

Taxation and Economic Growth in Colombia

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Abstract

In this paper we assess for Colombia the impact on investment of a reduction in corporate taxes and the impact on employment, labor formality and growth of a reduction in non-wage labor costs. First, and following Hall and Jorgensen (1967), we estimate an investment function which depends on the user cost of capital, one of whose determinants is the corporate tax rate. Our estimations suggest that a reduction of the corporate tax rate from 33 to 23% –as originally envisioned by the government in early 2012 but finally not included in the reform submitted to Congress– has very different short and long-term effects on investment in machinery & equipment. While the user cost of capital declines 0.9%, investment (excluding the oil & mining sector) increases on impact only 28 bps in relation to GDP, an increase that does not compensate the fiscal cost incurred. In the long term, however, it is likely that the significant boost in investment (of around 5% of GDP) makes such a policy intervention fiscally sustainable. Second, using a computable general equilibrium model calibrated for Colombia, we estimate that the reduction of the “pure tax” component of non-wage labor costs approved in late 2012 is associated with a 0.5% increase in overall employment and, more importantly, with a 1.4% increase in formal sector employment. Our estimations indicate that this is achieved at no fiscal cost since government revenue increases as a result of higher output and employment.

JEL Classification: D58, E22, H30, J32, O5

Keywords: Computable general equilibrium models, investment, user cost of capital, corporate taxation, non-wage labor costs.

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1. Introduction

Despite the fact that the Colombian economy enjoys comparatively low volatility, it has failed to achieve sustained rates of growth above 4.5%. During the last 20 years, there has never been a 5-year period in which average growth has surpassed 5% (Steiner, Clavijo and Salazar, 2009). Structural constraints to sustained growth include poor quality infrastructure, low levels of human capital and probably also distortions and inefficiencies that stem from a highly distorted tax system. Unlike the first two constraints, public policy could in principle improve the tax structure in the short term.

A review of tax policy in Colombia over the past two decades supports the view that the goals of enhancing collections and improving tax administration have taken precedence over fundamental principles such as pursuing economic efficiency and enhancing equity. As Perry (2010) and Steiner and Cañas (2013) point out, this policy has resulted in a combination of distortionary taxes such as a tax on financial transactions (FTT), a wealth tax and very high payroll taxes. On the other hand, a significant portion of the tax burden is paid by companies rather than individuals, presumably affecting business competitiveness and almost certainly compromising progressiveness.² The statutory rate currently paid by corporations is 34%³ and is slightly higher than the regional average of 31% and well above the world average, which has fallen steadily in recent years (Figure 1).

In addition to the distortions coming from the distribution of the tax burden, tax benefits are prominent. While in principle they have been geared towards promoting investment, encourage savings and make the tax system more equitable, in reality they have distorted resource allocation, generated inequalities between sectors and made the tax system much more complex. Needless to say, benefits have a significant fiscal cost. For 2011, the fiscal cost of benefits related to income taxes amounted to 1% of GDP (compared with collections of 5.4% of GDP), while the cost of VAT exemptions reached 2.2% of GDP, compared with collections of 5.7% of

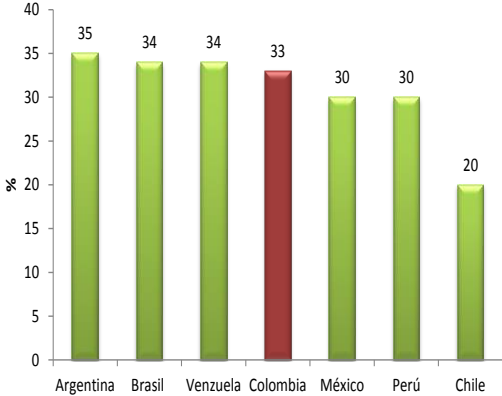
² In 2011 income taxes accounted for 40% of total tax revenues. Regarding income taxes, 34 percentage points (or 4.7% of GDP) was contributed by companies and only 6pp (0.8% of GDP) by individuals.

³ It was 33% until 2012, and was established in relation to taxable income (i.e. profits less several exemptions). It was recently hiked to 34%, in two tranches: (i) 25% on taxable income which funds the government's general budget; (ii) 9% on profits, which funds social security.

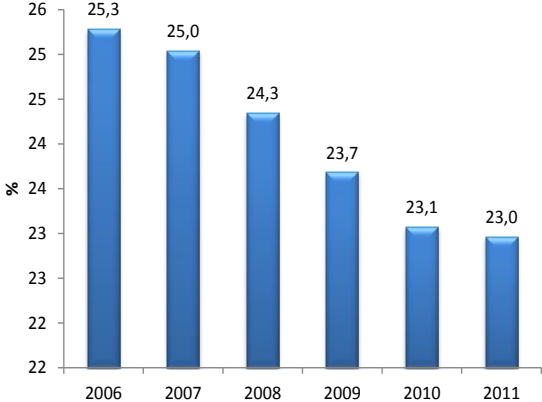
GDP (Ministry of Finance, 2012). It is no surprise therefore that tax productivity in Colombia is very low in comparative terms (Figure 2).

Figure 1. Income Tax Rates

a. Maximum income tax rate in Latin America, 2011



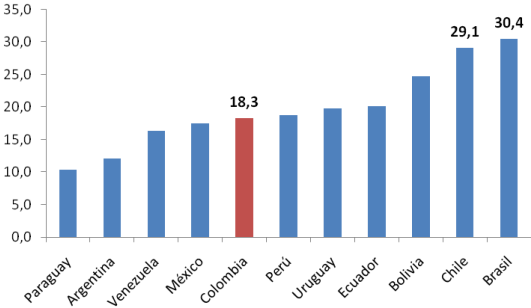
b. Average income tax rate throughout the world, 2006-2011



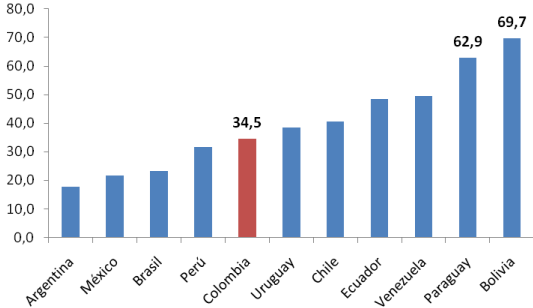
Source: KPMG International, Corporate and Indirect Tax Survey (2011).

Figure 2. Tax Productivity (2009)

a. Income tax productivity



b. VAT productivity



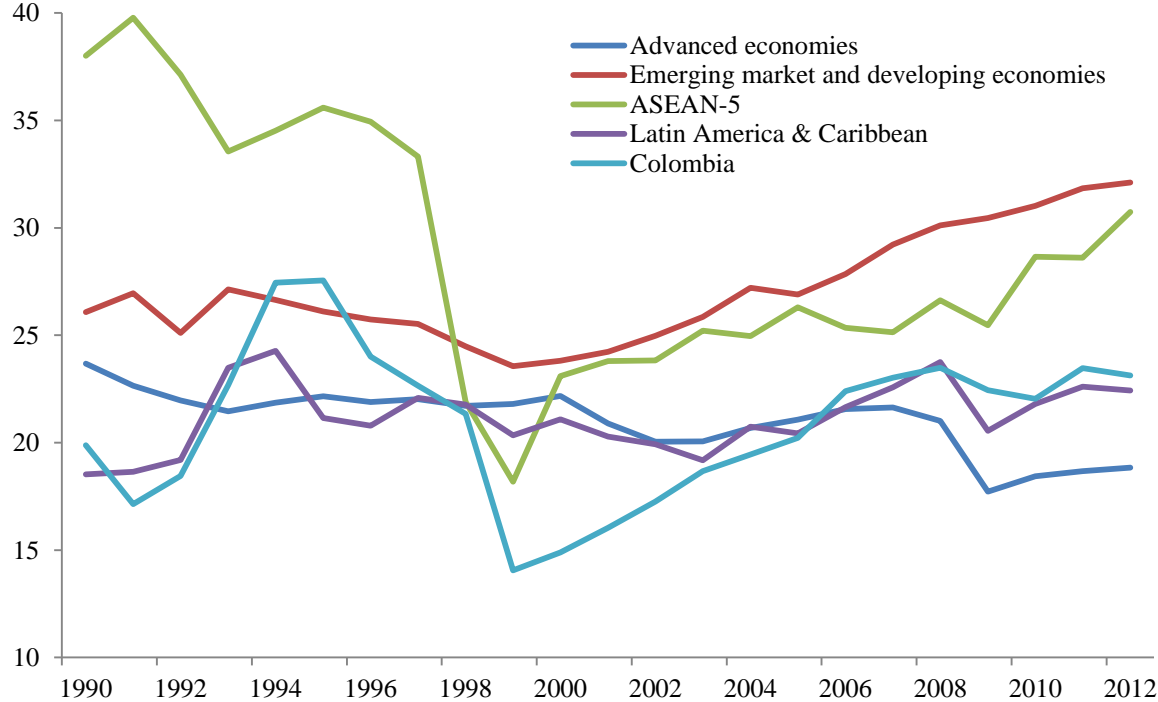
Source: ECLAC.

In this paper we explore the likely effects on economic activity of changes to the tax code. The paper has four sections, including this introduction. In the second section we estimate the impact on private investment of reducing the corporate income tax, following the methodology outlined by Hall and Jorgenson (1967). In the third section we estimate the impact on employment and labor informality of reducing non-wage labor costs using a Computable General Equilibrium Model. In the fourth section we conclude and present some policy recommendations.

2. The impact on investment of reducing the corporate income tax

Investment in Colombia has increased in the last twelve years, in line with developments in most emerging markets (Figure 3). Although Colombia has not reached the average level of investment of emerging economies, it is now close to the Latin American average. This after a major collapse of investment in the second half of the 1990s.

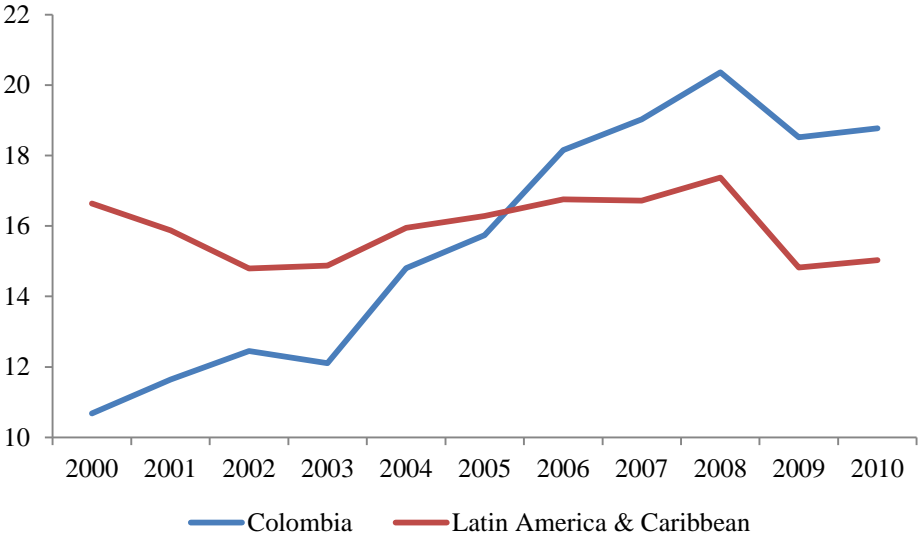
Figure 3: Total Investment (% of GDP)



Source: WEO, IMF October 2012.

With regard to private investment, it has recovered from 10% of GDP in early 2000 to 18% in 2010 (Figure 4). Private investment (as a % of GDP) in Colombia is now higher than the Latin American average (which has hovered around 15%).

Figure 4: Gross Fixed Capital Formation, Private Sector (% of GDP)

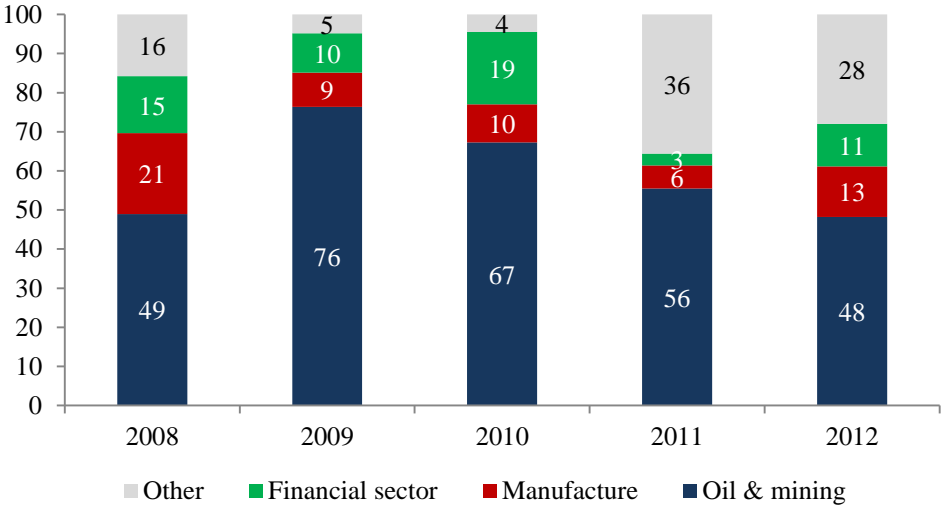


Source: Finance Minister for Colombia and World Bank.

This recovery in both total investment and private investment presumably is related to four factors. First, the huge boost of the oil & mining sector, in turn driven by regulatory changes, high commodities prices, relatively low “government take” and a significant improvement in security conditions. Second, the general recovery of the world economy, in particular for emerging economies, that came after the crisis at the end of the 1990s. Third, the improvement of security conditions not only affected oil and mining, but business in general as well, including prominently agriculture and transportation. Finally, the tax stimulus arising from the possibility, established in 2004 and eliminated in 2010, of discounting 30% (and then 40%) of purchases of fixed assets from corporate tax obligations. Of course, these four factors may be interrelated. In what follows we provide some detail with regard to the surge in oil and mining, to enhanced security conditions and to changes in the tax regime.

Investment in oil and mining has surged in Colombia in the recent years. For example, a very high proportion of FDI is directed to oil and mining (Figure 5). In 2009, for example, it reached 76%. To a great extent, this investment boost in oil and mining has been associated with a comprehensive regulatory reform that took place in 2003. Until then, the state-run oil company (Ecopetrol) was both the policy-maker and the main producer, mainly through association contracts, and was fully owned by the government. In 2003 the National Hydrocarbons Agency (ANH, acronym in Spanish) was established as the policy-making body, Ecopetrol was forced to compete with other (mainly foreign companies) in a level-playing field, concession contracts were re-instated and a minority stake in Ecopetrol was put in private hands (Perry *et al.*, 2010). As a consequence, between 2003 and 2010 exploratory wells initiated in each year increased from 28 to 112, oil production increased from 541 kbpd to 785 kbpd and FDI in oil surged from US\$278 million to US\$2.8 billion.

Figure 5: FDI in Colombia
(%)



Source: Banco de la República de Colombia.

Despite these innovations in the regulatory system, it is quite likely that the investment boom in oil would not have materialized had it not been for the surge in oil prices, and in commodity prices in general. For instance, the WTI price went from US\$31 per barrel in 2003 to US\$80 in

2010 while the price of thermal coal went from US\$27 per ton to US\$77 USD in the same period. Colombian coal production expanded from 39 million tons in 2002 to 85 million in 2011.

Enhanced security conditions have benefitted all sectors of the Colombian economy, but probably the oil & mining sector has been the main beneficiary. A 2012-13 survey of mining companies by the Fraser Institute the main factor that discourages mining companies in Colombia is the security situation, followed by the uncertainty over which areas will be protected and by the legal system. Interestingly, the tax regime ranks 18th out of 19 possible factors. This is consistent with the fact that Colombia's government does not get to keep a very high portion of the benefits stemming from this sector.

Table 1 reports the “fiscal take” per barrel calculated as the average portion of the price appropriated by the government (Manzano and Monaldi, 2008). Colombia's “government take” was the second lowest after Bolivia's and much lower than in Venezuela, Ecuador or Mexico.

Table 1: Fiscal Take per Barrel
(Percentage of international price)

Country	1996-98	1999-2001	2002-04
WTI (dollars per barrel)	19	25.1	32.9
Argentina	No data	20	24
Bolivia	37	24	15
Colombia	22	21	22
Ecuador	66	46	51
México	42	38	52
Trinidad y Tobago	37	16	23
Venezuela	51	47	53

Source: Manzano and Monaldi (2008).

Another factor that may have led to an increase in total investment is the much improved security situation. Between 2002 and 2006 homicides declined 39%, blackmail & kidnapping 83% and terrorist attacks 61%. This trend is associated with an increase in defense and security spending, which went from 4.2% of GDP in 1998 to 5.3% in 2007 (Ministerio de Defensa Nacional, 2009). Experts claim that this additional expenditure came hand in hand with major improvements in efficiency.

Finally, the positive dynamics of private investment during the last decade might be associated with tax policy. In order to encourage private investment, in 2004 the government approved an exemption on income tax of 30% for purchases of machinery and equipment. This exemption was raised to 40% in 2006 and eliminated in 2010, because of fiscal considerations. After controlling for year effects (i.e. capturing macroeconomic conditions and capital flows), Galindo and Meléndez (2013) were not able to identify a positive effect of this tax benefit on private investment. To the best of our knowledge, this is the only rigorous evaluation of this policy intervention, which to a certain extent we replicate in what follows.

In order to assess the impact of changes in the corporate income tax rate on investment, in the following sections we proceed as follows. First, we derive and explain the concept of the user cost of capital. Second, we calculate each of the several components of the user cost, for two different types of investment goods (machinery & equipment and construction, which is a non-tradable concept that does not include civil works and housing). Third, for each type of investment good we estimate an investment function which depends on the user cost which, *inter alia*, depends on the corporate rate of taxation.

a) The user cost of capital

The user cost of capital has been a topic of special interest given its strong relationship with investment. Jorgenson and Hall (1967) provided the first theoretical development of this concept, which has been extensively used in the case of Colombia.⁴ Following Coen (1968), the user cost of capital (C) is obtained by way of maximizing profits and is defined as⁵:

⁴ Fainboim (1990) developed the first series of the user cost for Colombia, covering the 1950-1987 period. Cárdenas and Olivera (1995) disaggregated the variable into three effects: relative price of capital, real discount rate and taxes. Steiner and Soto (1998) analyzed a 1996 representative sample of companies from the Superintendency of Companies and estimated the user cost of capital differentiating by type and source of funding. Pombo (1999) estimated the user cost for the manufacturing sector by type of capital good for the 1970-1995 period. More recently, Rhenals (2005) started from the maximization of benefits and took into consideration the concept of funding sources. Finally, Botero *et al* (2007) followed the methodology proposed by Cardenas and Olivera and estimated the user cost during 1990-2007.

⁵ In Appendix 1 we derive this equation.

$$C = \frac{P^I}{P} \left(i + \delta - \frac{\Delta P^I}{P^I} \right) \frac{1 - k - \tau z}{1 - \tau} \quad (1)$$

where P^I is the price index of investment goods, P the producer price index, δ the depreciation rate, $\Delta P^I/P^I$ the P^I rate of growth, k are investment tax credits, τ the corporate income tax, z the present value of deductions for depreciation and i the nominal rate of interest. The user cost can be broadly understood as having three components:

- i. The relative price of capital goods P^I/P : since most investment goods are tradable and the producer price index includes non-tradable goods, an appreciation of the exchange rate generally reduces the user cost of capital.
- ii. The effective discount rate $(i + \delta - \Delta P^I/P^I)$: an increase in the nominal interest rate or in the rate of depreciation implies a higher cost of capital, while the relative appreciation of capital goods reduces C .
- iii. The tax effect $((1 - k - \tau z)/(1 - \tau))$: the user cost of capital increases whenever the corporate income tax rate (τ) increases or when tax credits on investment decline.

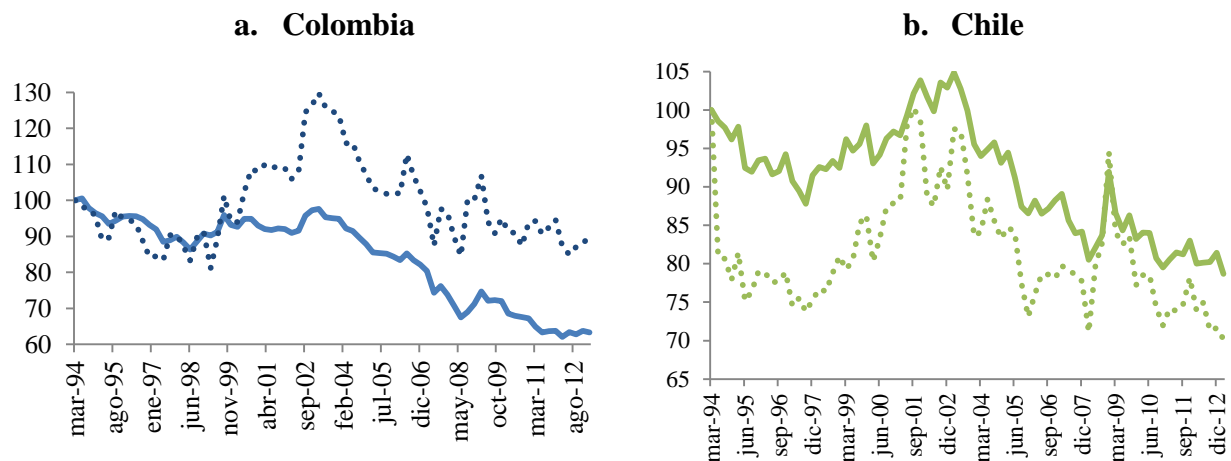
In what follows we estimate the main components of the user costs of capital in Colombia, for machinery & equipment and construction, using quarterly data for the 1990:Q1 - 2012:Q4 period. In Appendix 2 we provide a definition of all the variables we have employed, including their sources.

i. The relative price of capital goods

Figure 6 shows the PPI series, the series for the investment goods component of the PPI and the relative price of investment goods (P^I/P). We highlight the fact that between 2003 and 2012 the relative price of investment goods declined by 35%, in tandem with the appreciation of the currency.⁶ This trend is similar to the one in Chile, where both the relative price of investment goods and the real exchange rate (REER) have also declined steadily since 2001.

⁶ The peso/dollar exchange rate went from 2958 at the beginning of 2003 to 1768 at end 2012, a nominal appreciation of 40%.

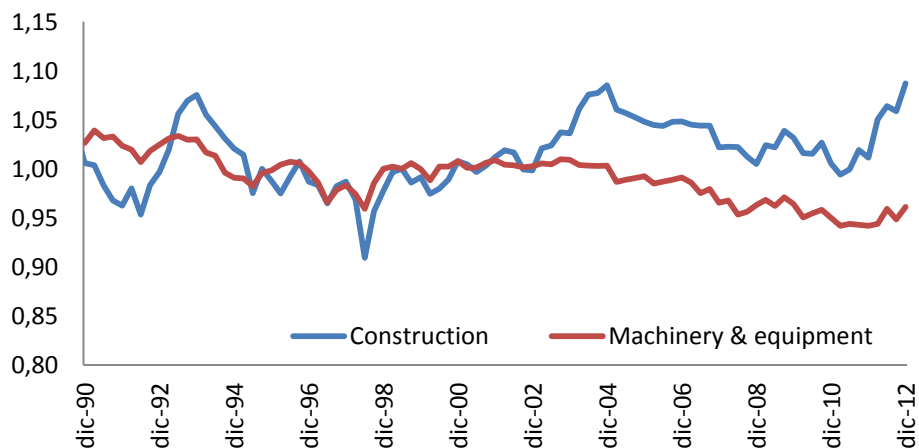
Figure 6: Peru and Chile: P^I/P and REER



Source: Our estimations based on Banco Central de Chile and Banco de la República. Solid lines represent P^I/P , dashed lines represent the real exchange rate index.

Figure 7 shows the relative prices of investment goods for the two kinds of investment goods under study (machinery & equipment and construction).⁷ Since 2002, when an important appreciation process began, the relative price of machinery & equipment has declined while the relative price of capital goods for construction has fluctuated quite significantly.

Figure 7 : P^I/P for machinery & equipment and construction



Source: Our calculations based on Dane.

⁷ P is the overall Producer Price Index estimated by DANE. The price index for construction capital goods is proxied by the price index for construction materials; the price index for machinery & equipment capital goods is proxied by the price index for all capital goods.

ii. The effective discount rate

Figure 8 presents the series for the nominal rate of interest –the fixed interest rate on 90-day CDs issued by commercial banks. This rate experienced a major decline at the end of 90s, very much associated with a sharp decline in inflation, which went from 32% in 1990 to 4% in 2006.

Figure 8: Nominal Interest Rate i
(%)



Source: Banco de la República

We use a different depreciation rate for each type of capital goods (8% for machinery & equipment, and 2.5% for construction) to estimate the different user costs. The recent surge of the aggregate depreciation rate (computing stocks for each type of capital) is due to the increased importance of investment in transport equipment and in machinery & equipment (Table 2), which have a higher depreciation rate.

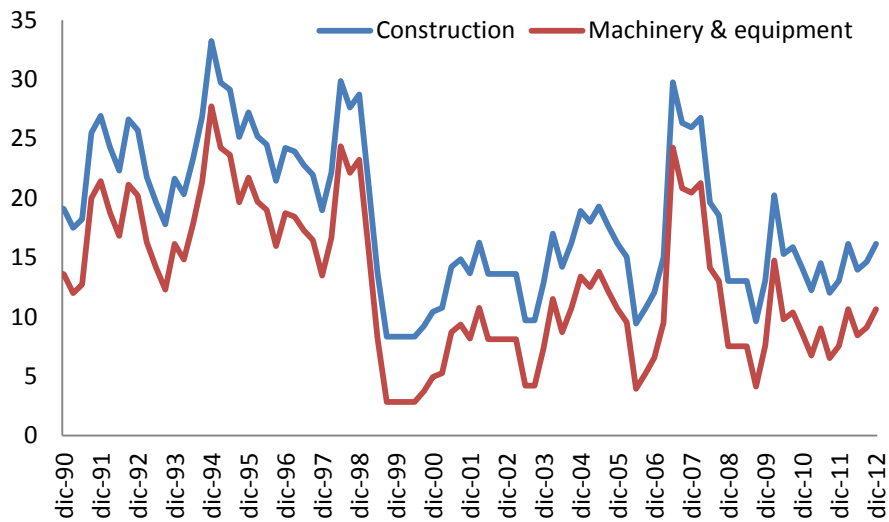
Table 2: Gross Investment by Type of Capital Good
(%)

	Agriculture	Machinery & equipment	Transport equipment	Construction	Civil works	Services
2001-2004	3.8	23.0	8.1	31.6	31.1	2.5
2005-2007	2.8	27.3	10.8	30.1	27.0	2.0
2008-2010	2.4	29.6	11.0	27.3	28.0	1.7
2011-2012	2.1	31.6	13.8	22.4	28.6	1.5

Source: DANE.

We use the above information regarding the nominal interest rate, the rate of change of the price of investment and the depreciation rate to estimate the effective discount rate for each type of investment good (Figure 9).

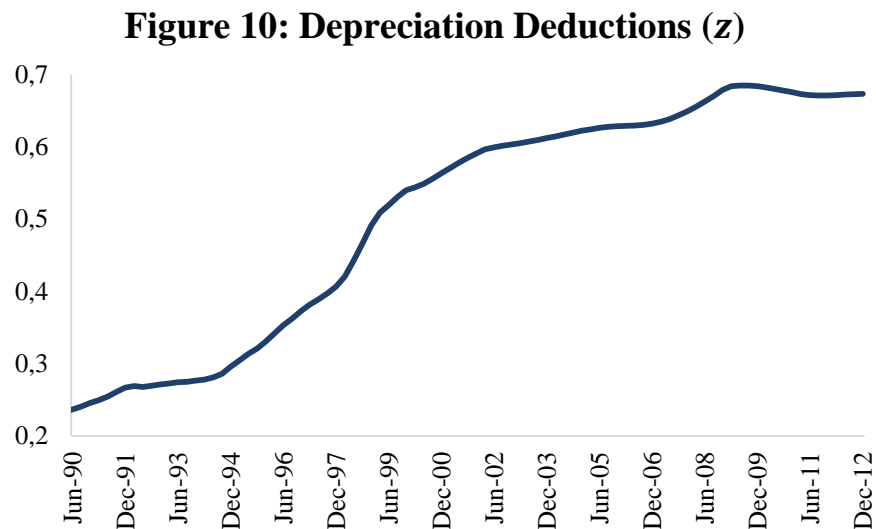
Figure 9: Effective Discount Rate
(%)



Source: Author's calculations.

iii. Tax component

Depreciation deductions have increased in the last twenty years (Figure 10). These are calculated as the discounted value of depreciation charges stemming from a current peso of capital expenditures. Lower interest rates explain the increase in these deductions since discounting by lower interest rates implies a higher present value of depreciations.

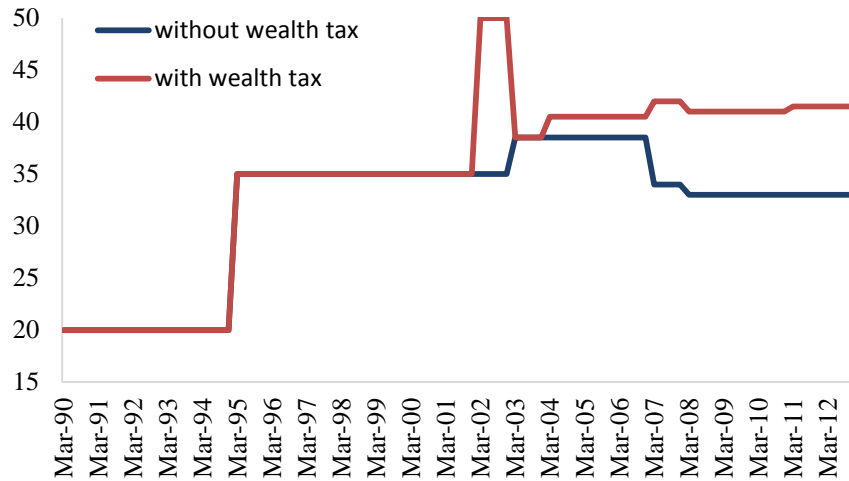


Source: Our calculations.

Figure 11 reports the series for the corporate tax rate, including the wealth tax and without it. In 2002 a wealth tax both on individuals and on corporations was introduced. Although based on a corporations net worth, it is paid out of current revenue and is equivalent to a higher corporate tax rate. In order to find the “income tax equivalent” of the net worth tax, we assume that net income is one tenth of corporate wealth. Originally, a rate tax of 0.3% was imposed for wealth over 3 billion pesos (US\$ 1.6 million). In 2007 this rate was increased to 1.2%⁸.

⁸ In 2010, due to an unusual rainy season, both the base and the rate were expanded to include individual wealth over 1 billion pesos (0.55 million dollars) and a tax rate of 3% for wealth over 3 billion pesos.

Figure 11: Corporate Tax Rate (τ)



Source: DIAN.

As in many other countries, there is an important difference between the statutory corporate tax rate and the effective tax rate paid by corporations. This on account of an array of tax benefits and exemptions which vary according to economic sector, firm size and even geographic location. Using data for 2011, Steiner and Cañas (2013) estimated that the effective rate of corporate taxation was 28.2%, with significant variation across sectors –ranging from 19.1% in the case of other services to 32.1% for mining. The effective rate of taxation was 27.3% in manufacturing and 29% in construction. These rates are in comparison to the 33% statutory rate.

In Colombia there are four different types of tax benefits (Steiner and Cañas, 2013). First, there are certain revenues -- including dividends and shares in companies and the capitalization of profits – which do not constitute taxable income. Second, there are many tax deductions, the one for investment in real fixed assets in place between 2003 and 2010 being the most important in recent history⁹. Third, there are several tax exemptions¹⁰. Finally, there are tax discounts¹¹. Since Colombia’s tax regime has a plethora of tax benefits which vary significantly in time and not

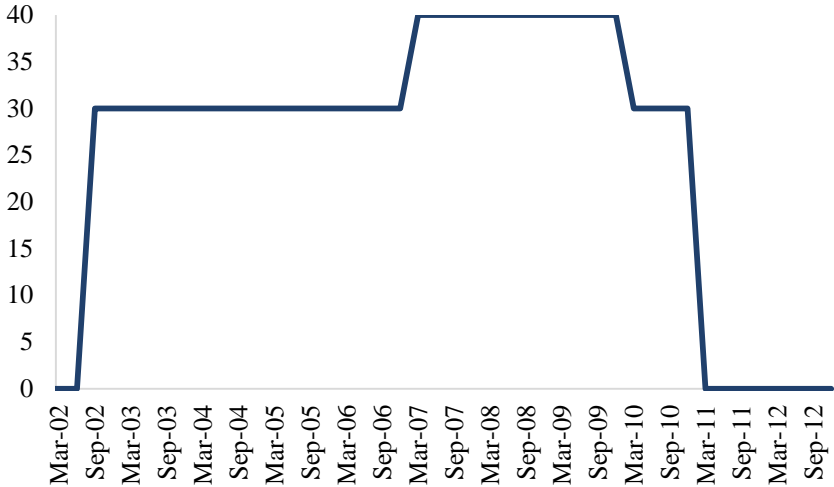
⁹ Other important deductions are related to scientific research and investment projects in agriculture.

¹⁰ Including services to build or remodel hotels in place since 2002, the sale of electricity generated with wind, biomass or other agricultural resources, and interest received on government bonds.

¹¹ For example, discounts related to the payment of sales tax on imports of industrial machinery for basic industries, discounts for portfolio investment in agriculture stocks, and discounts of 40% of the value of investments undertaken by utilities.

only by sector but also by firm, it is simply not feasible to consider them in a time series econometric framework. Nevertheless, we do consider the very important deduction for investment in machinery & equipment given in 2003, because it is straight forward and simple to include in our framework (Figure 12). This exemption was removed in 2010.

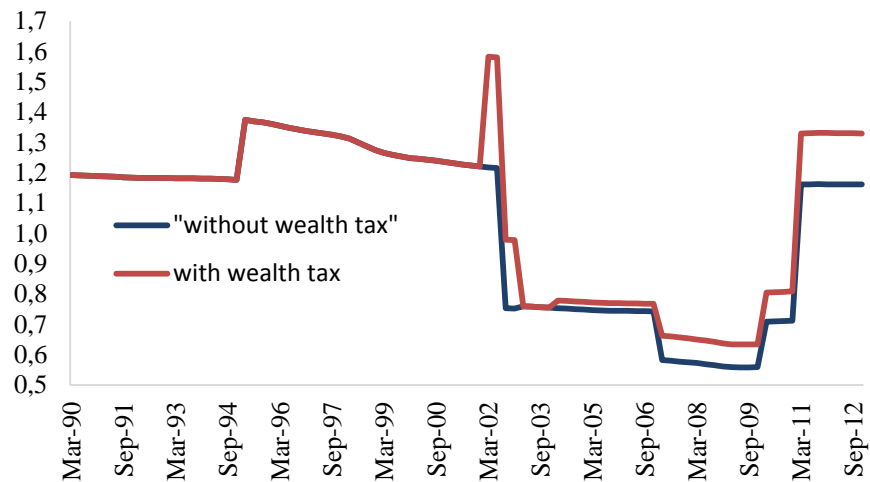
Figure 12: Tax Investment Credits (k) (%)



Source: Law 863 (2003), Law 1111 (2006), Law 1370 (2009) and Law 1430 (2010).

Figure 13 shows the tax component of the user cost with and without considering the wealth tax. This component was relatively stable in the 90s while tax credits had a significant impact during 2002-2010.

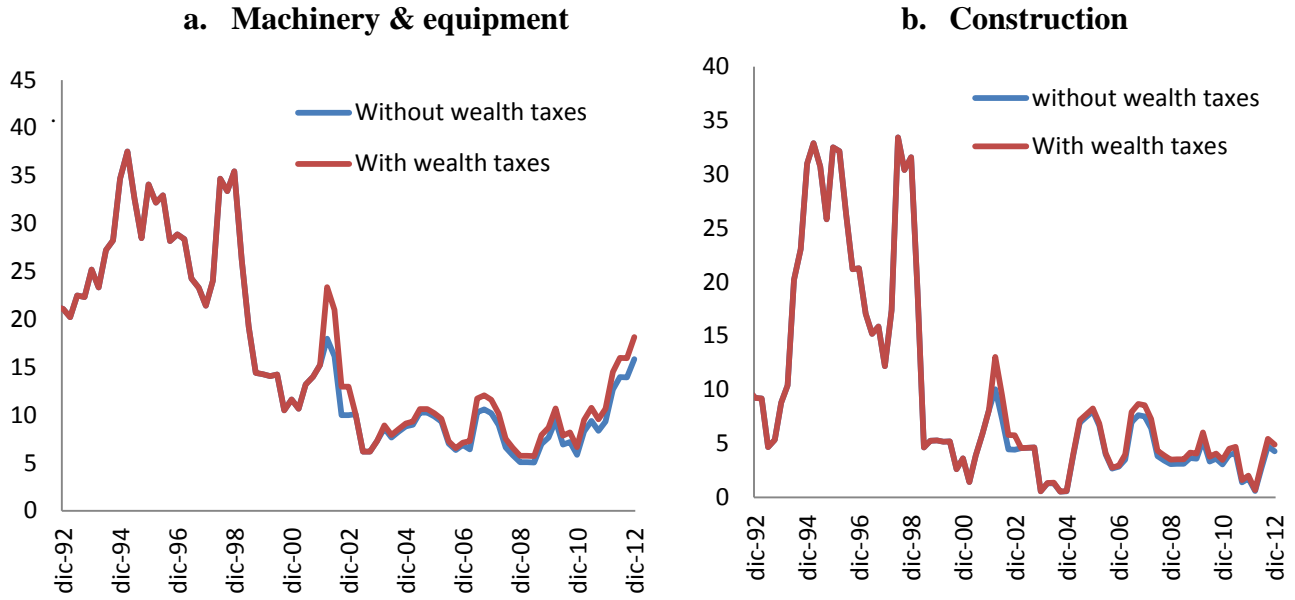
Figure 13: Tax Component of the User Cost of Capital



Source: Our calculations.

Finally, using equation (1) we are able to calculate the user costs of capital (Figure 14). It remained high though unstable between 1990 and 1997 and declined sharply in the late 1990s, in tandem with the reduction in interest rates. After 2000 the volatility in the user costs of capital is associated with fluctuations in exchange rates and changes in tax regulations, given the relative stability of interest rates. Despite the fact that in recent years the peso appreciation has contributed to the reduction in the relative price of capital goods (for machinery & equipment and construction), this has been offset by the introduction of a wealth tax and the elimination of tax deductions for investment.

Figure 14: User Cost of Capital (%)



Source: Our calculations.

b) Investment model

Following Hall and Jorgenson (1967) and under the assumption of a constant depreciation rate, a firm's investment function adopts the form:

$$I_t = \sum_{s=0}^{\infty} \mu_s \Delta K_{t-s}^* + \delta K_t \quad (2)$$

Gross investment is the weighted sum of past changes in the optimal capital and the depreciation. This equation can be written in terms of net investment (N_t) as:

$$N_t = I_t - \delta K_t = \sum_{s=0}^{\infty} \mu_s \Delta K_{t-s}^* \quad (3)$$

Taking the first two terms of $\{\mu_s\}$ as arbitrary and the remaining as a geometric sequence, the final form of the function is:

$$N_t = \gamma_0 \Delta K_t^* - \omega N_{t-1} \quad (4)$$

Where γ_0 , and ω are parameters which characterized the $\{\mu_s\}$ sequence. For a Cobb-Douglas technology the optimal level of capital can be written as follows

$$K_t^* = \alpha \frac{Y_t}{C_t} \quad (5)$$

Where α is the elasticity of output with respect to capital. If we replace (5) in (4) and include an error term, we can obtain:

$$N_t = \alpha \gamma_0 \Delta \frac{Y_t}{C_t} - \omega N_{t-1} + \epsilon_t \quad (6)$$

Where ϵ_t is an i.i.d. error term. Note that in estimating (6) we are implicitly incorporating lags of $\Delta \frac{Y_t}{C_t}$.

In sum, investment depends on the optimal capital stock and its past changes. This in turn depends on output, the user cost of capital and technological parameters. The effect of the tax structure enters into the investment function through the user cost. A change in tax rates affects the user cost and therefore the optimal level of capital. An adjustment in net investment is needed to reach this optimal capital stock (Hall and Jorgenson, 1967).

c) Investment functions estimations

In this subsection we present the estimations of the investment equation for Colombia using quarterly data for 1990-2012. Recent studies on the determinants of investment include for Villegas (2009), Botero *et al.* (2007) and Posada (2010). Using a dynamic data model at the firm level with a sample of 17,396 observations for the period 1995-2007, Villegas (2009) estimates that for every 1pp increase in the user cost of capital, firm-level investment declines 8pp. This effect is large and significant. According to Botero *et al.* (2007), a 10pp increase in the user cost of capital causes a 1pp decline in investment. On the other hand, Posada (2010) found no relationship between the user cost and investment, although this is likely due to specification

problems since the set of regressors includes, along with the user cost, the real rate of interest. None of these studies isolate the effect on investment of changes in the corporate tax rate.

Table 3 presents the estimation of Equation (6), with net investment in machinery & equipment (columns (1) and (2)) and construction (columns (3) and (4)) as the dependent variables. These series come from DANE's national accounts database. Our series on construction does not include civil works and housing. Investment on machinery and equipment and construction each account for 8.6% of GDP. The user costs were constructed in two ways: (i) without considering the wealth tax (C_{1t}) and including the wealth tax (C_{2t}) according to equation (1) from the previous section for each type of investment goods. Y_t was approximated with the real GDP series from the National Accounts DANE.

Equation (6) was estimated using OLS for time series data without a constant as specified by this equation. When net investment in machinery & equipment is used as dependent variable (columns (1) and (2)), the current value of the optimal capital is positive and significant at the 5% level of significance, while the lag is not significant. These results are robust when we take into account the user cost without the wealth tax (column 1) or with the wealth tax (column 2). In general, the sensitivity of net investment to the user cost of capital is always negative,¹² but it is not a constant since it depends on the level of the latter. That being the case, the coefficient cannot be interpreted as an elasticity (or a semi-elasticity). Despite this fact, we are able to estimate this sensitivity for the end of our sample, given the level of the user cost of capital at that point in time.¹³ On the other hand, when investment in construction is used as the dependent variable, the only variable that is significant is the lag of net investment. This result suggests that neither the user cost nor its determinants –i.e. the relative price of investment goods, the discount rate and the tax regime – are relevant explanatory variables.

¹² For an increase in one unit of the user cost of capital, net investment increases by $-0.72/C_t^2$ where C_t is the current level of the user cost.

¹³ The positive and significant coefficient of lagged net investment shows the well-known positive serial correlation in the investment series.

Table 3: Investment function with different user costs

	-1	-2	-3	-4
VARIABLES	Machinery & equipment		Construction	
$\Delta(Y_t/C_{1,t})$	0.6034** (0.3148)		-0.0003 (0.028)	
$\Delta(Y_t/C_{2,t})$		0.6743** (0.341)		0.000006 (0.003)
N_{t-1}	0.9559*** (0.0390)	0.9568*** (0.039)	0.9962*** (0.017)	0.9962*** (0.017)
Observations	91	91	91	91
R-squared	0.8708	0.871	0.984	0.984

Source: Our calculations.

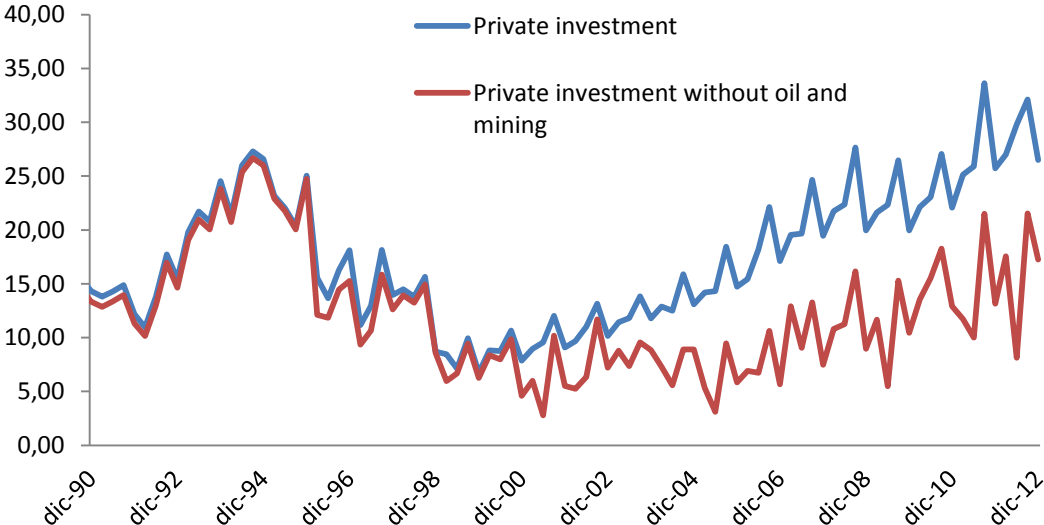
Note: Standard errors are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

The results reported in Table 3 refer to investment in two types of capital goods undertaken by the aggregate of all sectors in the economy. It is of interest to undertake additional estimations in which investment undertaken by firms operating in the oil & mining sectors is excluded. After all, the determinants of investment in these two activities have very specific determinants, including the price of commodities and, more importantly, a complex tax regime (including royalties) in which the corporate income tax is only one of its components.

This exclusion is not straightforward, given that the DANE database on investment is not presented on a sectoral basis. The procedure we followed starts with information on the US dollar value of foreign direct investment in oil & mining as reported by Banco de la República. This is transformed into pesos using market exchange rates and then converted to constant 1975 pesos using the CPI as deflator. Since in principle this new series is comparable to the private investment series in DANEs National Accounts, we have excluded from each type of investment

our estimate of investment in oil & mining (Figure 15). The results, reported in Table 4, are broadly similar to those reported for investment without excluding the oil & mining sector. The coefficient for the Y/C term is now smaller, thereby implying that investment in machinery & equipment is now slightly more sensitive to changes in the user cost of capital (and to changes in taxes as well).

Figure 15: Investment excluding oil & mining sectors
(COP billion, 1975 pesos)



Source: Our estimates based on DNP, DANE and Banco de la República.

Table 4: Investment function excluding oil & mining¹⁴

	-1	-2	-3	-4
VARIABLES		Machinery & equipment		Construction
$\Delta(Y_t/C_{1,t})$	0.5174*		0.008	
	(0.2153)		(0.011)	
$\Delta(Y_t/C_{2,t})$		0.559*		0.0002
		(0.234)		(0.0022)
N_{t-1}	0.946***	0.946***	0.9855***	0.9855***
	(0.0452)	(0.045)	(0.018)	(0.017)
Observations	91	91	91	91
R-squared	0.8308	0.8307	0.9707	0.9708

Source: Author's calculations.

Note: Standard errors are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

d) Impact on investment of a decline in corporate income taxes

Using the sensitivity parameter estimated above, we now calculate the impact on investment in machinery & equipment (excluding the oil & mining sector) of a reduction in the corporate income tax rate. In our exercise, the tax rate falls from 33% to 23% as of the first quarter of 2013, while all other variables remain constant. This change in corporate taxes reduces the user cost of capital by 0.9% and has a positive *impact effect* on investment (excluding oil & mining) of 1.37% (equivalent to 0.28% of GDP on a yearly basis). Given the large coefficient of the autoregressive term, the *long-term effect* on investment is much higher (i.e. around 5.2% of GDP).

¹⁴ We take into account the user cost without considering the wealth tax (col. 1) and with the wealth tax (col. 2).

On the other hand, a reduction in the corporate income tax from 33% to 23% brings about, *ceteris paribus*, a 0.395% of GDP decline in tax collections for 1Q2013, equivalent to a decline of 1.58% of GDP on a yearly basis. Evidently, while the reform is costly in the short-term, it is quite likely to pay for itself in the long term.

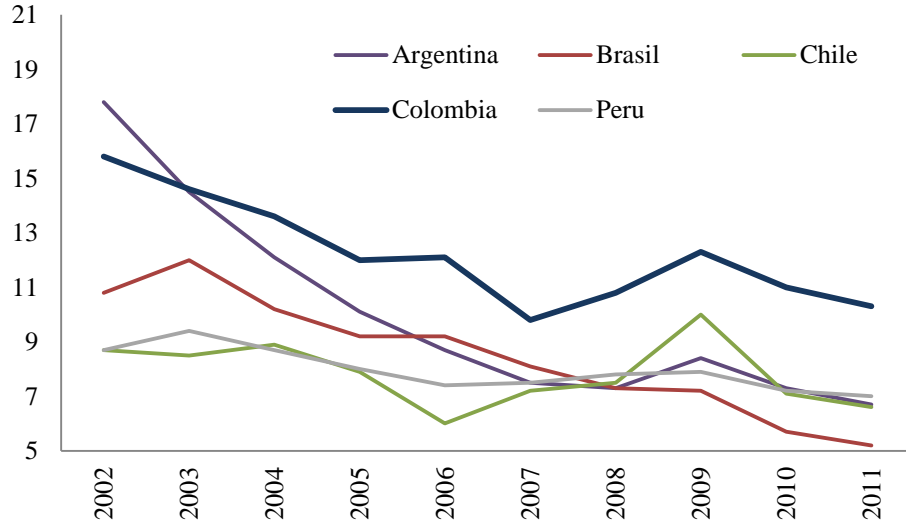
3. The impact on employment of lowering payroll taxes

This section is divided into three subsections. We first provide some stylized facts regarding Colombia's highly distorted labor market. Second, we highlight the main features of the model to be used in the simulations. Finally, the third section presents the simulations results.

a) Colombia's labor market

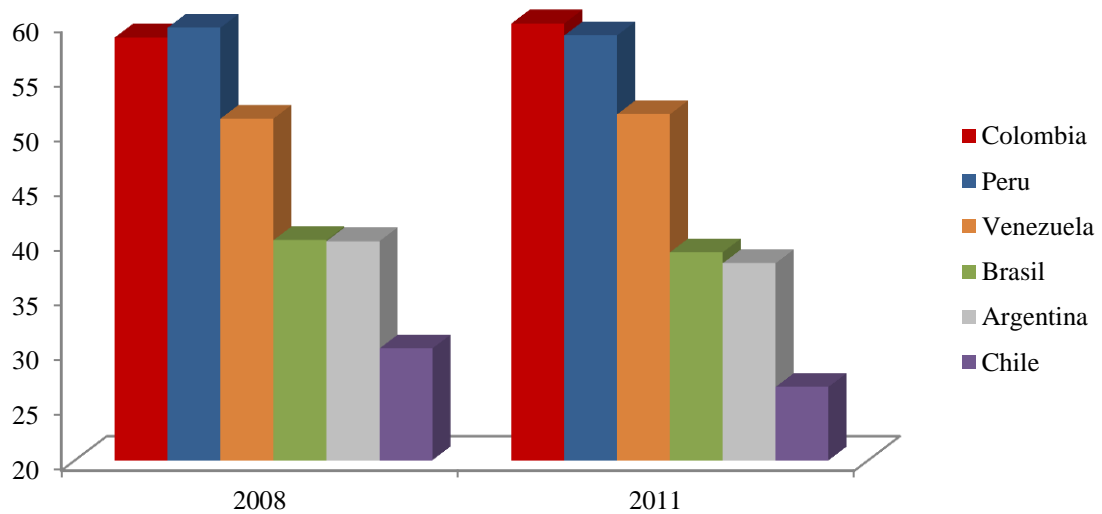
Colombia's unemployment rate is the highest in the region, in spite of the fact that GDP growth in Colombia is generally better than the regional average. In December 2011 unemployment in Colombia was 10.3%, while the regional average was less than 7% (Figure 16). On the other hand, labor informality is among the highest in the region (Figure 17). Reasonably solid growth and timid institutional and regulatory changes have done little to improve the quality of labor outcomes.

Figure 16: Unemployment Rate (%)



Source: ECLAC and author's calculations.

Figure 17: Urban employed in low-productivity sectors (informal sector) (% total population employed)

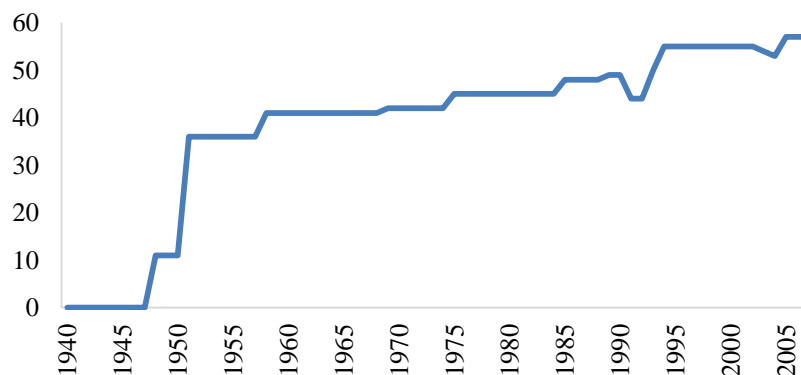


Source: ECLAC

In Colombia non-wage labor costs –i.e. charges paid by the employer other than direct compensation-- represent between 60 and 70% of wages (Figure 18). A portion of these charges,

equivalent to maybe 14% of wages¹⁵, do not provide direct benefits to the worker and are therefore considered to be a "pure tax".¹⁶ These non-wage labor costs are associated with greater labor informality, less formal employment and lower wages (Kugler & Kugler, 2009). These costs affects the labor market both from the point of view of the supply curve (there exist higher hiring costs) and the demand curve (workers have greater incentives to evade these charges by involving themselves in informal activities).

Figure 18: Non-wage labor costs
(% of payroll)



Source: Santa María *et al.* (2010)

According to Santa Maria *et al* (2010), informality is a result of exclusion and escape processes. On one hand, exclusion is driven by the segmentation of the labor market, which prevents the migration of lower-skilled workers to the formal sector. On the other hand, small firms have incentives to keep workers in informal agreements or contracts, as they evade taxes that they would have to pay in the formal sector. Therefore, escape processes are the result of a cost-benefit analysis made by agents in connection with the enforcement capacity of the State. Nonwage costs generate a perverse cyclical effect on the labor market. An increase in payroll taxes encourages informality, especially via escape processes. This reduces the tax base and,

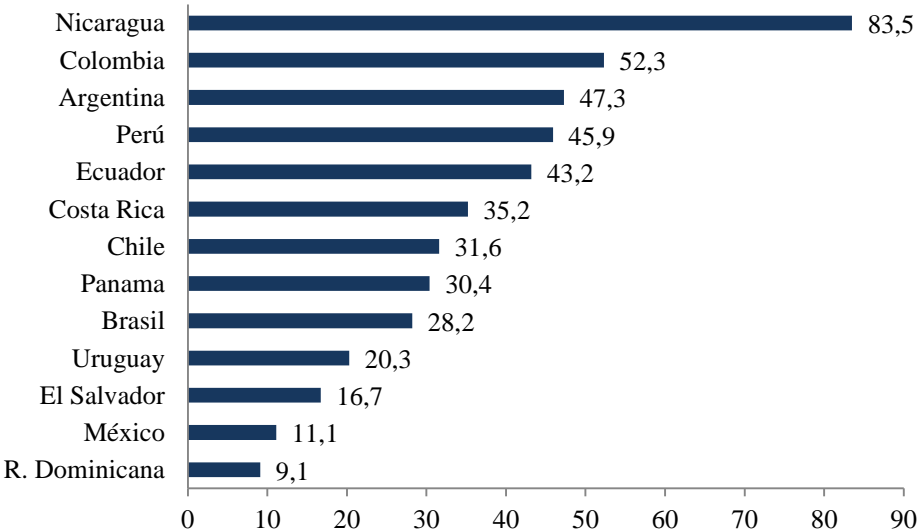
¹⁵ This include a 2% charge (over wages) to finance the national vocational education program (SENA); 4% to fund a privately operated system that provides services and transfers resources to formally employed workers and their families (Cajas de Compensación Familiar, CCF); 3% to fund the family welfare fund (ICBF); and between 1.2% and 3.5% as solidarity within the health and pension systems. The first three components, adding up to 9%, are the so-called parafiscales (i.e. earmarked quasi-taxes).

¹⁶ The bulk of non-wage labor costs are contributions to the pension and health systems, which private direct benefits to the worker in whose name the contribution is made. These costs are part of a worker's compensation package and, therefore, are not "pure taxes".

therefore, fewer resources are generated. To cope with this deficit, an increase in the tax rate is decreed, which repeats the cycle at the expense of ever higher levels of informality.

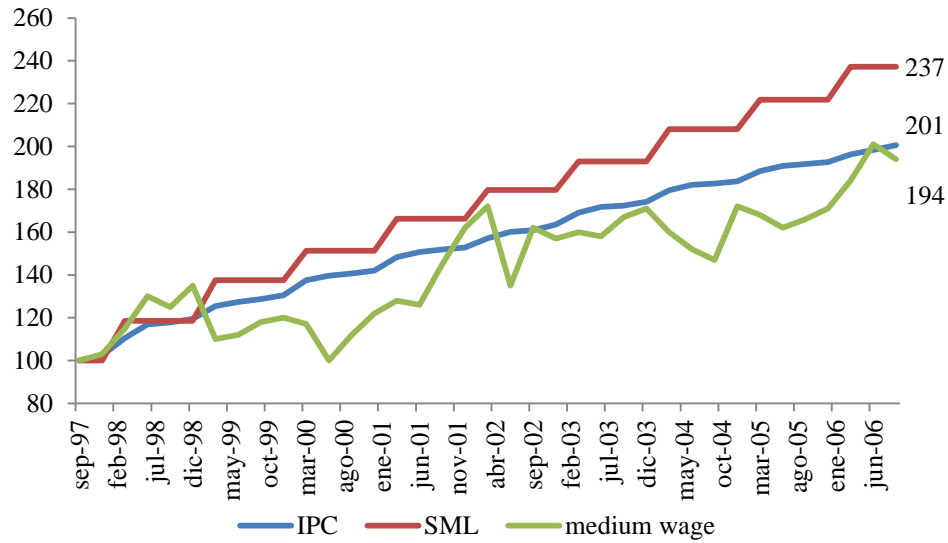
On the other hand, in the Latin American context Colombia has the second highest minimum wage (MW), as a percentage of per capita GDP (Figure 19). While per capita GDP in the U.S. is 11 times higher than in Colombia, the (average) MW is only five times higher. In the last twenty years, the MW as a proportion of the average wage has increased by 40%, indicative of the fact that the MW has grown much faster than average labor productivity. Indeed, during 1997-2006, the average wage grew at rates close to the rate of inflation –i.e. there was no meaningful increase in average labor productivity (Figure 20). However, during the same time span, the MW rose 36% above inflation, paying for a higher productivity that really did not happen. Having a high MW that is rising proportion of the average wage helps explain the fact that the proportion of workers earning *less* than the MW (i.e. in the informal sector) is also high and increasing, from around 26% two decades ago to around 35% today (Figure 21).

Figure 19: Minimum wage as a percentage of per capita GDP



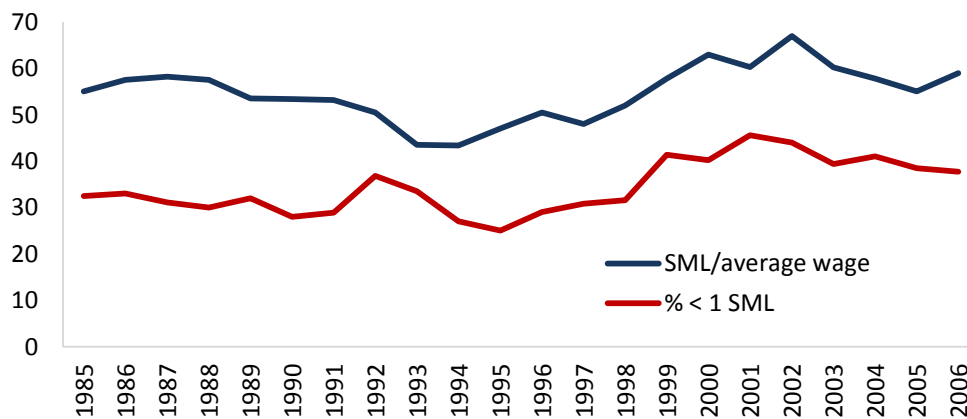
Source: Santa María *et al.* (2010).

Figure 20: Average and minimum wages and CPI (1997=100)



Source: Santa María et al. (2008) cited by Santa María et al. (2010).

Figure 21: Minimum wage as % of average wage



Source: Santa María et al. (2010)

Santa Maria *et al.* (2008) estimated the effects of non-wage labor costs over employment and found that a 1% increase in these costs caused a 2.9% decrease in relative¹⁷ employment. Not surprisingly, this effect is strengthened in the presence of a binding minimum wage –i.e. the adjustment in the formal labor market to the higher tax has to be done through quantities (employment) rather than through prices (wages). Montenegro and Pagés (2004) found that both the minimum wage and non-wage labor costs reduced employment of the young and the unskilled. They estimated that a 10% increase in non-wage costs reduces by 6.6% the likelihood of a young person of finding a job, in comparison to older workers¹⁸.

In what follows, we use a computable general equilibrium model (CGEM) to simulate the impact of a reform that reduces non-wage labor costs and replaces them, if needed, with less distortionary taxes such as the VAT.¹⁹ In particular, we explore the effects on employment, labor formality and fiscal revenue of the implementation of the tax reform approved by Congress in late 2012.ⁱ

b) General framework: CGEM

The CGEM is a set of equations and assumptions that allow the simulation of the transition of an economy from an initial economic equilibrium to a final equilibrium after it has been subjected to exogenous shocks (see Appendix 3 for details). In particular, the general equilibrium model for Colombia is calibrated for the year 2007 based on the Social Accounting Matrix produced by the National Planning Department. These models are widely used for the evaluation of policies and projects and allow for the interrelationships between all markets of the economy –i.e. they take into account both the direct as well as the indirect effects of policy interventions.

¹⁷ Defined as the ratio of employees to freelancers.

¹⁸ For the case of Peru, Saavedra and Torero (2004) showed that a 1% increase in labor taxes reduced labor demand by 0.19%.

¹⁹ In the Colombian context, the use of a CGEM to analyze the labor market is not new (see Hernández, 2011; Botero, 2011; and Forero, *et al* 2012).

As was already described, Colombia has a labor market that is segmented in a formal and an informal component. The formal segment receives social security benefits²⁰ and is governed by a rather high minimum wage. The informal segment is flexible and provided 60% of jobs in 2011²¹. Our CGEM captures these elements: the labor market is composed of a formal and an informal sectors following Todaro (1969). In the formal sector unemployment exists and the real minimum wage is a binding constraint (Hutton and Ruocco, 1999). In this segment, firms determine the level of employment. On the other hand, the informal labor market is assumed to be perfectly competitive –i.e. there is full employment, with flexible real wages. In the formal segment unemployment can be an equilibrium outcome because there is a part of the economically active population that prefers to remain unemployed since its remuneration in the informal sector is deemed to be very low.

With the following orthogonal condition it is straightforward to introduce this segmentation in the labor market (van der Mensbrugghe, 2005). Let W_{MIN} represent a minimum wage and UE_{MIN} be unemployment (for a certain segment)

$$(W - W_{MIN})(UE(W) - UE_{MIN}) = 0$$

In the formal sector the minimum wage is higher than the equilibrium wage. In this case, unemployment ($UE(W_{MIN})$) is higher than a minimum unemployment level (UE_{MIN}), and the prevailing wage, W , is set to the minimum wage. In the informal sector, there is no binding minimum wage so $W_{MIN} = 0$ and the market clears with $UE = UE_{MIN}$.

The “pure tax” component of non-wage labor costs (ICBF, SENA, CCF) are represented as a tax (τ^{xfl}) on net wages received by formal sector employees (NW). Total wages paid by employers (W) is equal to

$$W = (1 + \tau^{xfl})NW$$

²⁰ Formal sector workers receive health and pension benefits. Most informal sector workers, if poor, are affiliated to a subsidized health insurance program.

²¹ According to ECLAC.

In what follows we analyze the tax reform approved by Congress in late 2012. The reform reduced from 3% to 0 contributions to SENA, from 2% to 0 contributions to ICBF and from 8.5% to 0 health contributions. In all, the “pure tax” component was reduced permanently from 29.5% to 16%. Though such a policy could potentially produce a decline in fiscal revenues, we show that this is not the case for Colombia.

c) Simulation results

In Table 5 we present the results of the simulations based on our CGEM. In column (2) we present the calibrated values for 2012 for GDP, government revenue, non-wage labor costs, government expense, fiscal deficit as a share of GDP, employment, unemployment rate, net wage, formal and informal employment. These calibrated values are consistent with both the CGEM's equations and what actually happened in 2012²². Column (3) presents the values for all these variables for 2013, had there not been a reform --we call these simulations “business as usual”. Column (4) describes the simulations when τ^{xfl} is reduced, what we call “lowering payroll taxes” simulations. Finally, column (5) reports the changes between the two simulations (percentage difference and participation over GDP, depending on the variable).

In the first year of the reform, the level of real GDP is 0.23% higher when compared with the business-as-usual simulation. This is a once-and-for-all permanent effect. This increase in GDP is possible due to a 0.5% increase in overall employment, which means that the unemployment rate falls 0.5 percentage points (from 3% to 2.5%). It is important to note that the unemployment rate in the CGEM is the unemployment rate *above* the NAIRU, estimated at 10.8% for Colombia (Arango *et al.* 2007). Furthermore, formal employment increases on 1.4%, while informal employment falls 0.06%. Likewise, government revenue increases more than government expenditure and the fiscal balance marginally improves; i.e., the reform pays for itself.

²² For instance, the model calibrated a 2.4% of GDP fiscal deficit, which was actually 2.3% (*Marco Fiscal de Mediano Plazo*, Ministerio de Hacienda, 2012). While the model calibrated 21.9 million workers, DANE reports 21 million of workers; informality is calibrated at 62% of the labor force, close to the 59% reported by ECLAC.

Table 5: Simulations Results

(billions of 2007 pesos)

	Business as usual		Lowering payroll taxes	Difference between two scenarios
	2012	2013	2013	2013
GDP	524.2	546.7	548.0	0.236%
Non-wage costs (% wage)	29.5	29.5	16.0	
Fiscal deficit /GDP (%)	-2.3	-2.373	-2.371	-0.002 %
Employment (m. people)	21.8	22.15	22.26	0.497%
Unemployment rate (%) ⁱⁱ	3.0	3.0	2.5	-0.5 pps
Formal employment (m. people)	8.3	8.5	8.62	1.4%
Informal employment (m. people)	13.6	13.65	13.64	-0.06%

Source: Fedesarrollo's CGEM.

It is important to provide some intuition regarding these results. A reduction in non-wage labor costs reduces labor costs in the formal sector while maintaining take-home pay constant (NW in equation 1). This enhances the demand for formal workers, which implies a higher net wage, thereby increasing compensation in the formal sector relative to the informal sector (eq. 2).

$$W = (1 + \tau^{xfl})NW \quad (1)$$

$$AWAGE_{l,gz} = (1 - UE_{l,gz}) \frac{\sum_{i \in gz} NW_{i,l} L_{i,l}^d}{\sum_{i \in gz} L_{i,l}^d} \quad (2)$$

The migration of workers between the informal and formal sectors is governed by equation (3) and is a function of relative wages. On account of the proposed reform, which by reducing “pure taxes” increases relative wages on 2013 from 1.56 to 1.6, the migration goes up to 105320 (some 0.5% of total employed people). The reform has an impact effect by which real wages in the formal sector increase 4.29% in the first year. On account of “general equilibrium”

considerations, they then increase 2.2% per year²³. With the reform, the real wage in the formal sector is 1.8% higher than in the baseline.

$$MIGR_l = X_l^{migr} \left(\frac{AWAGE_{l,for}}{AWAGE_{l,inf}} \right) \omega^m \quad (3)$$

The incidence of informality varies across sectors. In a selected few (i.e. financial sector and civil works) there is no informality. In the other extreme, almost three fourths of output in agriculture is informal (Table 6). Consequently, the effect of the proposed reform should not be expected to be uniform throughout sectors; its direct effect on fully formal sectors is null. In agriculture, the reform is expected to have a significant effect.

Table 6: Informality per sector 2012

Sector	Participation in GDP (%)	Informal production as (%) of total production
Agriculture	7.28	73.88
Mining	5.74	9.25
Light manufacture	5.58	19.84
Services	28.10	29.37
Edifications	3.57	24.09
Civil works	3.39	0
Refining	2.19	0
Machinery and equipment	0.98	0
Financial sector	4.05	0
Other services	21.59	18.01

Source: Fedesarrollo's CGEM

One interesting feature of the proposed reform, making it a win-win situation from a political economy perspective, is that, in fiscal terms, it “pays for itself”. According to DNPs' 2007 Social Accounting Matrix, corporate income taxes represented 8.6% of GDP. Of course, these resources are contributed solely by formalized businesses. According to our estimations, the faster pace of

²³ In the baseline, real wages grow at an average yearly rate of 2.2%. The reform has an impact effect by which real wages increase 4.2% in the first year.

formal production induced by the elimination of the pure tax component of non-wage labor costs would enhance corporate tax collections in an amount similar to the cost of funding the social programs historically paid with the “parafiscales”.

4. Conclusions and recommendations

In this paper we have estimated the likely effects on investment and on employment and labor formalization of reducing the corporate income tax rate from 33% to 23% and of eliminating the “pure tax” component of non-wage labor costs. The main findings of the paper are: (i) while in the short term the fiscal costs associated with a decline in corporate taxes out-weigh any potential benefit in terms of enhancing investment, the long-term impact on non-oil & mining investment is significant. Therefore, the policy issue at hand is how to finance the transition of a policy that is fiscally costly in the short term but in all likelihood self-sustainable in the long term. (ii) eliminating the “pure tax” component of non-wage labor costs increases formal sector employment, a policy that essentially “pays for itself”.

These results would seem to lend support to key elements of the recent tax reform proposed and enacted by Congress. The reform, passed in December 2012, basically left corporate taxes unchanged, but reduced the “pure tax” component of non-wage labor costs almost in half. The reform was to be revenue neutral and was expected to boost formal sector employment. For the first half of 2013 overall tax collections (COP\$58.8 trillion) were slightly lower than for the first half of 2012 (COP\$ 58.9 trillion). Preliminary data²⁴ suggests, however, that tax collections in July and August evolved very favorably, with August 2013 collections surpassing August 2012 collections by as much as 25%. This evolution throughout 2013 is attributed to the fact that the government took much more time than expected in issuing the necessary decrees to make key elements of the tax reform operative.

²⁴ <http://justiciatributaria.co/recaudo-tributario-llego-a-715-billones-en-agosto/>
<http://www.elespectador.com/noticias/economia/recaudo-tributario-agosto-va-71-billones-articulo-372902>

On the other hand, the labor component of the reform –i.e. the reduction in the “pure tax” component of non-wage labor costs—which came into effect on May 1st 2013 already seems to be yielding very positive results. In particular, for the 13 largest metropolitan areas during the 3-month period May-July total employment increased 204 thousand in comparison to the same period in 2012. Interestingly, while formal sector employment increased 367 thousand, informal sector employment declined by 163 thousand.

Given the recent positive evolution of the labor market and taking into consideration the supporting evidence provided in this paper, there is no reason, other than political expediency, for not having fully eliminated the “pure tax” component of non-wage labor costs. There is merit and no fiscal cost in completely eliminating the “pure tax” component of non-wage labor costs. In fact, if the reform had indeed eliminated all non-wage costs, the unemployment rate would be lower and formal workers would have a higher relative wage.

Finally, an important caveat is in order. While it is true that the short term fiscal costs of a sharp reduction in corporate taxes is huge whereas the increase in investment is only marginal, there is another powerful reason to consider a fiscally neutral reform that shifts income taxes away from corporations and towards individuals. Colombia has one of the most un-equal income distributions in the world, and taxation (not to mention ill-targeted public expenditure) does little to change this. Since some taxes lend themselves better than others to improving income distribution, the case can be made that, without compromising efficiency, shifting the income tax burden from corporations to individuals could go a long way in terms of improving income distribution –even if this does not have a significant effect on corporate investment.

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Appendix 1. Derivation of the user cost equation

Following Cardenas and Olivera (1995), a firms' net cash flow is defined as:

$$X_t = (1 - \tau)(p_t F(K_t, L_t) - w_t L_t) - (1 - k - \tau z)q_t I_t$$

The cash flow is equal to income earned, net of wages, income tax and the cost of capital goods purchased by the company (including investment tax credits and depreciation). τ is the income tax rate²⁵, p_t the product price, w_t wages, q_t the cost of a unit of capital unit, k represents deductions for investment in fixed assets and z depreciation deductions.

The company seeks to maximize profits, so the optimization problem is as follows.

$$\text{Max} \int_t^{\infty} X_t e^{-rt} dt$$

The restriction of the problem is given by the neoclassical capital accumulation equation:

$$\dot{K}_t = I_t - \delta K_t$$

The Hamiltonian is as follows

$$H_t = e^{-rt} X_t + u_t \dot{K}_t$$

When we multiply both sides by e^{rt} and we take into account that $\lambda_t = u_t e^{rt}$ (λ_t the shadow price of a unit of capital):

$$H_t^* = H_t e^{rt} = X_t + \lambda_t \dot{K}_t = (1 - \tau)(p_t F(K_t, L_t) - w_t L_t) - (1 - k - \tau z)q_t I_t + \lambda_t (I_t - \delta K_t)$$

The derivative of the Hamiltonian with respect to the control variables (in this case I and L) must be equal to zero

$$\frac{\partial H_t^*}{\partial I_t} = \lambda_t - (1 - k - \tau z)q_t = 0$$

²⁵ We can include the wealth tax here as $(1 - \tau - x)$, where x is the wealth tax transformed by assuming a return on assets of 10%.

$$\lambda_t = (1 - k - \tau z)q_t$$

$$\frac{\partial H_t^*}{\partial L_t} = (1 - \tau)p_t F_L - w_t = 0$$

$$(1 - \tau)p_t F_L = w_t$$

$$F_L = \frac{w_t}{(1 - \tau)p_t}$$

The second order condition is

$$\frac{dH}{dK_t} = -\dot{u}_t$$

Which is equivalent to

$$\frac{dH_t^*}{dK_T} = r\lambda_t - \dot{\lambda}_t$$

Solving

$$(1 - \tau)p_t F_K - \delta\lambda_t = r\lambda_t - \dot{q}_t(1 - k - \tau z)$$

$$(1 - \tau)p_t F_K = r\lambda_t + \delta\lambda_t - \dot{q}_t(1 - k - \tau z)$$

From the F.O.C. we know that $\lambda_t = (1 - k - \tau z)q_t$

$$(1 - \tau)p_t F_K = r(1 - k - \tau z)q_t + \delta(1 - k - \tau z)q_t - \dot{q}_t(1 - k - \tau z)$$

Multiplying and dividing the last term in the equation by q_t

$$(1 - \tau)p_t F_K = r(1 - k - \tau z)q_t + \delta(1 - k - \tau z)q_t - \dot{q}_t(1 - k - \tau z)\frac{q_t}{q_t}$$

Factorig the term $(1 - k - \tau z)q_t$ in the second term of the equation

$$(1 - \tau)p_t F_K = (r + \delta - \frac{\dot{q}_t}{q_t})(1 - k - \tau z)q_t$$

When we divide and merge

$$F_K = \frac{(r + \delta - \frac{\dot{q}_t}{q_t})(1 - k - \tau z)q_t}{(1 - \tau)p_t}$$

The user cost of capital is given by the marginal product of capital

$$F_K = C = \frac{q_t}{p_t} (r + \delta - \frac{\dot{q}_t}{q_t}) \frac{(1 - k - \tau z)}{(1 - \tau)}$$

Replacing q_t for P^I , p_t for P , we obtain the user cost equation used in this paper:

$$C = \frac{P^I}{P} \left(i + \delta - \frac{\Delta P^I}{P^I} \right) \frac{1 - k - \tau z}{1 - \tau}$$

Appendix 2. Data description

Variable		Definitions and sources
P	Price index	P represents the prices at which firms sell goods and services. In this paper we use the Producer Price Index from the BdR database.
P^I	Price index of capital goods	P^I represents the price index for capital goods. It is the capital goods component of the PPI, from the BdR database.
i	Interest rate	The interest rate is calculated as expectations for the 1-year DTF. Expectations were estimated using ARIMA models.
δ	Depreciation rate	Calculated using the perpetual inventory method. The sectoral investment data required is from the DNP and DANE databases. To use the perpetual inventory method, we estimate the historical growth of the investment series and assume a different depreciation rate for each type of capital (i.e. 8% for machinery and equipment, 10% for transport equipment).
k	Investment tax credits	k represents deductions for investment in fixed assets. This information is available in taken from the tax regulation of the last 20 years
τ	Income tax	This information is available from the tax regulation of the last 20 years
z	Depreciation deductions	Estimated using the formula suggested by Cohen (1968).

Appendix 3. Some relevant labor-market features of Fedesarrollo's Computable General Equilibrium Model

Fedesarrollo's Computable General Equilibrium Model (CGEM) allows us to simulate the transition of the economy from an initial to a final equilibrium, following an exogenous shock (in this case a reduction in non-wage labor costs). For that purpose we use the 2007 Social Accounting Matrix (SAM) describing economic transactions between 59 sectors of the Colombian economy. .

Production

Each sector's output is based on a production function that uses two inputs (capital K and labor L) and a basket of intermediate goods. Inputs and intermediate goods are combined by means of nested CES functions. In the first level the amount of productive factors that are used as inputs is determined, and capital and labor, with some degree of substitution, are combined with intermediate goods to generate aggregate value (VA) by means of a CES production function.

Production of the first level nest XP is the result of the interaction of VA and an aggregate demand for goods and services, ND. Equations 1 and 2 are the optimal demand conditions for the CES production function, where PVA and PND are the Armington prices of VA and ND for the $i=1\dots n$ subsectors in the economy. VC is the variable cost of production, as determined in equation 3.

$$ND_i = \alpha_i^{nd} \left(\frac{VC_i}{PND_i} \right)^{\sigma_i^p} XP_i \quad (1)$$

$$VA_i = \alpha_i^{va} \left(\frac{VC_i}{PVA_i} \right)^{\sigma_i^p} XP_i \quad (2)$$

$$VC_i = \left(\alpha_i^{nd} PND_i^{1-\sigma_i^p} + \alpha_i^{va} PVA_i^{1-\sigma_i^p} \right)^{1/1-\sigma_i^p} \quad (3)$$

Total costs is the sum of a unit variable cost and a unit fixed cost, in turn composed of units of K and L. Firms are assumed to be symmetric, i.e. they have identical cost structures and the fixed costs are specified on a per firm basis. If N is the number of firms, the unit fixed cost FC is given

by equation 4, where KF and LF are the units of K and L needed to produce the first unit of output. As the amount of output increases, the average fixed cost goes down. Total cost, TC, is defined by equation 5.

$$FC_i = N_i(\sum_{kt} R_{i,kt} KF_{i,kt}^d + \sum_l W_{i,l} LF_{i,l}^d) / XP_i \quad (4)$$

$$TC_i = FC_i + VC_i \quad (5)$$

Firms may be able to establish a mark-up (π) over variable costs. The producer's price, PX, is given by equation 6. IN our case we will assume that both fixed costs and the mark-up are zero – i.e. we assume perfect competition and constant returns to scale.

$$PX_i = \left(VC_i + \frac{VatdY_i}{XP_i} \right) (1 + \pi_i) \quad (6)$$

In the second level of production aggregate demand for inputs is a sectoral demand for goods and services, indexed by an Armington good XA. Equation 7 is the demand for good k by sector j, where α is this sector's demand as a proportion of aggregate demand. In equation 8 PND is the weighted average of the price of goods and services, PA, where the weights are given by the α coefficients. The Armington price is the price of composite good XA.

$$XA_{k,j} = \alpha_{k,j} \left(\frac{PND_j}{PA_{k,j}} \right)^{\sigma_j^p} ND_j \quad (7)$$

$$PND_j = \left[\sum_k^n \alpha_{k,j} (PA_{k,j})^{1-\sigma_j^n} \right]^{1/1-\sigma_j^n} \quad (8)$$

In the third level of production aggregate demand for K and L is decomposed into a demand for non-skilled labor and a demand for skilled labor and capital (KSK). In the fourth level of production KSK is decomposed into a demand for capital and a demand for skilled labor. Each sector's demand for skilled and non-skilled labor is modeled with a CES function, with different sectoral elasticities of substitution.

As in Steiner, Forero & Rojas (2012), aggregate demand has four components: government consumption, household consumption, intermediate consumption and investment. Household's save a portion of their income which goes to finance investment and they consume the remainder. Firms demand inputs produced by other sectors and the government demands goods and services for current consumption. These components are grouped together in an Armington total consumption.

Labor market²⁶

The labor market is divided into two segments - informal and formal- indexed in gz , with each segment having different dynamics (equation 9). The elasticity of migration between segments is ω^m . If such elasticity is infinite, there will be perfect labor mobility. If it is finite, there will be labor market segmentation, a function of the costs of migration, costs that are, in turn, determined by relative wages.

$$gz \in \{\text{Inf, For}\} \quad (9)$$

Labor supply

In the informal sector labor supply in period t is equal to labor supply in $t-1$ adjusted by population growth g^l minus migration (MIGR) to the formal sector (equation 10). Likewise in the case of formal labor supply (equation 11). Total labor supply is defined in equation 12.

$$L_{l,Rur}^S = (1 + g_{l,Inf}^L) L_{l,Inf,-1}^S - MIGR_l \quad (10)$$

$$L_{l,Urb}^S = (1 + g_{l,For}^L) L_{l,For,-1}^S + MIGR_l \quad (11)$$

$$L_{l,Tot}^S = L_{l,For}^S + L_{l,Inf}^S \quad (12)$$

In order to explain the behavior of MIGR, we define the average expected wage (AWAGE), which is determined by the different net wages received by employees (NW)²⁷. The average

²⁶ For more details, please consult Banco Mundial (2005): "Prototypes Model for a Single Country: Real Computable General Equilibrium Model".

expected wage is adjusted for the probability of being employed (and equal to 1 minus the rate of unemployment, UE) (equation 13). Migration is a function of the expected wage in the formal sector relative to the expected wage in the informal sector (equation 14). In case the elasticity of migration (ω^m) is infinite, this equation is disregarded since the labor market would be completely unified.

$$AWAGE_{l,gz} = (1 - UE_{l,gz}) \frac{\sum_{i \in gz} NW_{i,l} L_{i,l}^d}{\sum_{i \in gz} L_{i,l}^d} \quad (13)$$

$$MIGR_l = X_l^{migr} \left(\frac{AWAGE_{l,urb}}{AWAGE_{l,rur}} \right) \omega^m \quad (14)$$

Wage rigidities are introduced so as to introduce a wedge between labor supply and labor demand. Let W_{min} be the minimum wage²⁸ and UE the rate of unemployment. Equation 15 is the orthogonality condition supporting two possible regimes:

$$(UE - UE_{min})(W - W_{min}) = 0 \quad (15)$$

In the informal sector the equilibrium wage is above the minimum. As a result, there will be full employment. In the formal sector the equilibrium wage is below the minimum. As a result, the actual wage will equal the minimum and there will be unemployment in equilibrium (equation 16).

$$W \geq W_{min} \quad UE \geq UE_{min} \quad (16)$$

Although there is perfect labor mobility across sectors, there can be sectoral wage differentials, which we assume to be fixed. Equation 17 determines the sectoral skill-specific wages as a function of the base inter-sectoral wage differentials and changes in the segment-specific wage. Gross wages (W in equation 18) is equal to net wages received by employees, NW , plus non-wage labor costs ($\tau_{i,l}^{xfl} NW$).

²⁷ NW is defined for skilled and non-skilled workers, for youngsters and adults, and for formal and informal workers.

²⁸ For analytical purposes, the minimum wage in the informal sector is 0.

$$NW_{i,l} = \phi_{i,l}^l W_{i,gz}^e \quad (17)$$

$$W_{i,l} = (1 + \tau_{i,l}^{xfl}) NW_{i,l} \quad (18)$$

Labor demand

Total labor demand by sector and level of skill²⁹ is composed of a fixed (LF) and a variable demand (LV), in turn a function of the terms included in equations 19 to 21. The elasticities of substitution for skilled and un-skilled labor are σ^s and σ^u respectively, whereas labor productivity per sector and level of skill is represented by λ^l . Wages for skilled and un-skilled workers are, respectively, PSKL and PUL.

$$L_{i,l}^d = LF_{i,l}^d + LV_{i,l}^d \quad (19)$$

$$LV_{i,ul}^d = \alpha_{i,ul}^l (\lambda_{i,ul}^l)^{\sigma_i^u - 1} \left(\frac{PUL_i}{W_{i,ul}} \right)^{\sigma_i^u} UL_i \quad ul \in \{Unskilled\ labor\} \quad (20)$$

$$LV_{i,skl}^d = \alpha_{i,skl}^l (\lambda_{i,skl}^l)^{\sigma_i^s - 1} \left(\frac{PSKL_i}{W_{i,skl}} \right)^{\sigma_i^s} SKL_i \quad skl \in \{skilled\ labor\} \quad (21)$$

A reduction in non-wage labor costs

A reduction in non-wage labor costs $\tau_{i,l}^{xfl}$ reduces formal sector wages paid by employers (eq. 18). This brings about a reduction in labor costs (W), thereby increasing formal labor demand (eqs. 20 and 21), so that take-home-pay in the formal sector goes up (eq. 17). This mechanism is only at play in the formal sector given that there are no non-wage labor costs in the informal sector. A higher net wage for formal sector workers brings about an increase in formal AWAGE (eq. 13). This affects relative wages, fostering migration from the informal to the formal sector (eq. 14). As a result, total employment goes up, unemployment goes down, and a higher proportion of workers in the formal sector increases GDP.

²⁹ The demand for skilled labor is SKL; the demand for un-skilled labor is UL.
