are also carried out.

EMTR are defined as the difference between the gross (*GR*) and the net return of taxes (*NR*) of a marginal investment, expressed as the ratio of the gross return:

$$EMTR = \frac{GR - NR}{GR}\%$$

The calculation of *EMTRs* is conducted in three stages: In the first and most extensive, *GR* is determined. In the second, we define the *NR* and in third *EMTRs* are calculated.

A1. Calculation of the Gross Returns (GR)

The *GR* is obtained by equaling the acquisition cost (*AC*) of an investment unit, or an asset package and the present value of the expected profits net of taxes using the asset package (E)

$$(AC = E) \tag{1}$$

A1.1 The acquisition cost (AC)

To calculate the *AC,* we start with the value of the asset package before indirect taxes, denoted as *Q*. According to the Colombian tax system, the market price of the asset package (*M*) should include two indirect taxes that are not fully recoverable and have an impact on the cost of acquisition, which are the tariffs on imported assets (*a*) and VAT on capital goods (*v*). It is also necessary to consider that tariffs affect only the share of imported capital goods. Denoting this ratio as μ_1, the market price may be expressed as follows:

$$M = Q(1 + a\mu_1)(1 + v) \tag{2}$$

In some periods, the market price of the asset package (*M*) received a tax benefit called deduction for investment in productive fixed assets. The aim of the National Government with this measure was to stimulate investment by encouraging firms to buy new tangibles assets. This deduction is not given to the total value of the investment but has been applied to a percentage that has fluctuated between 0% and 40%[24]. We will refer to this percentage as *k*. It is important to consider that not all the asset package consists of fixed productive assets. So, it

[24] The 2003 tax reform created this special deduction for the investment in productive assets. The percentage was 30%. The percentage was increased to 40% in the 2006 tax reform. In the 2009 tax reform, the percentage was set again at 30%. In the 2010 tax reform the deduction was finally eliminated.

is assumed that within *M*, the share of productive fixed assets is μ_2 and therefore the deductible amount of investment will be $k\mu_2 M$. A deduction in income tax reduces the tax base, but its effect on the tax payable is calculated by multiplying the value of the deduction ($k\mu_2 M$) by the income tax rate (u). Thus, savings in the cost of acquisition due to this deduction is equivalent to $uk\mu_2 M$.

Moreover, it is assumed that the funds to purchase the asset package are deposited in the formal financial market and its withdrawal involves the payment of the tax on financial transactions, *GMF*, with a rate, g. This implies that the acquisition cost of the asset package becomes more expensive by the *GMF*, thus:

$$AC = M(1 - uk\mu_2 + g) \tag{3}$$

By considering the *GMF*, and by rewriting *M* to include non-discountable indirect taxes, we obtain a more general expression of the acquisition cost of capital, which includes three taxes and a tax deduction as follows:

$$AC = Q(1 + a\mu_1)(1 + v)\left(1 - uk\mu_2 + g\right) \tag{4}$$

In the calculation of the *GR*, it is important to differentiate taxes that affect firms' results only once (in the constitution of the firm or in the acquisition of assets), whose parameters are included in equation (4), from those taxes levied recurrently on income, sales, profits or capital (wealth), which are taken into account in the calculation of the present value of the expected profits of the project.

A1.2 Present value of the expected returns of the project (E).

It is assumed that *E* is the difference between the commercial profits before taxes and depreciation, *P*, and the payment of total taxes (*T*):

$$E = P - T \tag{5}$$

The taxes involved are: the corporate income tax (U), the "equity" tax on corporate income, *CREE*, which we will be denoted as (C), the wealth tax (W), the tax on financial transactions (G), social security contributions (S) and parafiscal contributions (F) [25].

$$T = U + C + W + G + C + S \tag{6}$$

From this point on, all recurrent taxes are rewritten in function of the market value of the acquired asset package.

[25] Although social security contributions and parafiscal contributions are taken into account in the analysis (when corresponds, they are included as deductions from the corporate income tax), to facilitated international comparisons, these contributions are excluded from *EMTRs* presented in the paper.

The "Equity" tax on corporate income, CREE: The "Equity" tax on corporate income, *CREE* (C) has as tax base that can be approximated to the commercial profits of the firm (P), net of fiscal depreciation of the assets package (Z). In general, exempted revenues, which are applied to main corporate income tax, are not included in the "equity" tax *CREE*. Defining as (c) the rate of *CREE*, we have:

$$C = c(P - Z)$$

Tax on financial transactions: Into the recurrent taxes, the tax on financial transactions *GMF* is included, which refers to the tax paid on the disposable income that are generated over the lifetime of the project and does not deal with the tax paid on the original provision of resources that financed the purchase of assets. The *GMF* is levied on the disposal of financial deposits. It is assumed that the resources allocated in the financial system are approximated to the income declared on the tax return data at firm level (Y). It is also supposed that there is a ratio of productivity (μ_4), that will be constant during the life of the project, between incomes (Y) and the asset package (M). Thus, the productivity will be: $\mu_4 = Y/M$, or in other words: $Y = \mu_4 M$.

If g is defined as the rate of the financial transactions tax and (Y) as the value of income that the project produces and uses over time, we have:

$$G = g\mu_4 M$$

Parafiscal contributions: A technical constant relationship between labor and capital is supposed between the payroll value (N) and the market value of the asset package (M). If we denote this relationship as μ_3 it must be: $\mu_3 = N/M$, or $N = \mu_3 * M$. *Parafiscal* contributions (F) may be rewritten in function of the asset package, as:

$$F = f\mu_3 M$$

Social security contributions: The basis of these contributions is also the value of the payroll (N), and its value can be obtained in a similar way to the calculation of the parafiscal contributions, as:

$$S = s\mu_3 M$$

Wealth tax: If the fraction of assets financed by debt is defined as μ_5, the value of assets will be: $M(1 - \mu_5)$. If it is further established that the wealth tax rate is (w), the tax can be defined as:

$$W = w(1 - \mu_5)M$$

Corporate Income tax: The tax base of the tax is defined as (U) and its statutory rate as (u). It is assumed that the taxable base is comprised of taxable profits (H) that differ from commercial profits (P).

$$U = uH$$

In turn, taxable profits (H) are comprise of commercial profits before taxes and depreciation (P), from which deductions (DD) and exempted revenues (Ü) are subtracted. Amongst tax deductions (DD), it is important to remark the deduction from the tax on financial transactions, as well as the deductions granted to social security contributions and *parafiscal* contributions. We denote as (d) this subset of deductions. Moreover, we identify as (Z) the value of the deduction granted to the depreciation of the asset package.

$$H = P - D - Z - Ü$$

If the deductible share from the tax on financial transaction, *GMF*, is represented as (ß), the amount to be deducted in the corporate income tax is:

$$ßG = ßg\mu_4 M$$

The total deductions on the corporate income tax caused by the payment of other taxes or fiscal charges, including deductions from social security and parafiscal contributions is represented by:

$$D = [ßg\mu_4 + (f + s)\mu_3]M$$

Considering the previous notations, corporate income tax (U) will be defined as:

$$U = u(1 - ü)P - u(1 - ü)[(f + s)\mu_3 + ßg\mu_4]M - u(1 - ü)Z \qquad (7)$$

In the expression, the taxable base of the corporate income tax includes three elements, all of them net of the effect of exempted revenues. The first corresponds to the commercial profits; the second, grouped within the square bracket, to deductions for contributions, for the tax on financial transactions and other, all of them are expressed in terms of assets. Finally, the tird term correspond to deductions for depreciation.

Now that we have defined the taxes and contributions that affect the investment project in the long run, based on the market value of the asset package, these definitions can be replaced in equation (5), by regrouping terms, we obtain the project's expected profits, as:

$$E = \{1 - c - u(1 - ü)\}P$$
$$- [\{1 - u(1 - ü)\}(f + s) * \mu 3 + \{1 - u(1 - ü) * ß\}g * \mu 4 + w(1 - \mu 5)]M$$
$$+ \{c + u(1 - ü)\}Z \qquad (8)$$

The above expression represents the expected value of the return of the investment project summarized into three terms. The first one is comprised of commercial profits, net of corporate income taxes and of *CREE*. The second term includes parafiscal and social security contributions, taxation on financial transactions and the wealth tax, net of the corresponding deductions that each of them receives in the corporate income tax. Finally, third component considers deductions for depreciation of the asset package, included in the corporate income tax and in the *CREE*. To discount the project flows and express them in present value, it is taken into account that in the first two components the integration variable is time (t) and in the third component this role is met by the average life of assets (l).

The asset package decreases over time to the rate (δ), which represents the economic depreciation. Assets increase their nominal value with inflation (π). The different flows use the discount rate (r) to calculate their present value. This rate is a weighted average of the nominal and net return of the corporate income tax, offered by the two sources of financing (credits from the financial system and contributions from investors). The weighting factor applied to funding sources is the debt ratio (μ_5) of each firm. Thus, (r) can be expressed as:

$$r = r_1(1 - u) * \mu_5 + r_2(1 - u)(1 - \mu_5) \tag{9}$$

In turn, r_1 is the active interest rate at which the financial system lends to firms, and r_2 is the expected return of shareholders that has two components: i) a passive interest rate with zero risk, such as that offered by the national treasury bonds, and ii) a premium for assuming the risk of investment. So, equation (8) expressed in present value is:

$$\begin{aligned} E = \{1 - c - u(1 - \ddot{u})\}P * \int [e^{\{-(r+\delta-\pi)t\}} * dt] \\ -[\{1 - u(1 - \ddot{u})\}(f + s) * \mu_3 \\ +\{1 - u(1 - \ddot{u}) * ß\}g * \mu_4 + w(1 - \mu_5)]M * \int [e^{\{-(r+\delta-\pi)t\}} * dt] \\ +\{c + u(1 - \ddot{u})\}M * \int [1 - e^{\{-(r-\pi)l\}} * dl] \end{aligned} \tag{10}$$

Solving these integrals and evaluating the time (t) between zero and infinity, we have:

$$E = \frac{\{1 - c - u(1 - \ddot{u})\}P}{r + \delta - \pi} - \frac{[\{1 - u(1 - \ddot{u})\}(f + s) * \mu 3 + \{1 - u(1 - \ddot{u}) * ß\}g * \mu_4 + w(1 - \mu_5)]M}{r + \delta - \pi} + \frac{\{c + u(1 - \ddot{u})\}M[1 - e^{\{-(r-\pi)l\}}]}{\{l(r - \pi)\}} \tag{11}$$

A1.3 Final expression of GR

Now, we can equate the acquisition cost of capital, (equation 4) with the present value of the expected returns of the project (equation 11).

$$M(1 - uk\mu_2 + g) = \frac{\{1 - c - u(1 - ü)\}P}{r + \delta - \pi} - \frac{[\{1 - u(1 - ü)\}(f + s) * \mu_3 + \{1 - u(1 - ü) * ß\}g * \mu_4 + w(1 - \mu_5)]M}{r + \delta - \pi} + \frac{\{c + u(1 - ü)\}M\left[1 - e^{\{-(r-\pi)l\}}\right]}{\{l(r - \pi)\}} \quad (12)$$

Dividing all the terms by the market value of the asset package (M) we obtain:

$$(P/M)\{1 - c - u(1 - ü)\}/(r + \delta - \pi) =$$

$$= (1 - uk\mu_2 + g)$$

$$+[\{1 - u(1 - ü)\}(f + s) * \mu_3 + \{1 - u(1 - ü) * ß\}g * \mu_4 + w(1 - \mu_5)]/(r + \delta - \pi)$$

$$-\{c + u(1 - ü)\}[1 - e\hat{}\{-(r - \pi)l\}]/\{l(r - \pi)\} \quad (13)$$

Then, the gross return P/Q will be:

$$P/Q = [(1 - uk\mu_2 + g)(r + \delta - \pi)$$

$$+\{1 - u(1 - ü)\}(f + s) * \mu_3 + \{1 - u(1 - ü) * ß\}g * \mu_4 + w(1 - \mu_5)$$

$$-\frac{\{c + u(1 - ü)\}\{1 - e^{-(r-\pi)l}\}\{r + \delta - \pi\}}{\{l(r - \pi)\}}] * \{(1 + a\mu_1)(1 + v)\}/\{1 - c - u(1 - ü)\} \quad (14)$$

Finally, the gross return, net of the average rate of economic depreciation is:

$$RB = P/Q - \delta \quad (15)$$

The gross return can be understood as the minimum return of the investment project that, once covered the cost of acquisition of the asset package and its economic depreciation, allows the firm to pay taxes and deliver the expected returns to the sources of financing.

A2. Net return (*NR*)

The *NR* is the real return of the sources of financing, net of the corporate income tax. The *NR* is equivalent to the discount factor of the project minus the rate of inflation.

$$RN = r - \pi \quad (16)$$

In the absence of taxes, the gross return, after covering the acquisition cost of the asset package and its depreciation, will be equivalent to the net return.

A3. Marginal effective tax rate, EMTR

$$EMTR = \frac{GR - NR}{GR}\%$$

The *EMTR* is zero if the gross return is equal to the net return and this only occurs when there are no taxes that levy the purchase of assets, their profitability or any other economic element related to the operation of the investment project. When taxes appear, the gross return rises away from the net return. This difference expressed as the ratio of the gross return is a measure of the burden of taxation over the life of the project. In such conditions the *EMTR* will be greater than zero and will increase the higher the taxes levy on the investment project.

Appendix B: Exercise for the total tax burden

In this Appendix we present the results of an exercise that calculates *EMTRs* and their effect on investment for "*the total burden of taxes*", by considering not only the effect of corporate taxation and wealth taxes, but also other national taxes such as taxes on financial transactions, tariffs on imports, and VAT, given that they are not completely deducted for the corporate income tax. Although social security and *parafiscal* contributions are taken into account in the analysis, (when corresponds, they are included as deductions from the corporate income tax), to facilitate international comparisons, these contributions are excluded from *EMTRs*.

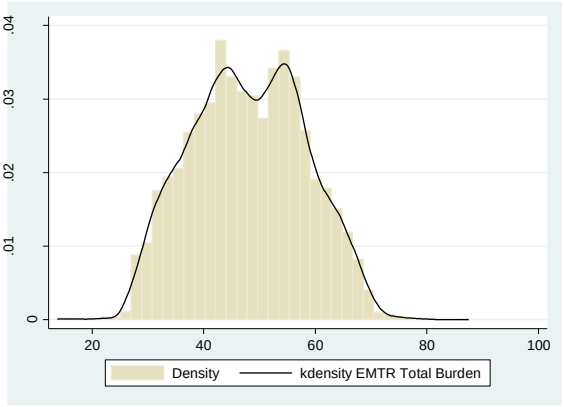
Table B1: EMTRs for *the total burden of taxes* by economic sector

	2005	2008	2011	2014
Agriculture, forestry, fishing	26.5	44.4	42.0	41.9
Mining and quarrying	40.0	50.8	57.6	50.0
Manufacturing	37.1	47.5	58.2	47.3
Construction	41.2	38.8	46.9	43.1
Wholesale and retail trade	41.1	48.3	53.5	48.3
Accommodation and food	38.6	41.8	42.6	39.2
Transportation and storage	39.8	53.0	52.1	50.0
Financial, insurance activities	36.3	44.3	41.2	40.2
Other services	40.7	46.3	52.5	43.4
Artistic activities	42.0	40.0	63.9	47.9
Total Sectors	**40.0**	**47.1**	**53.5**	**46.6**

1/ EMTR of the total burden includes in addition to CI and wealth taxes, taxes on financial transactions, tariffs on imports and VAT, considering that firms are not refunded for the VAT paid on fixed assets.
Source: Authors' calculations.

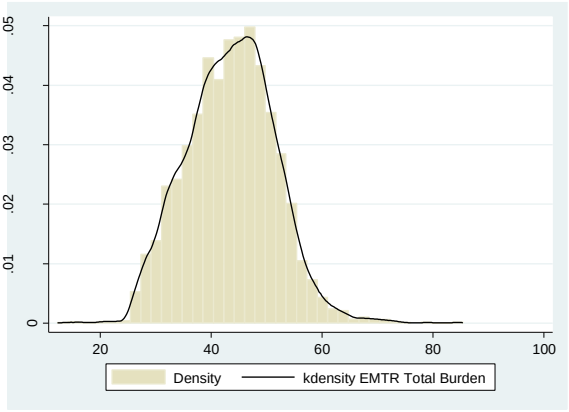
Figure B1: Frequency distributions of *EMTRs* for *the total burden of taxes*

2014



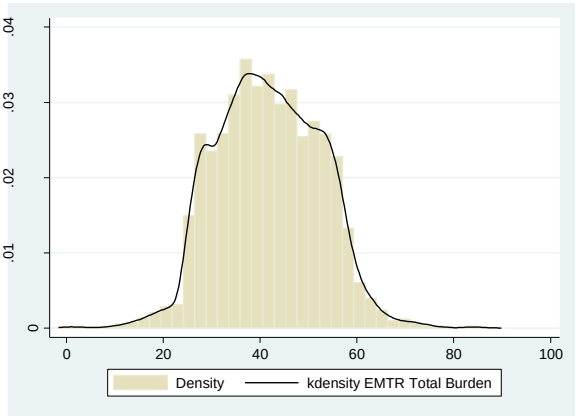
EMTR: 46.6

2011



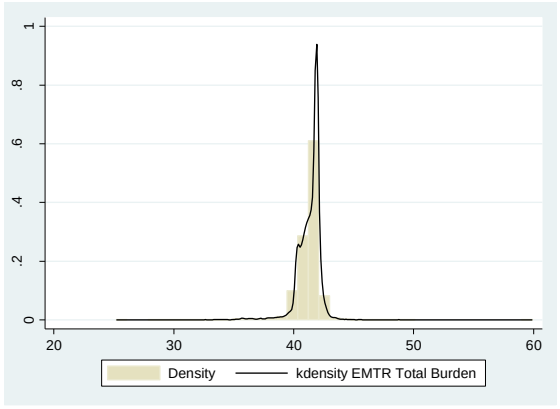
EMTR: 53.5

2008



EMTR: 47.1

2005

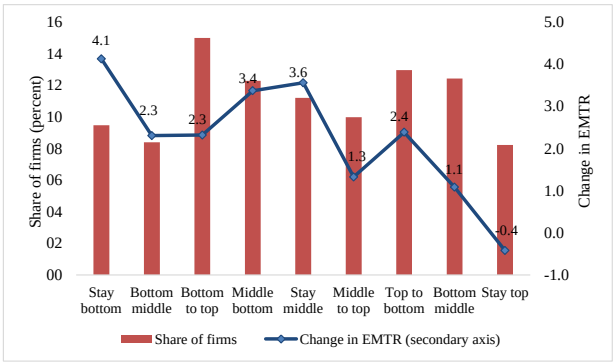


EMTR: 40.0

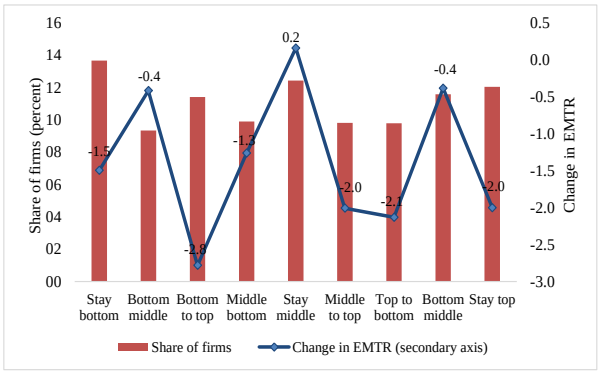
Note: Frequency distributions are plotted by using information of a balanced panel, in order to compare the same firms in the different years.
Source: Authors' calculations

Figure B2: Mechanical variation in EMTR for *the total burden of taxes*

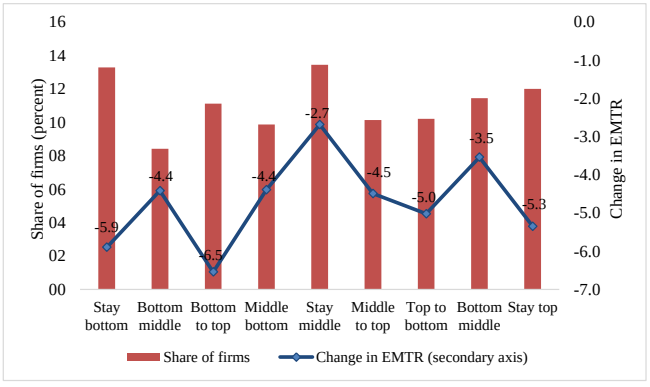
2006 Reform: (2005-2008 Difference)



2009 Reform: (2008-2011 Difference)



2012 Reform: (2011-2014 difference)



Notes: Figure B2 shows the mechanical variation in *EMTRs* (blue lines) due to the 2006-tax reform, the 2009-tax reform and 2012-tax reform, calculated for the total burden of taxes. Each panel shows the three-year differences in *EMTRs*. The sample of firms is split into seven groups using the three year difference in investment: (i) firms that are in the bottom bracket both before and after the reform, (ii) firms moving from the middle to the bottom bracket, (iii) firms moving from the bottom to the middle bracket, (iv) firms that are in the middle bracket both before and after, (v) firms that pass from the top to the middle bracket, (vi) firms that pass from the middle to the top bracket, and (vii) firms that are in the top bracket both before and after the reform. The figure also illustrates the share of firms in each group (red bars).
Source: Authors' calculations.

Table B2: The *total burden taxes* elasticity of investment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Elasticity	-0.5886***	-0.6555***	-0.6374***	-0.4523***	-0.4516***	-0.4525***	-0.5786***	-0.5703***	-0.3600***
	(0.092)	(0.089)	(0.090)	(0.088)	(0.088)	(0.088)	(0.096)	(0.095)	(0.088)
Pre-reform controls									
Splines of *log*-total assets	no	yes	no	no	No	No	no	no	no
Log-total assets			-0.0687***	-0.0816***	-0.0814***	-0.0813***	-0.1689***	-0.5041***	-0.5214***
			(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.025)	(0.024)
Debt ratio				-0.9881***	-0.9840***	-0.9828***	-0.9828***	-1.0194***	-0.4399***
				(0.076)	(0.077)	(0.077)	(0.080)	(0.078)	(0.073)
ROA					-4.051***	-4.050***	-4.9311***	-4.8329***	-3.949***
					(0.933)	(0.933)	(1.044)	(1.055)	(0.7732)
Solvency ratio						0.4590***	0.3891***	0.3746***	0.4592***
						(0.018)	(0.229)	(0.0272)	(0.032)
Log-EBITDA margin							0.1401***	0.1414***	0.1263***
							(0.011)	(0.011)	(0.011)
Tax reforms dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Size dummies	no	no	no	no	no	no	no	yes	yes
Sector dummies	no	no	no	no	no	no	no	no	yes
Tests of endogeneity	1.865	12.350	6.389	0.281	0.283	0.287	0.017	0.455	3.081
	(0.172)	(0.000)	(0.012)	(0.596)	(0.595)	(0.592)	(0.897)	(0.500)	(0.079)
R-squared (1-step)	0.592	0.6105	0.605	0.608	0.608	0.608	0.618	0.6205	0.623
Observations	23,039	23,039	23,039	23,039	23,028	23,027	20,269	20,269	20,269

Notes: Estimates 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 variable of interest is the three-year growth rate in the *EMTR*, instrumented using the three-year growth rate of $\text{Log}\big(EMTR_{t+3}(parametres_t)\big) - \text{Log}\big(EMTR_t(parametres_t)\big)$ "Splines" refer to a flexible piecewise linear functional from with teen components.
***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Table B3: Heterogeneous responses to tax rates (*total burden*)

Interaction terms	*coefficient*	*Rate*
EMTR x 2012 reform	-1,4803***	4,335
	(0,269)	
EMTR x 2009 reform	-0,7098***	2,748
	(0,285)	
EMTR x 2006 reform	1,0447***	0,219
	(0,216)	
EMTR x large firms	0,6936***	0,074
	(0,200)	
EMTR x medium firms	-0,0608	1,110
	(0,166)	
EMTR x small firms	-0,4346***	2,100
	(0,187)	
Pre-reform controls	yes	

Notes: Estimates are based on 2SLS regressions, where standard errors (shown in parentheses) are clustered by firm. The dependent variable in all specifications is the three-year growth rate of investment. The interaction term is calculated as the product between the dummy variable and the simulated *EMTR*. The rate is calculated between the coefficient of the interaction term and the total elasticity (the sum of the elasticity in each regression and the interaction term). A negative rate indicates a more negative elasticity.

***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.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