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# **Inflation targeting and tax effort: Evidence from Colombia**

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## ***Abstract***

This paper relates to the literature on the possible effect of inflation targeting on fiscal discipline in developing countries. In particular, we present empirical evidence to address this issue based on the Colombian experience. An empirical analysis to evaluate the reputation gains of the central bank on tax capacity use is made. The results indicate that an increase in the reputation of the monetary authority can lead to an increased tax effort.

**Key words:** tax capacity, tax effort, inflation targeting, reputation.

**JEL classification:** E52, E58, H20, H83.

## 1. Introduction

The search for institutional arrangements to achieve fiscal balance depends to some extent on the monetary policy management. In particular, how much the government uses the tax base depends on the likelihood of the central bank monetize the public budget deficits. For the inflation targeting, a precondition for its success is the fiscal balance. Therefore, the effort of the fiscal authority to not compromise the achievement of the inflation target is fundamental. In this context, an important issue for the policy makers is whether the inflation targeting can influence the tax effort. The degree of commitment of the monetary authority with the inflation target is essential to avoid the fiscal dominance problem. Therefore, the achievement of the inflation target over time by the monetary authority (gain of reputation) is an important indicator to observe the performance of the inflation targeting regime. This paper examines which factors affect the tax effort and, in particular, if the reputation of the monetary authority to succeed in achieving the inflation target is relevant. For this, are made regressions that take into account the tax effort measures and reputation of the monetary authority, as well as another variables that can affect this relationship. Data of the Colombian economy are used in this paper based on information extracted from the Central Bank of Colombia and the National Bureau of Statistics of Colombia. These data enable the construction of reputation indicators (based on the difference between the observed inflation and the inflation target) and tax effort index, and the data also allow to build a set of macroeconomic variables used in the literature.

Several studies have examined the determinants of use of the tax base. A part of the literature is focused on analyzing the tax capacity through the sector composition of the economy (e.g. Tait, Gratz and Eichengreen, 1979; Tanzi, 1989, 1992b; Stotsky and Woldemariam, 1997). Another part of the literature is concerned on assessing the role of the population profile and the informal economy on tax revenues (e.g. Ansari, 1982; Teera and Hudson, 2004; Davoodi and Grigorian, 2007). There are also studies showing that various socio-cultural and institutional characteristics (honesty, tax morale, inequality, property rights, political instability, corruption) affect the commitment of the agents with the financing of the public sector (e.g. Torgler, 2005; Gupta , 2007; Bird, Martinez-Vasquez and Torgler, 2008; Fenochietto and Pessino, 2013).

Despite the above literature, there are few studies that analyze the influence of fiscal constraints on tax effort. According to Mkandawire (2010) and Feger and Asafu-Adjaye (2014), in Africa the tax exemption to companies (revenues constraints) and the colonial past limited the tax capacity. In an influential paper, Tanzi (1989, 1992 a, b) shows that the public debt service need is an important variable to push tax revenues. Moreover, Brun, Chambas and Guerineau (2008) and Mosley (2015) show that there is an important effect of international financial aid on the efficiency of applying taxes.

The present study differs from these related studies in several dimensions. A first aspect refers to the fact that this study considers the role of the inflation targeting as a fiscal restriction. In particular, can be seen what is the impact on tax effort in the absence of fiscal dominance (impossibility of use of inflationary tax in the inflation targeting). A second aspect refers to the fact that this study takes into account the role that has the public investment, public wages and the payment of interest on public debt as explanatory variables of the tax effort. A third aspect relates to the fact that the insertion of reputation (achieving the inflation target over the time) in the analysis allows to contribute to the literature that evaluates the effect of the central bank's performance on fiscal discipline in emerging economies.

The evidence presented in this paper suggests that in Colombia the tax effort is affected by the reputation of monetary policy. Another important result is that in the period under inflation targeting in Colombia, implementation of the efficiency of taxes can be classified as high. In other words, there is a greater use of the tax base that can be attributed to the fulfillment of the inflation targets by the central bank.

The rest of the paper is organized as follows. Section 2 presents the methodology used to measure the tax capacity and tax effort. Section 3 presents the methodology used to capture the inflation targeting effect on tax effort. Section 4 provides the empirical results and analyzes the effect of reputation on tax effort and Section 5 offers some concluding remarks.

## **2. Methodology and data**

To analyze the tax effort is necessary observe the changes in the tax capacity. After this, the tax effort is built by comparing tax revenues observed with the tax revenues explained by the tax capacity. In general, the literature indicates that variables associated with the level of economic development, sector composition of the economy and the performance of public institutions are key to explaining the tax capacity.<sup>1</sup>

According to Lotz and Morss (1970), Chelliah (1971), Teera and Hudson (2004), Davoodi and Grigorian (2007), Bird, Martinez-Vasquez and Torgler (2008) the tax base depends on the extent of the markets for goods and services. In addition, is recognized that consumer's purchasing power

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<sup>1</sup> The seminal works in the literature are Lotz and Morss (1970), Bahl (1971), Tait, Gratz, and Eichengreen (1979). For a literature review of the tax capacity measuring, see: Teera and Hudson (2004) and Fenochietto and Pessino (2013).

serves as a proxy of the willingness to pay taxes. Therefore, a first variable to consider as explanatory of the tax capacity is the GDP per capita (*GDPPC*).

Such as observed by Lotz and Morss (1970), Bahl (1971), Chelliah (1971), Tanzi (1992b), Teera and Hudson (2004), and Davoodi and Grigorian (2007) foreign trade is an important source of tax revenues for emerging economies because these economies use taxes on imports as a strategy to protect domestic activities. Therefore, a second explanatory variable to measure the tax capacity refers to the ratio imports/GDP (*IMP*).

The sector composition of economy affects tax revenues. In general, public sector activities are funded with taxes collected in large cities where employment is generated by the industrial and service sectors. The growth of these sectors is associated with a lower share of agriculture in the GDP. As Davoodi and Gregorian (2007) show, the share of agriculture in the economy affects tax revenues since agriculture does not generate a large economic surplus. Therefore, a third explanatory variable to measure the tax capacity refers to the share of agriculture in GDP (*AGRI*).

According to Perilla (2010), Lopez et al. (2013) and Villar and Forero (2014) in some emerging economies such as Colombia, the oil sector share in the economy is a relevant source of fiscal revenue. Therefore, as a fourth explanatory variable of the tax capacity is considered the price of oil (*OIL*).

One of the tax collection problems in emerging economies is due to the fact that the agents do not have incentives to pay taxes. According to Tanzi (1992a), Torgler (2005), Bird, Martinez-Vasquez and Torgler (2008), Sookram and Saridakis (2009), and Cyan, Martinez-Vasquez and Vulovic (2013) when the fiscal authorities does not have commitment with the public services quality produced, arises a tax evasion tendency. One way to capture the public sector efficiency can be made through the resources allocated to investments. The largest investment affects the payer perception on the performance of the public sector and increases the tax morale. Thus, another explanatory variable of tax capacity considered in this study is the ratio public investment/GDP (*PUBINV*).

Hence, to analyze the tax capacity are considered the variables: *GDPPC* and *IMP* (economic development), *AGRI* and *OIL* (sector composition), and the *PUBINV* (institutional quality). Thus, the basic model to analyze the tax capacity is as follows:<sup>2</sup>

$$TAX_t = \beta_0 + \beta_1 GDPPC_{t-1} + \beta_2 IMP_{t-1} + \beta_3 AGRI_{t-1} + \beta_4 OIL_{t-1} + \beta_5 PUBINV_{t-1} + \varepsilon_t \quad [1]$$

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<sup>2</sup> As Feger and Asafu-Adjaye (2014), the variables were lagged one period to eliminate potential endogeneity, specification, and simultaneity problems.

As Teera and Hudson (2004), Bird, Martinez-Vasquez and Torgler (2008), Fenochetto and Pessinus (2013), and Feger and Asafu-Adjaye (2014), the difference between observed tax revenue and the estimated tax revenue is explained by efficiency that shows the tax authority in the use of tax base. The tax effort index is derived as the ratio of the actual tax revenue relative to the tax capacity:

$$TE_t = \frac{TAX_t}{\widehat{TAX}_t} \quad [2]$$

That is  $\widehat{TAX}_t$  is the ratio of tax/GDP would be recorded given the characteristics of the economy (level of economic development, sector composition and institutional quality). So, the tax effort is an indicator of fiscal performance because it measures how much the government uses the tax burden.<sup>3</sup>

The tax effort index can vary according to the different specifications that can be used to estimate the tax capacity. Taking like a reference the procedure adopted by Mkandawire (2010) and Feger and Asafu-Adjaye (2014), to eliminate the above problem, the model used in this study was selected for having the best statistical performance: greater significance in the parameters, most F-statistic, and largest R<sup>2</sup> adjusted.

In order to observe what is the existing specification in the literature on tax capacity that provides the best fit for Colombian economy, the selected model was compared with another specifications. Proposals considered employ many variables related to those considered in the basic model. For example, the models of Bahl (1971), Chelliah (1971) and Tait et al. (1979), and Stotsky and Woldemariam (1997) use the participation of the mining sector in GDP (*MIN*), the share of industry in GDP (*IND*) and the share of foreign trade in GDP (*XM*) to analyze the influence of sector composition of the economy on tax revenues. There are also studies that consider population variables. For example, Teera et al. (2004) and Mkandawire (2010) use the population growth rate (*POP*) and the urbanization degree (*URB*). Finally, in order to verify the effects of institutional quality on tax capacity, some studies use the size of the informal sector in the economy (*INFORMAL*) and the debt/GDP ratio (*DEBTEXT*) (see, for example, Stotsky and Woldemariam, 1997; Bird et al., 2008; Mkandawire, 2010). The results of estimation of specifications that are in the empirical literature are presented in conjunction with the estimation of the basic model proposed (equation (1)). In general, the variables listed in the empirical literature are of little statistical significance to estimate the tax capacity in the Colombian case. Moreover, the tax effort behavior is not significantly changed.

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<sup>3</sup> The tax effort indices are complementary indicators to the concept of tax burden. See empirical applications in: Teera and Hudson (2004), Bird, Martinez-Vasquez and Torgler (2008), Mkandawire (2010), and Feger and Asafu-Adjaye (2014).

### 3. Inflation targeting reputation and tax effort

The persistent inflation in emerging economies causes disincentives in public sector management and deteriorates the effectiveness of tax collection. Studies of Tanzi (1989, 1992b) provide evidence that the tax collection is a fiscal variable affected by past inflation and by indexation degree of the economy. In this context, the inflation targeting is relevant because the fiscal authority is unable to make use of seigniorage revenues (inflationary tax).<sup>4</sup>

According to Kydland and Prescott (1977) and Barro and Gordon (1983) is observed that inflation persistence has been associated with lack of systematic commitment to fighting inflation and, as a result, to a government reputation loss due to non-compliance with the agreements previously signed with the society. Furthermore, the reputation in the inflation targeting regime refers to the achievement of the objectives announced by the central bank. Thus the reputation of the central bank (backward-looking measure) can be used as an element to observe the effect of the central bank's performance on tax effort.

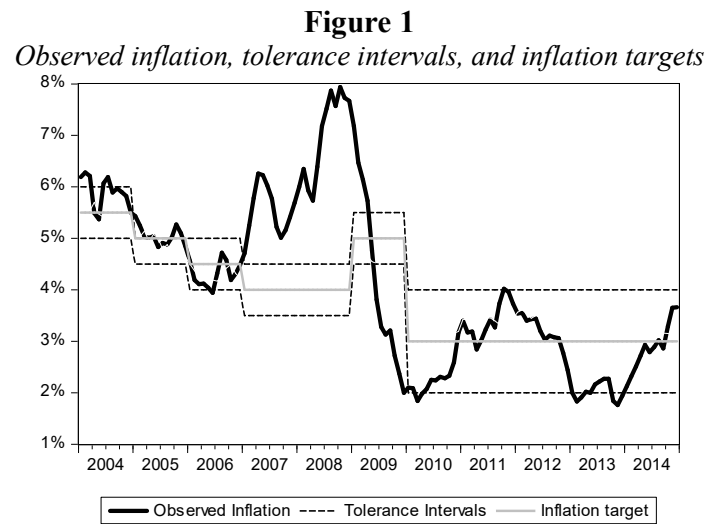
In developing countries reputation can be essential for developing credibility. According to de Mendonça (2007) and de Mendonça and de Guimarães e Souza (2009) a high operational credibility of inflation targeting is a result of the central bank proving its competence in achieving the inflation target. Therefore, the reputation of the central bank under inflation targeting can be measured by the difference between observed inflation and the inflation target announced by the central bank. Among several indices that measure reputation, the index proposed by de Mendonça and de Guimarães e Souza (2009), and de Mendonça and Galveas (2013) is particularly useful for this study because it fits well in the case of developing countries that have adopted inflation targeting. In this sense, reputation is maximum ( $REPUT$  is equal to 1) when the observed inflation ( $INF_t$ ) is equal to the inflation target ( $INF_t^*$ ). When the observed inflation exceeds the limits of the tolerance interval, the  $REPUT$  is equal to 0. Because there is the limit of tolerance interval inflation fixed by the monetary authority, the index considers the minimum ( $INF_t^{lower}$ ) and maximum limits ( $INF_t^{upper}$ ) for the inflation target each year. So, the reputation index decreases in a linear fashion as observed inflation deviates from this target. As a consequence, the scale of the  $REPUT$  is from 0 to 1. Therefore,  $REPUT$  is a result of:

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<sup>4</sup> See, for example, Minea and Villieu (2009), Lucotte (2012), Nolivos and Vuletin (2014), and Minea and Tapsoba (2014).

$$REPUT_t = \left\{ \begin{array}{ll} 1 & \text{if } INF_t = INF_t^* \\ 1 - \frac{1}{INF_t^{bound} - INF_t^*} (INF_t - INF_t^*) & \text{if } INF_t^{lower\_bound} < INF_t < INF_t^{upper\_bound} \\ 0 & \text{if } INF_t \geq INF_t^{upper\_bound} \text{ or } INF_t \leq INF_t^{lower\_bound} \end{array} \right\} \quad [3]$$

The behavior of the variables essential for building the reputation index (observed inflation, tolerance intervals, and inflation target) after the adoption of inflation targeting in Colombia is shown in Figure 1. It is possible to note that the observed inflation is near the upper limit of the tolerance interval for the inflation during most of the period between 2004 and 2006. For the period between 2007 and 2009, observed inflation has exceeded the tolerance interval for inflation. After this period, observed inflation started to approach the central inflation target.

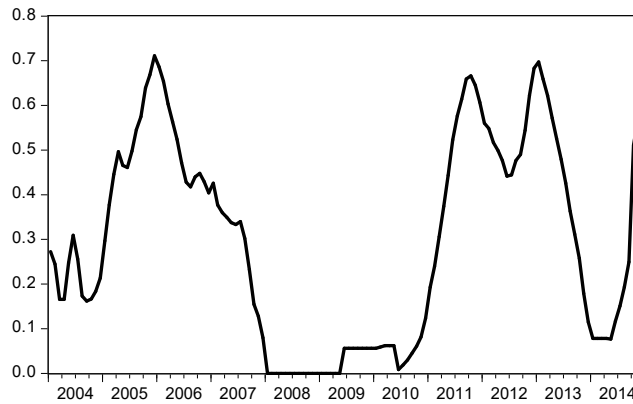


Source of data: Central Bank of Colombia (see table A.1 – appendix).

Figure 2 shows the performance of reputation from 2004 to 2014 in Colombia. As expected, to the extent that the bank started to reach the inflation target's reputation showed an increase (2004-2006). However, from late 2006 the observed inflation crossed the tolerance intervals and the reputation went into a downward phase (index equal to zero between 2008 and mid-2009). The period 2010-2012 shows reputation gains and therefore indicates greater efficiency of monetary policy to keep inflation within the tolerance range. Nevertheless, the reputation gains began to fall again since 2013 due to the fact that observed inflation was below the tolerance intervals, but after rebounded in 2014.



**Figure 2**  
*Reputation index*



In short, to observe the effect of the central bank's performance on tax effort, the following model is considered:

$$TE_t = \alpha_0 + \alpha_1 REPUT_t + \alpha_2 X_i + u_t \quad [4]$$

Where  $TE$  is the tax effort,  $REPUT$  is the reputation index,  $X_i$  is a vector of explanatory variables and  $u_i$  is the residual term. The vector of control variables used are macroeconomic variables associated with the public sector in order to see if there are other determinants beyond monetary policy that may affect the tax effort. As shown by Tanzi (1989) and Torgler (2005), public employees should be stimulated in order to promote tax morale. Thus, a first control variable that affects the tax effort are the wages in the public sector ( $WAGE$ ). The human capital formation of a country is important to collecting taxes. According to Torgler (2005), Cyan, Martinez-Vasquez, e Vulovic (2013), e Fenochietto e Pessino (2013), a society with over education, have greater capacity to design strategies to persuade the payment of taxes. So, government expenditure on education/GDP ratio ( $EDUC$ ) is another variable inserted into the model to explain the tax effort. A measure of the necessity for the fiscal authorities to seek revenue is the public debt service (see, for example, Teera and Hudson, 2004; Brun, Chambas, and Guerineau, 2008). Therefore, a third control variable considered is the service of the public debt ( $DEBT$ ).

In order to calculate the tax capacity and tax effort, the equations (1) and (4) are estimated through two approaches: Ordinary Least Squares with heteroskedasticity and autocorrelation covariance matrix estimators (HAC), and one-step Generalized Method of Moments (GMM) with HAC (see Davidson and MacKinnon, 2004). As pointed out by Greene (1993), the main reason for using GMM is that although the OLS estimator is useful, it is not reliable in the presence of serial autocorrelation, heteroskedasticity, or nonlinearity (tests in appendix – table A.4). Furthermore, there may be

endogeneity problems in the proposed models that invalidate the estimates through the OLS. To deal with the endogeneity problem, the instrumental variables used in the GMM estimations should be exogenous. So, the chosen instrumental variables were lagged at least one period in order to help predict the corresponding contemporary variables. As Wooldridge (2001), for efficient estimation with GMM are necessary overidentifying restrictions. Therefore, the J-test was applied (see, Hansen, 1982).<sup>5</sup>

Taking into account the information available from Central Bank of Colombia and National Bureau of Statistics of Colombia, the data in this study has monthly frequency for the period from January of 2004 to December of 2014 (descriptive statistics are presented in table A.2 – appendix). Our analysis begins in 2004 because this is when Central Bank of Colombia starts to provide information regarding tolerance intervals (essential data for building the reputation index). As usual, the use of time series data in estimations entails checking whether the series have a unit root (non-stationary data series) to avoid the possibility of spurious regression. Therefore, the Augmented Dickey–Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are performed. The series I(0) are considered levels and the series I(1) are used in first differences (see table A.3 – appendix).

## **4. Empirical results**

The purpose of this section is to present empirical evidences regarding the estimation of tax capacity and the tax effort performance. In the first section is estimated the tax capacity. In the second subsection is built the tax effort taking into account the estimates of tax capacity. The third subsection presents the empirical analysis to check if the reputation of the monetary authority, such as a performance measure in achieving the inflation target, is important to explain the tax effort. The fourth subsection realizes robustness tests. Finally, in the fifth subsection is ranked the tax effort between low, medium and high in order to assess the efficiency of taxing by the fiscal authority during the period under inflation targeting.

### **4.1. Estimation of tax capacity**

The main purpose of this section is to use the variables associated with the Colombian economy structure to estimate the ratio of tax/GDP. The results of the basic model estimation, equation (1), and other models that are in the empirical literature (models (2) - (6)) are shown in Table 1.

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<sup>5</sup> To eliminate any possibility of skewing the results, the number of instruments/number of observations ratio is lower than 0.18 in all GMM estimations (list of GMM instruments is available on table A.5– appendix).

**Table 1**  
**Estimates of the tax capacity (OLS-HAC e GMM)**

Dep. Variable $TAX_t$	Model (1)		Bahl (1971), Chelliah (1971), Tait et al. (1979) Model (2)		Stotsky and WoldeMariam (1997) Model (3)		Teera and Hudson (2004), Mkandawire (2010) Model (4)		Davoodi and Grigorian (2007) Model (5)		Bird, Martinez-Vasquez, and Torgler (2008) Model (6)	
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Constant	0.0588*** (0.0134)	0.0645*** (0.0172)	0.1000*** (0.0147)	0.1116*** (0.0230)	0.0990*** (0.0142)	0.1024*** (0.0162)	0.1055*** (0.0342)	0.1184*** (0.0229)	0.1064*** (0.0179)	0.1134*** (0.0232)	0.1032*** (0.0286)	0.1206*** (0.0251)
$GDPPC_{t-1}$	3.56E-09 (4.95E-08)	1.31E-08 (7.16E-08)	1.37E-07 (9.51E-08)	9.26E-08 (9.18E-08)	1.41E-07 (9.51E-08)	7.41E-08 (6.06E-08)	1.52E-07 (1.07E-07)	1.15E-07 (1.07E-07)	1.32E-07 (1.13E-07)	4.75E-08 (8.38E-08)	1.52E-07 (1.25E-07)	9.67E-08 (1.12E-07)
$IMP_{t-1}$	0.3036*** (0.0678)	0.2912*** (0.0864)										
$AGRI_{t-1}$	-5.9591*** (1.8481)	-7.5612*** (2.7870)	-5.5438 (4.1489)	-6.6589* (3.7050)	-5.4844 (4.2119)	-5.7956** (2.6855)	-4.6896 (3.8796)	-1.0690 (2.4614)	-4.2520 (3.7551)	-0.7303 (1.9801)		
$OIL_{t-1}$	0.3036*** (0.0678)	0.00011** (5.37E-06)										
$PUBINV_{t-1}$	0.9727** (0.3908)	1.2213** (0.4740)										
$MIN_{t-1}$			-0.6900 (0.7514)	-0.6685 (0.5874)	-0.6440 (0.7865)	-0.4662 (0.4204)						
$IND_{t-1}$					-0.5537 (1.0238)	-0.8848 (0.6335)	-1.3400 (0.8771)	-2.0338 (1.2338)			-0.9258 (0.8902)	-1.0869 (0.7119)
$XM_{t-1}$			0.0950** (0.0471)	0.0612 (0.0818)	0.0976** (0.0475)	0.0919* (0.0552)	0.0924 (0.0601)	0.1208** (0.0567)	0.0877* (0.0477)	0.0915 (0.0705)	0.1163* (0.0667)	0.1191* (0.0643)
$NAGRI_{t-1}$											0.5854 (0.9564)	0.0875 (0.5450)
$URB_{t-1}$									-24.056 (56.390)	-51.371* (26.939)		
$INFORMAL_{t-1}$							0.1229 (0.5343)	-0.2603 (0.2647)	0.0879 (0.4621)	-0.0733 (0.2653)		
$DEBTEXT_{t-1}$							0.1879 (0.1724)	0.1655 (0.3262)				
$POP_{t-1}$							-1.25E-07 (8.97E-07)	-5.71E-07* (3.29E-07)			-2.16E-07 (7.82E-07)	-5.85E-07** (2.77E-07)
$R^2_{adj}$	0.33	0.31	0.17	0.15	0.17	0.15	0.16	0.10	0.18	0.15	0.13	0.11
F-statistic	14.07		7.79		6.42		4.63		6.99		4.93	
Prob(F-Stat)	0.00		0.00		0.00		0.00		0.00		0.00	
J-statistic		11.08		6.39		6.67		11.11		10.41		10.32
Prob(J-stat)		0.43		0.38		0.57		0.60		0.57		0.50
N. Instr./N. Obs.		0.12		0.08		0.10		0.15		0.13		0.12

**Note:** Marginal significance levels: (\*\*\*) denotes 0.01, (\*\*) denotes 0.05, and (\*) denotes 0.10. Robust (Newey-West) standard errors are in parentheses and t-statistics in brackets. P(Fstat) report the respective p-value of the F-test. P(J-statistic) report the respective p-value of the J-test.

The results presented in Table 1 suggest that in the case of Colombia changes the tax capacity are explained by the sector composition (agriculture and oil price), institutional quality (public investment), and the ratio imports/GDP. As the results in Table 1, the parameter associated with the GDP per capita is not statistically significant in the estimations. Therefore, the tax capacity in Colombia is not explained by the performance of GDP per capita. Similar results are found by Junguito and Rincon (2004) and OECD (2015). It is found that the parameter associated with the share of agriculture in GDP is negative and has statistical significance at 1% only in the estimates of the basic model. Thus, there is empirical evidence that the changes in the share of agriculture in GDP relate inversely with the tax capacity. The agricultural sector is a subsistence sector without economic surplus and therefore the revenues from agriculture are low.<sup>6</sup> Moreover, as Bird, Martinez-Vasquez and Torgler (2008), in emerging economies the agricultural sector exerts political pressure not to pay taxes. In short, the hypothesis that the tax capacity is affected by the loss of economic importance of the agricultural sector is confirmed. The results also show that the performance of another different sectors of agriculture (mining, industry and non-agricultural sector) are not important to explain the tax capacity.

For the basic model, the signal associated with the parameter of the ratio imports/GDP is positive and has statistical significance (see Table 1). As shown Davoodi and Gregorian (2007) and Gupta (2007), taxes on foreign trade are an alternative for the emerging economies seeking tax revenues because the foreign trade is centralized and can be monitored with lower costs by the fiscal authorities.

The oil price is important to analyze the tax revenues in Colombia. As can be seen in the estimates shown in Table 1, the parameter associated with the oil price is positive and has statistical significance. As suggested by Lopez et al. (2013) and Villar and Forero (2014) there are indications that the revenue generated by rising oil prices affect positively the public budget. Finally, the parameter associated with public investment is positive and has statistical significance (see Table 1). Thus, in the same direction which is observed by Bird, Martinez-Vasquez and Torgler (2008) and Fenchietto and Pessino (2013), the results indicate that institutional improvements represented by public investments allow an increase in tax collection and, therefore, a higher tax capacity.

The results also show that the parameters of the other measures of institutional quality, as the debt/GDP ratio and the informal sector are not significant in statistical terms to estimate the tax capacity (see Table 1). In addition, the parameters of the variables that measure the population growth rate and urbanization degree are not significant in statistical terms. The results of the regressions

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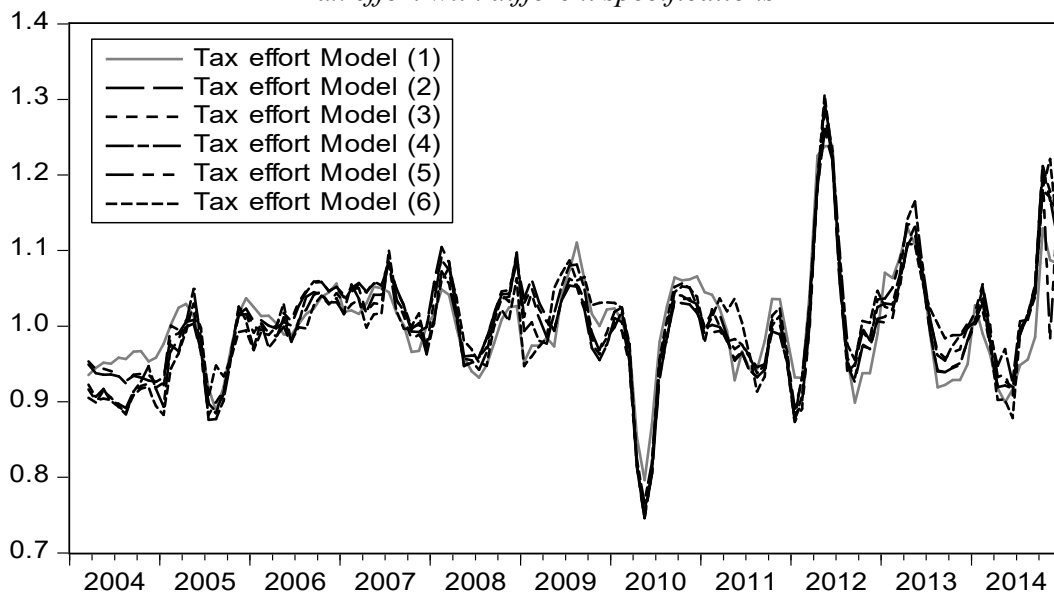
<sup>6</sup> Similar results for the recent period are found Fenchietto and Pessino (2013).

performed with the OLS and GMM methods (see Table 1) indicate that the coefficient of determination is low. Therefore, this suggests that the tax effort may be relevant to explain the changes in the ratio tax/GDP.

#### 4.2. Construction of the tax effort

This section aims to build the tax effort with the estimates presented in Table 1. In order to obtain the tax effort, the tax/GDP estimated by OLS was used, since there is no significant difference in the ratio tax/GDP estimated by the OLS and GMM. Once constructed the  $\widehat{TAX}_t$  variable, the tax effort was calculated from equation (2). As can be seen in Figure 3, the different measures of tax effort are similar. In other words, the specification used to estimate the tax capacity does not change significantly the tax effort behavior for the Colombian economy.

**Figure 3**  
*Tax effort with different specifications*



Taking into account the results of the estimates presented in Table 1, the tax effort built by the basic model (model (1)) is used by have best statistical performance: greater significance in the parameters, greater statistical F and higher adjusted  $R^2$  (see table 1).

#### 4.3. The inflation targeting effect on tax effort

This section aims to present empirical evidence of the reputation, as a monetary policy performance measure under inflation targeting, affects the tax effort. The Table 2 presents the results for estimates of OLS and GMM for the model of equation (4).

**Table 2**  
**Tax effort estimates with model (1) - OLS and GMM**

Dep. Variable $TE_t$	OLS estimates					GMM estimates				
	<i>Esp. (1)</i>	<i>Esp. (2)</i>	<i>Esp. (3)</i>	<i>Esp. (4)</i>	<i>Esp. (5)</i>	<i>Esp. (1)</i>	<i>Esp. (2)</i>	<i>Esp. (3)</i>	<i>Esp. (4)</i>	<i>Esp. (5)</i>
Constant	0.9816*** (0.0094) [103.43]	0.6549*** (0.1122) [5.8331]	0.7475*** (0.0840) [8.8987]	0.8132*** (0.0497) [16.341]	0.2188 (0.1565) [1.3972]	0.9801*** (0.0121) [80.927]	0.6563*** (0.1356) [4.8395]	0.7213*** (0.1025) [7.0349]	0.8289*** (0.0441) [18.7883]	0.2509* (0.1331) [1.8838]
$REPUT_t$	0.0613** (0.0251) [2.4331]	0.0724*** (0.0250) [2.8974]	0.0592** (0.0247) [2.3959]	0.0804*** (0.0249) [3.2264]	0.0892*** (0.0239) [3.7276]	0.0633** (0.0300) [2.1079]	0.0775** (0.0308) [2.5168]	0.0549** (0.0273) [2.0082]	0.0688** (0.0301) [2.2851]	0.0812** (0.0317) [2.5602]
$WAGE_{t-4}$		0.0030*** (0.0010) [2.9330]			0.0029*** (0.0011) [2.6336]		0.0029** (0.0012) [2.4126]			0.0022** (0.0008) [2.6117]
$EDUC_{t-6}$			9.9022*** (3.4971) [2.8315]		13.060*** (3.3842) [3.8590]			11.1886*** (4.2328) [2.6433]		11.995*** (3.6403) [3.2950]
$DEBT_{t-7}$				57.290*** (16.382) [3.4971]	44.125*** (16.684) [2.6447]				51.8932*** (14.703) [3.5294]	68.510** (31.145) [2.1996]
$R^2_{adj}$	0.04	0.08	0.08	0.11	0.21	0.03	0.07	0.09	0.10	0.19
F-statistic	5.92	7.19	6.84	8.84	9.42					
Prob(F-Stat)	0.01	0.00	0.00	0.00	0.00					
J-statistic						6.27	5.05	5.52	6.65	4.76
Prob(J-stat)						0.28	0.28	0.59	0.24	0.57
N. Instr./N. Obs.						0.05	0.05	0.07	0.06	0.08

**Note:** Marginal significance levels: (\*\*\*) denotes 0.01, (\*\*) denotes 0.05, and (\*) denotes 0.10. Robust (Newey-West) standard errors are in parentheses and t-statistics in brackets. P(Fstat) report the respective p-value of the F-test. P(J-statistic) report the respective p-value of the J-test.

The estimation results presented in Table 2 show the expected behavior from the theoretical perspective. There is a positive relationship between the reputation and the effort in all estimated models. Therefore, this is evidence that better performance of the central bank in achieving the announced inflation target brings as result a better use of tax capacity. In general, the reputation gains of monetary policy increases the tax effort for two reasons. The first reason is that reputation gains of the central bank as a result of price stabilization causes the government values its tax revenues because there is a loss of revenue from the inflation tax (see, Lucotte, 2012; Minea and Tapsoba, 2014). The second reason is that when inflation is outside the ranges of tolerance (loss of reputation), the central bank must make increases in interest rates to control inflationary pressure. As the inflation is anchored (reputation gains), the government is obliged to make a greater tax effort to avoid default risk due to the increase in debt service caused by the inflation fighting. So, the inflation control implies an increase in the primary surplus to reduce the debt burden.<sup>7</sup>

As the results show (see Table 2), the signs of the coefficients of the control variables used in the models have the expected behavior. The parameter associated with the public sector wages is positive and is statistically significant. As is pointed out by Tanzi (1989) and Torgler (2005), a higher salary in the public sector provides an incentive to improve revenue administration and as a result there is a greater tax effort. The parameter associated with government expenditure on education is positive and has statistical significance. Thus, just as is observed by Fenochietto and Pessino (2013), human capital can have a positive influence on tax collection, both because of the improvement in the administration of the institutions of government, like by the positive effects it brings on the willingness to pay taxes. Finally, it is noted that the parameter associated with the public debt service is positive and statistically significant at the 1% (see Table 2). A possible explanation for this result is that an increase in debt service leads to a fiscal deterioration that require the search for increased tax revenue (see, Tanzi, 1992a, b; Brun, Chambas, and Guerineau, 2008).

#### **4.4. Robustness**

With reference to the procedure adopted by Feger and Asafu-Adjaye (2014), the previous results underwent to robustness tests. Aiming to verify if the results do not depend of the model used to estimate the tax capacity, the different measures of tax effort presented in Figure 5 were used. The tax effort measures used refer to the models (2) - (6), and were constructed from the results of OLS

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<sup>7</sup> This phenomenon is known as the unpleasant fiscal arithmetic. See Blanchard (2004) and de Mendonça and Silva (2009).

estimates shown in Table 1. By the same procedure adopted in the previous section (section 4.3 the model that incorporates all the explanatory variables is estimated to present better statistical performances: greater significance in the parameters, greater statistical F and higher adjusted  $R^2$  (see table 2, Esp. 5).

As can be seen in Table 3, the different measures of tax effort not change the empirical evidence presented in the previous section. The parameter associated with reputation has positive sign and retains statistical significance. Thus, the scope of the inflation targets by the central bank always leads to a greater use of the tax base, regardless of the form it is calculated the tax capacity. It is also observed that the parameters associated with the salary and the public debt service retain their positive sign with statistical significance. Therefore, empirical evidence also reinforces the importance of improving the working conditions and greeting the public debt service to take advantage of the tax base. Finally, despite of conserving the expected signal, the parameter associated with public spending on education is not significant in statistical terms.



**Table 3**  
**Tax effort estimates with models (2)-(6) - OLS and GMM**

Dep. Variable $TE_t$	OLS estimates					GMM estimates				
	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Constant	0.3916** (0.1862) [2.1027]	0.4272** (0.1879) [2.2728]	0.3623 (0.1814) [1.9970]	0.3716** (0.1761) [2.1100]	0.3301* (0.1853) [1.7813]	0.2855 (0.2048) [1.3934]	0.5353*** (0.2000) [2.6766]	0.2477 (0.1819) [1.3614]	-0.1543 (0.3124) [-0.4938]	0.1428 (0.2100) [0.6800]
$REPUT_t$	0.0764*** (0.0284) [2.6872]	0.0758*** (0.0287) [2.6405]	0.0793*** (0.0277) [2.8596]	0.0753*** (0.0269) [2.7997]	0.0829*** (0.0239) [2.9290]	0.0879** (0.0461) [1.9160]	0.0718* (0.0404) [1.7737]	0.0881** (0.0438) [2.0077]	0.0805** (0.0369) [2.1774]	0.0904** (0.0450) [2.0088]
$WAGE_{t-4}$	0.0036*** (0.0013) [2.7660]	0.0033** (0.0013) [2.4735]	0.0035*** (0.0012) [2.7745]	0.0039*** (0.0012) [3.1264]	0.0032** (0.0013) [2.4178]	0.0039** (0.0015) [2.5091]	0.0032*** (0.0011) [2.8169]	0.0035*** (0.0013) [2.6030]	0.0085*** (0.0026) [3.2599]	0.0037* (0.0020) [1.8450]
$EDUC_{t-6}$	3.6830 (4.0252) [0.9149]	3.8261 (4.0624) [0.9418]	5.0436 (3.9213) [1.2861]	3.1667 (3.8070) [0.8318]	7.2979* (4.0053) [1.8220]	1.3214 (5.1032) [0.2589]	-0.8455 (5.4098) [-0.1563]	5.5470 (4.4661) [1.2420]	7.3309* (4.1909) [1.7492]	7.5673* (4.4484) [1.7011]
$DEBT_{t-7}$	35.8805* (19.844) [1.8081]	35.767* (20.027) [1.7858]	37.857* (19.331) [1.9583]	37.948** (18.768) [2.0219]	44.9057** (19.7463) [2.2741]	77.619** (36.864) [2.1055]	39.304* (21.993) [1.7871]	71.349* (37.547) [1.9002]	11.422 (24.401) [0.4680]	85.553** (39.062) [2.1901]
$R^2_{adj}$	0.10	0.09	0.12	0.13	0.12	0.07	0.08	0.07	0.06	0.06
F-statistic	4.82	4.27	5.24	5.91	5.41					
Prob(F-Stat)	0.00	0.00	0.00	0.00	0.00					
J-statistic						2.09	0.48	1.79	0.50	0.58
Prob(J-stat)						0.35	0.78	0.77	0.91	0.44
N. Instr./N. Obs.						0.05	0.05	0.06	0.06	0.04

**Note:** Marginal significance levels: (\*\*\*) denotes 0.01, (\*\*) denotes 0.05, and (\*) denotes 0.10. Robust (Newey-West) standard errors are in parentheses and t-statistics in brackets. P(Fstat) report the respective p-value of the F-test. P(J-statistic) report the respective p-value of the J-test.

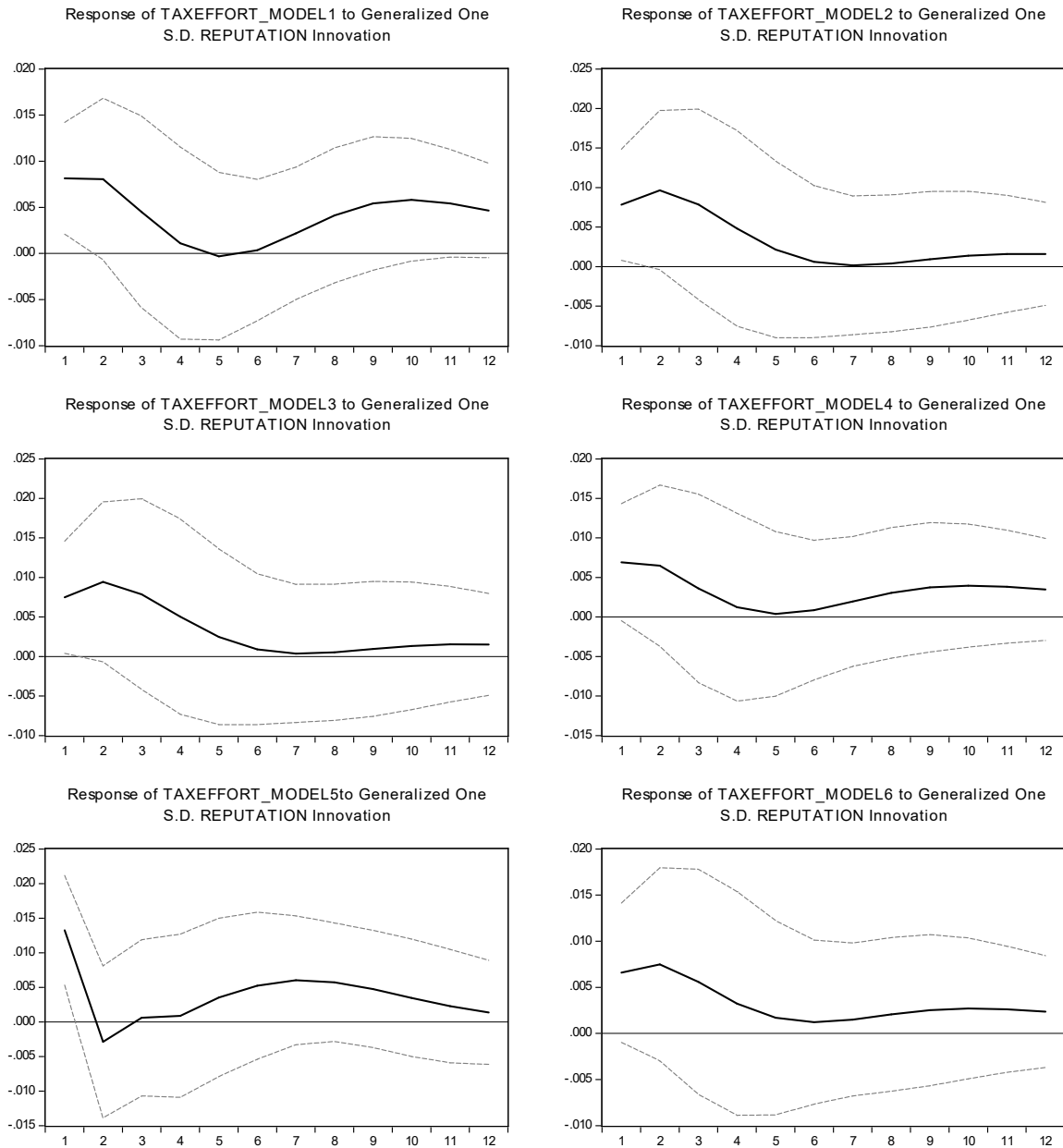
Taking into account the different measures of tax effort (models (1)-(6)), we extend our analysis providing new empirical evidence of the effect of reputation on tax effort through a Vector Auto Regressive (VAR) model. As usual, the dynamic analysis of VAR is made through impulse response functions because it allows one to observe the impulse on the reputation index caused by shocks (or innovations) provoked by residual variables over time. As suggested by Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998), we make use of the generalized impulse response function (impulse responses are invariant to any re-ordering of the variables in the VAR).

Figure 4 shows the results of the generalized impulse-response functions and are plotted out to the 12th month.<sup>8</sup> The several graphs suggest that an unexpected positive shock on reputation provokes a significant increase in the tax effort that abides over time. In brief, the gain of reputation due to the success in achieving the inflation target help improve the use of the tax base.

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<sup>8</sup> All VARs are order 2 based on Akaike criterion. Furthermore, all VAR satisfy the stability condition. Tests are available from the authors on request.

**Figure 4**  
*Accumulate response to generalized one s.d. innovations  $\pm 2$  S.E.*



#### 4.5. Efficiency in the use of the tax base

The purpose of this section is to evaluate the changes in application efficiency of taxes on their tax base under inflation targeting. Thus, the tax effort is classified for years and is made a comparison between the ratio tax/GDP ratio observed with the tax/GDP estimated. Due to the use of monthly

data, the tax efficiency for each specific year was calculated with the final month data (accumulated tax effort).

As Tait, Gratz and Eichengreen (1979), Piancastelli (2001), and Feger and Asafu-Adjaye (2014) the tax effort can be ranked among high ( $TE > 1$ ), medium ( $0.84 < TE \leq 1$ ) or low ( $TE \leq 0.84$ ). In Table 4 are shown the cumulative results for 2004 to 2014.

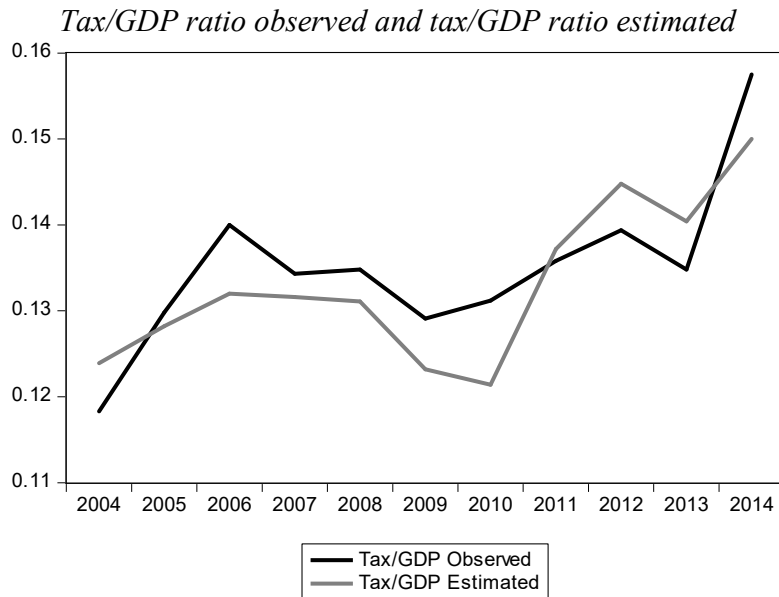
**Table 4**  
**Tax effort in Colombia**

<b>Year</b>	<b>Tax effort</b>	<b>Classification</b>
2004	0.95	medium
2005	1.03	high
2006	1.06	high
2007	1.02	high
2008	1.02	high
2009	1.04	high
2010	1.08	high
2011	0.98	medium
2012	0.97	medium
2013	0.93	medium
2014	1.05	high
<b><i>mean 2004-2014</i></b>	<b><i>1.01</i></b>	<b><i>high</i></b>

By the results of Table 4, in the period 2004 to 2014 the tax effort was high (average 1.01). Since the reporting period corresponds to the period under inflation targeting, there is evidence that the fight against inflation by the central bank is associated with an improvement in the use of the tax base.

Based on the procedure adopted by Davoodi and Gregorian (2007), in the Figure 5 is presented the tax/GDP ratio observed and the tax/GDP ratio estimated for the end of each year in the period 2004-2014 based on the basic model estimates. It is observed that the tax effort was high between 2005-2010 because the tax/GDP ratio observed was higher than the tax/GDP ratio estimated. The 2005-2010 period also coincides with a significant disinflationary process of the Colombian economy toward long-term inflation target of the central bank (5.5% in January 2005 to 3% in January 2010, see Figure 1). So, the period 2005-2010 shows a high tax effort combined with a strong central bank's effort to fight inflation. In the period 2011-2013, the tax/GDP ratio estimated was above of the tax/GDP ratio observed indicating that the tax effort declined. However, the tax effort still ranks as average in 2013. Finally, in 2014 the tax effort was again ranked as high. In short, there is evidence that the tax effort does not rank as low in the period analyzed.

**Figure 5**



## 5. Concluding remarks

Based on data from Colombia, this study examined the use of tax capacity. In particular, it was considered as the tax effort is affected by the reputation of the central bank under inflation targeting. The tax effort and reputational measures were built, as were also taken into account macroeconomic variables used in the literature. Through an empirical analysis with regressions, two aspects were checked. The first aspect was to verify the importance of tax effort as a determining tax/GDP ratio. The second above-mentioned aspect was to evaluate the importance of reputation to explain the tax effort.

The results suggest that the central bank success in achieving the announced inflation target causes better use of the tax base. It was also noted that there is a high efficiency in the application of taxes during the period under inflation targeting in Colombia. In particular, the results of this study help to understand the importance of price stability for the tax revenues management in emerging economies. Is important to highlight that the tax effort can be affected by many other factors that cannot be related to the reputation of the central bank. For example, the evidence presented in this study also showed that the tax effort is affected positively by higher wages in the public sector and, to a lesser extent, by human capital improvements. In addition, the need for payment the public debt service encourages the use of the tax base.

## 6. References

- ANSARI, M. (1982). "Determinants of tax ratio: a cross-country analysis." *Economic and political weekly*, 17(25), 1035-1042.
- BAHL, R. W. (1971). "A Regression Approach to Tax Effort and Tax Ratio Analysis." *IMF Staff Papers*, 18(3), 570-612.
- BARRO, R. J., GORDON, D. (1983). "Rules, discretion and reputation in a model of monetary policy." *Journal of Monetary Economics*, 12(1), 101–122.
- BIRD, R., J. MARTINEZ-VAZQUEZ, B. TORGLER. (2008). "Tax Effort in Developing Countries and High Income Countries: The Impact of Corruption, Voice and Accountability." *Economic Analysis and Policy*, 38(1), 55-71.
- BLANCHARD, O. (2004). Fiscal Dominance and Inflation Targeting: Lessons from Brazil. NBER Working Paper, No. 10389, Cambridge, 1-46.
- BRUN, J.-F., CHAMBAS, G., GUERINEAU, S. (2008). Aide et mobilisation fiscale dans les pays en développement. CERDI, Etudes et Documents, E-2008.12, Clermont-Ferrand, 1-76.
- CHELLIAH, R. J. (1971). "Trends in taxation in developing countries." *IMF Staff Papers*, 18(2), 254-331.
- CYAN, M., MARTÍNEZ-VÁSQUEZ, J., VULOVIC, V. (2013). Measuring tax effort: Does the estimation approach matter and should effort be linked to expenditure goals?. International Center for Public Policy, Working Paper, No. 13-08, Georgia, 1-48.
- DAVOODI, H.R., GRIGORIAN, D. A. (2007). Tax Potential vs. Tax Effort: A Cross-Country Analysis of Armenia's Stubbornly Low Tax Collection. IMF Working paper, No. 07(106), Washington, 1-38.
- de MENDONÇA, H.F. (2007). "Towards credibility from Inflation targeting: the Brazilian experience." *Applied Economics*, 39(20), 2599–2615.
- de MENDONÇA, H.F., GALVEAS, K.A.S. (2013). "Transparency and Inflation: What is the effect on the Brazilian Economy?." *Economic Systems*, 37(1), 69-80.
- de MENDONÇA, H.F., de GUIMARÃES e SOUZA, G.J.G. (2009). "Inflation targeting credibility and reputation: the consequences for the interest rate." *Economic Modelling*, 26(6), 1228–1238.
- de MENDONÇA, H.F., SILVA, R.T. (2009). "Fiscal effect from inflation targeting: the Brazilian experience." *Applied Economics*, 41(7), 885-897.
- FEGER, T., ASAFU-ADJAYE, J. (2014). "Tax effort performance in sub-Saharan Africa and the role of colonialism." *Economic Modelling*, 38(2), 163-174.
- FENOCHIETTO, R., PESSINO, C. (2013). Understanding Countries' Tax Effort. IMF Working Paper, No. 13/244, Washington, 1-30.
- GUPTA, A.S. (2007). Determinants of tax revenue efforts in developing countries. IMF Working Paper, No. 07 (184), Washington, 1-41.
- HANSEN, P. L. (1982). "Large Sample Properties of Generalized Method of Moments Estimators." *Econometrica*, 50(4), 1029-1054.
- JUNGUITO, R., RINCON, H. (2004). "La política fiscal en el siglo XX en Colombia." *Borradores de Economía*, No. 318, Colômbia, 1-160.
- KOOP, G., PESARAN, M. H., POTTER, S. M. (1996). "Impulse response analysis in non-linear multivariate models." *Journal of Econometrics*, 74(1), 119-147.

- KWIATKOWSKI, D., PHILLIPS, P. C. B., SCHMIDT, P., SHIN, Y. (1992). "Testing the null hypothesis of stationarity against the alternative of a unit root." *Journal of Econometrics*, 54(1), 159–178.
- KYDLAND, F.E., PRESCOTT, E.C. (1977). "Rules rather than discretion: the inconsistency of optimal plans." *Journal of Political Economy*, 85(3), 473-492.
- LOPEZ, E., MONTES, E., GARAVITO A., COLLAZOS, M. (2013). "La economía petrolera en Colombia. Relaciones intersectoriales e importancia en la economía nacional." *Borradores de Economía*, No. 748, Colombia, 1-57.
- LOTZ, J., MORSS, E. (1970). "A theory of tax level determinants for developing countries." *Economic Development and Cultural Change*, 18(3), 328-341.
- LUCOTTE, Y. (2012). "Adoption of inflation targeting and tax revenue performance in emerging market economies: An empirical investigation." *Economic Systems*, 36(4), 609-628.
- MINEA A., TAPSOBA, R. (2014). "Does inflation targeting improve fiscal discipline?." *Journal of International Money and Finance*, 40(1), 185–203.
- MINEA, A., VILLIEU, P. (2009). "Can inflation targeting promote institutional quality in developing countries?." In: *The 26th Symposium on Money, Banking and Finance*. University of Orléans. Orléans.
- MKANDAWIRE, M. (2010). "On Tax Efforts and Colonial Heritage in Africa." *Journal of Development Studies*, 46(10), 1647-1669.
- MOSLEY, P. (2015). "Fiscal Composition and Aid Effectiveness: A Political Economy Model." *World Development*, 69(C), 106-115.
- NOLIVOS, R., VULETIN, G. (2014). "The role of central bank independence on optimal taxation and seigniorage." *European Journal of Political Economy*, 34(3), 440-458.
- OECD (2015). *OECD Economic Surveys: Colombia*. OCDE Publishing. 1-48.
- PERILLA, J. R. (2010). "El Impacto de los Precios del Petróleo Sobre el Crecimiento Económico en Colombia." *Economía del Rosario*, 13(1). 75-116.
- PESARAN, M. H., SHIN, Y. (1998). "Generalized impulse response analysis in linear multivariate models." *Economic Letters*, 58(1), 17-29.
- PIANCASTELLI, M. (2001). *Measuring the Tax Effort of Developed and Developing Countries: Cross-Country Panel Data Analysis, 1989-95*. Discussion Paper, No. 818, IPEA, Rio de Janeiro, 1-23.
- SOOKRAM, S., SARIDAKIS, G. (2009). "The effect of economic factors on the tax ratio in Trinidad and Tobago." *Journal of developing areas*, 42(2), 111-128.
- STOTSKY, J., A. WOLDEMARIAM. (1997). *Tax Effort in Sub-Saharan Africa*. IMF Working Paper, No. 97(107), Washington, 1-57.
- TAIT, A., GRATZ, W. L. M., EICHENGREEN, B. J. (1979). "International comparisons of taxation for selected developing countries 1972-76." *IMF Staff Papers*, 26(1), 123-156.
- TANZI V. (1989). "The impact of macroeconomic policies on the level of taxation and fiscal balance in developing countries." *IMF Staff Papers*, 36(3), 633-656.
- TANZI, V. (1992a). "Fiscal policy and economic reconstruction in Latin America." *World Development*, 20(5), 641-657.
- TANZI, V. (1992b). "Structural factors and tax revenue in developing countries: a decade of evidence." In: Goldin, I., Winters, A. (Eds.), *Open Economies: Structural Adjustment and Agriculture*. Cambridge University Press, Cambridge, 267–281.
- TEERA, J.M., HUDSON, J. (2004) "Tax performance: a comparative study." *Journal of International Development*, 16(6), 785-802.

- TORGLER, B. (2005). "Tax Morale in Latin America." *Public Choice*, 122(1), 133-157.
- VILLAR, L., FORERO, D. (2014). *Escenarios de vulnerabilidad fiscal para la economía colombiana*. Fedesarrollo, Bogotá, Colômbia, 1-32.
- WOOLDRIDGE, J. (2003). "Applications of Generalized Method of Moments Estimation." *Journal of Economic Perspectives*, 15(4), 87-100.

## Appendix

**Table A.1**  
**Sources of data and description of the variables**

Variable	Variable description	Data source
TAX	Tax/GDP – seasonal adjustment X12.	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm">http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm</a> )
GDPPC	Gross domestic product per capita – series was built on real GDP per capita (Colombian currency)	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/pib">http://www.banrep.gov.co/es/pib</a> )
IMP	Imports/GDP.	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/balanza-comercial">http://www.banrep.gov.co/es/balanza-comercial</a> )
AGRI	Agriculture/GDP.	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/pib">http://www.banrep.gov.co/es/pib</a> )
OIL	Oil price – West Texas Intermediate (WTI).	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/balanza-comercial">http://www.banrep.gov.co/es/balanza-comercial</a> )
PUBINV	Public Investment/GDP – seasonal adjustment X12	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm">http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm</a> )
INF*	Inflation target – Central Bank of Colombia.	<a href="http://www.banrep.gov.co/es/meta-inflacion">http://www.banrep.gov.co/es/meta-inflacion</a>
INF	Inflation accumulated in 12 months measured by the variation of the consumer price index.	<a href="http://www.banrep.gov.co/es/ipc">http://www.banrep.gov.co/es/ipc</a>
REPUT	Reputation index. Devised by authors, based on de Mendonça and Galveas (2013) methodology	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/ipc">http://www.banrep.gov.co/es/ipc</a> )
EDUC	Government expenditure on education/GDP – seasonal adjustment X12	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm">http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm</a> )
WAGE	Public sector wages index	National Bureau of Statistics of Colombia (DANE) ( <a href="http://www.dane.gov.co/index.php/">http://www.dane.gov.co/index.php/</a> )



estadisticas-por-tema/mercado-laboral)

DEBT	Public debt service/GDP – seasonal adjustment X12	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm">http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm</a> )
MIN	Mining Industry/GDP	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/pib">http://www.banrep.gov.co/es/pib</a> )
IND	Industry/GDP	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/pib">http://www.banrep.gov.co/es/pib</a> )
XM	Trade openness - total trade (i.e. the sum of exports and imports of goods and services) relative to GDP	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/balanza-comercial">http://www.banrep.gov.co/es/balanza-comercial</a> )
INFORMAL	Informal sector (measured by employment in the informal sector/total employment)	National Bureau of Statistics of Colombia (DANE) ( <a href="http://www.dane.gov.co/index.php/estadisticas-por-tema/mercado-laboral">http://www.dane.gov.co/index.php/estadisticas-por-tema/mercado-laboral</a> )
URB	Urbanization degree	National Bureau of Statistics of Colombia (DANE) ( <a href="http://www.dane.gov.co/">http://www.dane.gov.co/</a> )
POP	Population.	National Bureau of Statistics of Colombia (DANE) ( <a href="http://www.dane.gov.co/">http://www.dane.gov.co/</a> )
DEBTEXT	External debt/GDP	Central Bank of Colombia ( <a href="http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm">http://www.banrep.gov.co/es/series-estadisticas/see_finanzas_publici.htm</a> ).

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**Table A.2**  
**Descriptive statistics**

<b>Variables</b>	<b>Mean</b>	<b>Median</b>	<b>Maximum</b>	<b>Minimum</b>	<b>Std. dev.</b>
TAX	0.1323	0.1317	0.1797	0.0945	0.0113
GDPPC	8845375	8828384	10609031	7329522	890366.7
IMP	0.1965	0.1956	0.2358	0.1715	0.0133
AGRI	0.0669	0.0676	0.0811	0.0546	0.0078
OIL	77.7654	77.3300	133.8800	34.3100	22.3284
PUBINV	0.0219	0.0278	0.0517	0.0059	0.0089
REPUT	0.2986	0.2994	0.7111	0.0000	0.2278
EDUC	0.0237	0.0237	0.0288	0.0197	0.0017
WAGE	107.4981	107.8775	124.6583	96.2088	5.6402
DEBT	0.028	0.028	0.040	0.019	0.003
MIN	0.082	0.079	0.122	0.052	0.020
IND	0.130	0.131	0.148	0.104	0.012
XM	0.299	0.298	0.373	0.226	0.029
INFORMAL	0.509	0.513	0.544	0.480	0.012
URB	0.752	0.753	0.763	0.740	0.007
POP	44994439	44978748	47775027	42259425	1686499
DEBTEXT	0.2027	0.1917	0.3008	0.1510	0.0368

**Table A.3**  
**Unit root tests (ADF, PP, and KPSS)**

Series	ADF				PP				KPSS			
	Lags	Esp.	I/T	C. V (5%)	Band	I/T.	Test	C.V. (5%)	Band	I/T.	Test	C.V. (5%)
TAX	4	I	-3.31	-2.88	4	N	-3.40	-2.88	4	I, T	0.09	0.14
GDPPC	10	I, T	-2.40	-3.44	4	I, T	-0.70	-3.44	4	I, T	0.21	0.14
ΔGDPPC	9	N	-0.16	-1.94	4	N	-3.63	-1.94	4	I	0.26	0.46
IMPORT	1	I	-2.94	-2.88	4	I	-1.74	-2.88	9	I	0.29	0.46
AGRI	11	I	-1.48	-2.88	4	I	-1.16	-2.88	9	I	1.38	0.46
ΔAGRI	10	I	-4.20	-2.88	35	N	-3.37	-1.94	3	I	0.05	0.46
OIL	1	I	-2.93	-2.88	5	N	-0.56	-1.94	8	I, T	0.09	0.14
PUBINV	1	I, T	-4.48	-3.44	7	N	-1.22	-1.94	9	I	1.21	0.46
ΔPUBINV	12	I	-5.59	-2.88	26	I	-3.16	-2.88	7	I	0.11	0.46
REPUT	2	N	-2.76	-1.94	7	N	-0.89	-1.94	9	I	0.14	0.46
WAGE	4	I	-3.75	-2.88	4	I	-4.25	-2.88	10	I	0.23	0.46
EDUC	4	I	-3.59	-2.88	4	I	-3.89	-2.88	9	I, T	0.08	0.14
DEBT	12	I	-3.03	-2.88	37	I	-16.93	-2.88	31	I	0.28	0.46
MIN	4	N	-0.18	-1.94	2	N	-0.72	-1.94	9	I, T	0.11	0.14
ΔMIN	3	N	-4.16	-1.94	18	N	-4.05	-1.94	2	I	0.06	0.46
XM	1	I	-4.92	-2.88	4	I	-6.79	-2.88	7	I, T	0.07	0.34
IND	10	N	-2.44	-1.94	16	I, T	-2.95	-3.44	8	I, T	0.29	0.14
ΔIND	12	I	-1.86	-2.88	34	I	-3.97	-2.88	18	I	0.24	0.56
NAGRI	4	N	-0.36	-1.94	4	N	-0.70	-1.94	9	I, T	0.10	0.14
ΔNAGRI	3	N	-4.18	-1.94	17	N	-3.61	-1.94	4	I	0.06	0.46
INFORMAL	10	N	-1.37	-1.94	54	N	-1.42	-1.94	8	I, T	0.18	0.14
ΔINFORMAL	9	N	-2.87	-1.94	29	N	-4.13	-1.94	55	I	0.22	0.46
DEBTEXT	1	N	-0.58	-1.94	2	N	-1.68	-1.94	6	I, T	0.31	0.11
ΔDEBTEXT	0	N	-7.81	-1.94	0	N	-5.75	-1.94	2	I, T	0.03	0.14
ΔPOP	1	I	-2.36	-2.88	9	I	-3.26	-2.88	8	I	0.13	0.46
ΔURB	3	N	0.80	-1.94	6	N	-3.68	-1.94	6	I, T	0.13	0.14

Note: C.V. = critical value. Trend (T), intercept (I) and none (N) are included based on Schwarz criterion. ADF – the final choice of lag was made based on Schwarz criterion. PP and KPSS – spectral estimation method is Bartlett kernel and the Newey-West Bandwidth is used.

**Table A.4**  
**Specification (RESET), Heteroskedasticity (BPG) and autocorrelation (LM) tests model (1)**

Tests	F-stat	p-value
<b>Model (1)</b>		
LM test (1)	184.08	0.00
LM test (2)	171.55	0.00
Breusch-Pagan-Godfrey test	1.88	0.10
RESET test (1)	0.41	0.67
<b>Esp. 1</b>		
LM test (1)	182.34	0.00
LM test (2)	169.41	0.00
Breusch-Pagan-Godfrey test	1.18	0.27
RESET test (1)	0.09	0.93
<b>Esp. 2</b>		
LM test (1)	171.74	0.00
LM test (2)	159.83	0.00
Breusch-Pagan-Godfrey test	0.55	0.57
RESET test (1)	0.89	0.37
<b>Esp. 3</b>		
LM test (1)	180.71	0.00
LM test (2)	158.39	0.00
Breusch-Pagan-Godfrey test	1.08	0.34
RESET test (1)	1.94	0.06
<b>Esp. 4</b>		
LM test (1)	135.89	0.00
LM test (2)	110.59	0.00
Breusch-Pagan-Godfrey test	0.73	0.48
RESET test (1)	0.17	0.86
<b>Esp. 5</b>		
LM test (1)	144.47	0.00
LM test (2)	109.40	0.00
Breusch-Pagan-Godfrey test	0.68	0.60
RESET test (1)	0.44	0.65

**Table A.5**  
**List of GMM instruments**

Dependent Variable	Model	Instruments
TAX	Model (1)	TAX <sub>-1</sub> , TAX <sub>-2</sub> , TAX <sub>-3</sub> , TAX <sub>-4</sub> , TAX <sub>-5</sub> , TAX <sub>-6</sub> , ΔGDPPC <sub>-3</sub> , ΔGDPPC <sub>-4</sub> , IMPORT <sub>-5</sub> , IMPORT <sub>-6</sub> , ΔAGRI <sub>-4</sub> , ΔAGRI <sub>-5</sub> , ΔAGRI <sub>-6</sub> , ΔPUBINV <sub>-2</sub> , ΔPUBINV <sub>-3</sub> , OIL <sub>-4</sub> .
TAX	Model (2)	TAX <sub>-3</sub> , TAX <sub>-4</sub> , TAX <sub>-5</sub> , TAX <sub>-6</sub> , ΔGDPPC <sub>-2</sub> , ΔGDPPC <sub>-3</sub> , ΔAGRI <sub>-4</sub> , ΔAGRI <sub>-5</sub> , ΔMIN <sub>-2</sub> , XM <sub>-2</sub> .
TAX	Model (3)	TAX <sub>-3</sub> , TAX <sub>-4</sub> , TAX <sub>-5</sub> , TAX <sub>-6</sub> , ΔGDPPC <sub>-2</sub> , ΔAGRI <sub>-7</sub> , ΔMIN <sub>-2</sub> , ΔMIN <sub>-3</sub> , ΔMIN <sub>-4</sub> , ΔIND <sub>-2</sub> , ΔIND <sub>-3</sub> , XM <sub>-2</sub> , XM <sub>-3</sub> .
TAX	Model (4)	TAX <sub>-2</sub> , TAX <sub>-3</sub> , TAX <sub>-4</sub> , ΔGDPPC <sub>-2</sub> , ΔGDPPC <sub>-3</sub> , ΔGDPPC <sub>-4</sub> , ΔAGRI <sub>-2</sub> , ΔAGRI <sub>-3</sub> , ΔAGRI <sub>-4</sub> , ΔIND <sub>-3</sub> , XM <sub>-2</sub> , XM <sub>-3</sub> , XM <sub>-4</sub> , ΔINFORMAL <sub>-2</sub> , ΔINFORMAL <sub>-3</sub> , ΔINFORMAL <sub>-4</sub> , ΔDEBTEXT <sub>-2</sub> , ΔDEBTEXT <sub>-3</sub> , ΔDEBTEXT <sub>-4</sub> , ΔPOP <sub>-4</sub> .
TAX	Model (5)	TAX <sub>-2</sub> , TAX <sub>-3</sub> , TAX <sub>-4</sub> , ΔGDPPC <sub>-2</sub> , ΔGDPPC <sub>-3</sub> , ΔGDPPC <sub>-4</sub> , ΔAGRI <sub>-2</sub> , ΔAGRI <sub>-3</sub> , ΔAGRI <sub>-4</sub> , XM <sub>-2</sub> , XM <sub>-3</sub> , ΔINFORMAL <sub>-2</sub> , ΔINFORMAL <sub>-3</sub> , ΔINFORMAL <sub>-4</sub> , ΔURB <sub>-2</sub> , ΔURB <sub>-3</sub> , ΔURB <sub>-4</sub> .
TAX	Model (6)	TAX <sub>-2</sub> , TAX <sub>-3</sub> , TAX <sub>-4</sub> , ΔGDPPC <sub>-2</sub> , ΔGDPPC <sub>-3</sub> , ΔNAGRI <sub>-2</sub> , ΔNAGRI <sub>-3</sub> , ΔNAGRI <sub>-4</sub> , ΔIND <sub>-2</sub> , ΔIND <sub>-3</sub> , ΔIND <sub>-4</sub> , XM <sub>-2</sub> , XM <sub>-3</sub> , XM <sub>-4</sub> , ΔPOP <sub>-2</sub> , ΔPOP <sub>-3</sub> .
TE	Esp. 1	TE <sub>-4</sub> , TE <sub>-5</sub> , REPUT <sub>-2</sub> , REPUT <sub>-3</sub> , REPUT <sub>-4</sub> , REPUT <sub>-5</sub> .
TE	Esp. 2	TE <sub>-4</sub> , TE <sub>-5</sub> , REPUT <sub>-1</sub> , REPUT <sub>-2</sub> , REPUT <sub>-3</sub> , WAGE <sub>-5</sub> .
TE	Esp. 3	TE <sub>-4</sub> , TE <sub>-5</sub> , TE <sub>-6</sub> , REPUT <sub>-2</sub> , REPUT <sub>-3</sub> , EDUC <sub>-6</sub> , EDUC <sub>-7</sub> , EDUC <sub>-8</sub> , WAGE.
TE	Esp. 4	TE <sub>-3</sub> , TE <sub>-4</sub> , TE <sub>-5</sub> , TE <sub>-6</sub> , REPUT <sub>-1</sub> , REPUT <sub>-2</sub> , DEBT <sub>-7</sub> .
TE	Esp. 5	TE <sub>-3</sub> , REPUT <sub>-1</sub> , REPUT <sub>-2</sub> , EDUC <sub>-7</sub> , EDUC <sub>-8</sub> , WAGE <sub>-4</sub> , WAGE <sub>-5</sub> , WAGE <sub>-6</sub> , DEBT <sub>-8</sub> .
TE	Model (2)	TE <sub>-4</sub> , REPUT <sub>-1</sub> , EDUC <sub>-6</sub> , EDUC <sub>-7</sub> , WAGE <sub>-5</sub> , DEBT <sub>-8</sub> .
TE	Model (3)	TE <sub>-3</sub> , REPUT <sub>-2</sub> , REPUT <sub>-3</sub> , EDUC <sub>-7</sub> , WAGE <sub>-4</sub> , DEBT <sub>-7</sub> .
TE	Model (4)	TE <sub>-4</sub> , TE <sub>-5</sub> , TE <sub>-6</sub> , REPUT <sub>-1</sub> , REPUT <sub>-2</sub> , EDUC <sub>-6</sub> , WAGE <sub>-5</sub> , DEBT <sub>-8</sub> .
TE	Model (5)	TE <sub>-3</sub> , REPUT <sub>-1</sub> , REPUT <sub>-2</sub> , EDUC <sub>-6</sub> , EDUC <sub>-7</sub> , WAGE <sub>-6</sub> , DEBT <sub>-7</sub> .
TE	Model (6)	TE <sub>-4</sub> , REPUT <sub>-2</sub> , EDUC <sub>-6</sub> , WAGE <sub>-5</sub> , DEBT <sub>-8</sub> .