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TAX BUOYANCY IN BOLIVIA

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ABSTRACT

Taking advantage of the change of trend in 2006 in aggregate tax collection, as well as in the main taxes and their tax bases, this paper makes an evaluation of the effects of the new prevailing economic conditions as from implementation of the Economic Social Comunitarian Productive Model (MESCP, in Spanish) on tax collection in the period between 2006-First Quarter of 2017, compared to the results obtained from 1990 to 2005. The study is based on the quantification of tax buoyancy for both periods, for which impulse response functions, cointegration vectors and error correction models are estimated. The results suggest that the buoyancies in the second period are largely attributed to the economic context resulting from application of the MESCP. In addition, the estimations show that the tax bases have a useful predictive content to determine the future behavior in the collection of these taxes.

Keywords: Tax buoyancy, Cointegration, Error Correction Model.
JEL Classification: E69, H11.

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I. INTRODUCTION

In order to understand the role of taxes in an economic system, it is convenient to name the three economic functions of the public sector listed by Musgrave (1959): i) the allocation function, ii) the distribution function, and iii) the stabilization function.

The first one refers to the division which the state has to make of the goods and services that can be produced with the available resources in a certain country. To this end, the government uses fiscal policy and regulation, as well as the public provision of certain goods and services.

In order to fulfill the distribution function —which is in line with the objectives pursued by a society— the government uses fiscal policy through the general budget of the nation.

Finally, the stabilization function commits the government to support the constant search for efficient production methods for the benefit of collectivity. In this sense, the government has to take care of and maintain price stability, employment and, in an economy that trades with the rest of the world, the equilibrium in the balance of payments. As is the case in the first and second functions, fiscal policy is one of the mechanisms at the government’s disposal to help achieve macroeconomic stability.

It is therefore clear that fiscal policy plays an important role for operation of the public sector of any country. The government has two instruments in this sense: tax revenue and tax expenditure. Tax revenues comprise tax collection, which throughout history have been and at present still are the main source of revenues for the state[1]. In addition, public investment is the main tool, on the expenditure side, at the governments’ disposal –within their fiscal policy— to stabilize fluctuations of the economic cycle; in this understanding, to the extent that the resources translated into this investment are in balance, tax collection is the primary source thereof.

Therefore, studying and analyzing the tax system is relevant and of interest to enhance performance of the fiscal policy.

In this regard, this paper presents a comparative quantification of long-term evolution of the aggregate tax collection and of the main Bolivian taxes in years 1990-2005 and 2006-first quarter of 2017, using the remarkable change of trend as from 2006 in these taxes and their respective tax bases, in response to the economic conditions resulting from application of the Communitarian Economic Social Comunitarian Productive Model (MESCP). The following taxes are considered: value added tax (IVA), transaction tax (IT), corporate income tax (IUE), excise tax (ICE), complementary regime of the IVA (RC-IVA), value added tax for imports (IVA IMPORTS), excise tax for imports (ICE IMPORTS) and customs tariffs (CT).

One –widely used- recommendable methodology for this measurement is based on the concept of tax buoyancy[2], which measures the percentage change in total tax collection (or of any specific tax) due to a variation in the tax base —typically approximated by the revenues of an economy (GDP, Gross Domestic Product).

[1] According to data of the Economic Commission for Latin America and the Caribbean (ECLAC), approximately 70% of the budget financing of the countries in the region comes from tax collection.

[2] Some authors prefer the term ‘tax reaction’. Considering this, in the remainder of this paper the terms tax buoyancy or reaction will be used interchangeably.

Thus, a higher or lower tax collection would implicitly reflect the change in the economic conditions of a tax system as a result of discretionary variations[3] made by the policymaker.

In the case of obtaining, for any tax, a buoyancy greater than one, this points to the collection of that tax responses more than proportionately to the changes in its tax base, since the conditions of the system favor the generation of greater tax revenues. The other way around, supposing that a change in the tax base is not translated into more tax revenues —a buoyancy below one—, this would be showing that the tax context is not helping to generate resources through taxes collection.

There are different –standard- estimation strategies to calculate this tax reaction; Ordinary Least Squares (OLS) and the combination of Dynamic Ordinary Least Squares (DOLS) and the Newey-West correction (1987). However, they give rise to the presence of an asymptotic bias of the estimators and inefficient standard errors, as pointed out by Sobel and Holcombe (1996). Thus, falling back on the research that addressed these problems when estimating this tax indicator, in this paper we use time series models based on cointegration analysis and vector error correction (VEC).

This study is organized in five sections. The first one reviews literature on the impact of changes in the macroeconomic and/or microeconomic context on tax collection associated to the domestic market, based on tax buoyancy and elasticity. The second section shows a set of stylized facts about total tax collection and the main taxes in Bolivia. Next, the third, fourth and fifth sections describe the variables, the estimation strategy and the results. Finally, the last part concludes the paper.

II. LITERATURE REVIEW

In order to make an evaluation of the results of a fiscal system, as well as to analyze the budget and forecast tax revenues, the economic literature on buoyancy of a tax frequently uses another concept called tax elasticity, which provides a quantification in percentage terms of the expected increases in tax collection derived exclusively from changes in the tax base, *ceteris paribus*, i.e. without considering the effects of changes in the fiscal structure in that period[4]. In this sense, the difference between elasticity and buoyancy of a tax shows the importance of the discretionary changes for that period.

There has been growing literature on the measurement of these fiscal indicators associated to different economic-fiscal phenomena since the first work done in the 1970s, applied to different countries. Nevertheless, this literature review considers the papers that uses tax buoyancies and elasticities to measure the impact of economic activity or fiscal-tax reforms on tax collection. Furthermore, the most relevant and/or most widely quoted literature in this field is considered.

One of the pioneering works in the calculation of the buoyancies and elasticities of tax revenues dates from 1972 and was prepared by Mansfield: using the Proportional Adjustment Method developed by Prest (1962) to estimate the elasticities, and previously detailing the methodology to calculate the buoyancies, the author

[3] Discretionary changes or variations, as made explicit by Sury (1978), take into account all policy measures that give rise to changes in the tax system, among which: the creation of new taxes, the revision of rates, expansion of the tax bases, tax amnesties, institutional factors, the macroeconomic context, and others.

[4] It is difficult to calculate tax elasticity since it is necessary to create a counterfactual of the time series corresponding to the tax collection of a tax, which isolates the effects in the collection of that tax as a result of discretionary changes in the tax system. on this series. There are five methodologies in this sense: i) Proportional adjustment method, ii) the approach based on dummy variables, iii) Constant rate structure method, and, iv) Divisia index method., and v) econometric methods. A more in-depth examination of this last methods can be found in Guillani (1986), Bilquees (2004), Sen (2006) and Omondi, Wawire, Manyasa and Thuku (2014).

makes these estimates for the Paraguayan case with information on years 1962-1970. The results of this document show that the tax elasticities were slightly above one, both for the aggregate tax system and for the main taxes. The corresponding tax buoyancies, on the other hand, are greater in at least 0.5 percentage point (pp) of the elasticities, which reflects effectiveness of the discretionary changes, particularly the improvement of control and tax collection, as well as the elimination of exceptions.

On the other hand, Trinidad and Perio (1981) sought to determine the response of the tax reforms conducted in the Philippines in the 1970s, comparing the annual aggregate tax buoyancy and elasticity of years 1977-1980, both for collection of the total domestic market and for the taxes and duties linked to aggregate imports and exports, respectively. The work conducted by these authors provides a preliminary indication of the success of the implemented reforms because in every year the tax buoyancy was greater than the elasticities, except in 1979 for collection regarding the domestic market and exports, and in 1977 for imports. Despite these results, the authors conclude that a broader analysis that includes every specific tax is needed.

In a slightly different manner compared to the above-mentioned works, Shome (1988) presents a methodology to estimate tax buoyancy and elasticity, to then extract conclusions and recommendations in the field of tax policy, based on estimations that were made for these tax indicators in other documents, but using the analytical framework developed by the author. This study is made for five Asian countries —Bangladesh, Malaysia, Philippines, Sri Lanka and Thailand— and covers years 1977-1985. For all these countries, the tax buoyancies are greater than the elasticities; in particular, all the elasticities are lower than the unit product of: i) increases in the tax rates and not in the bases, ii) the structure of the taxes, and iii) the consumption and production patterns. The work concludes by pointing out that in order to improve the elasticities, there is a need for a tax reform focused on an increase of the tax bases, an expansion of coverage, a regular adjustment on its rates according inflation, the conversion to *ad valorem* taxes and progressiveness of the whole system.

Continuing with this line, Bilquees (2004) measures tax buoyancy and elasticity of the Pakistani tax system for the period between 1974 and 2003, with the objective of looking at the impact of a set of reforms implemented as from the 1970s in this country. For estimating every indicator, a Vector Autoregression (VAR) is used, since the used series are not integrated of order one. With regard to elasticity, in order to estimate the collection of taxes net of discretionary changes, the Divisia index methodology is used. The estimations show that the buoyancies of both aggregate taxes and specific taxes are greater than their respective elasticities, even though they are low, except for customs tariffs in which buoyancy is negative; because of this last factor, the aggregate buoyancy and elasticity are lower than the unit. The low buoyancies show that the reforms did not give rise to a significant increase of revenues. On the other hand, the low elasticities confirm the existence of exceptions, subsidies and gaps due to tax evasion.

In the same line as the above-mentioned work, Omondi et al. (2014) try to determine the effects of a tax modernization program and a reform in the revenue administration on Kenya's tax system by calculating the tax buoyancy and elasticity with time series concerning years 1963-2010. In order to calculate the elasticity, the data on total collection were adjusted because of the possible impact of discretionary changes, using the proportional adjustment method. The estimation strategy was based on the standard technique (OLS) and the introduction of dummies to model both policies. The results show that both the program and the reform yielded positive results on Kenya's tax system; the buoyancy was superior to the unit and to the elasticity, with statistically significant coefficients for both.

In a broader way, in the foregoing cases, Belinga, Benedek, De Mooij, and Norregaard (2014) want to see the impact of a faster economic growth on the government's total tax revenues and on certain taxes, using the concept of tax buoyancy. Using data from OECD (Organization for Economic Cooperation and Development) member countries covering years 1965-2012, the authors calculate this tax indicator by using a VEC model. The buoyancies of total tax revenues are calculated individually for every country, using the Mean Group (MG) estimator. The result they obtain is that buoyancies are greater than the unit in most countries, i.e. economic growth helped these countries to improve their fiscal ratios. At a disaggregate level, using a panel and the pooled MG estimator, the author finds that the impact of the corporate income tax is the most buoyant one, and to a lower extent the property and consumption taxes, while the income tax and the social security contribution display buoyancies under one.

Dudine and Jalles (2017) have recently estimated the short and long term tax buoyancies, at a total level as specific for certain taxes, contemplating 107 countries, broken down in developed, emerging and low-income countries for years 1980-2014. The estimations are calculated through a VEC model, using panel data and time series, whereby the latter uses the strategy of estimating Fully-Modified Ordinary Least Squares while the former uses Mean Group estimators, both for pooled and for non-pooled data. Findings: i) there are not significant differences in the estimations of buoyancies when using both econometric strategies, for each term (long and short), ii) the average total tax buoyancies related to each group of countries are not different from the unit, iii) at the level of specific taxes, the long-term tax buoyancy is greater than one in the case of the corporate income tax in developed countries, the income tax and the social security contribution in emerging economies, and the tax on goods and services for low-income countries, iv) the tax buoyancy is lower in real terms than in nominal terms, and v) the openness to trade and the improvement of human capital increase buoyancy, while inflation and output volatility reduce it.

In Latin America, there are few contributions about the measurement of tax buoyancy, one of which is the work of Cárdenas, Ventosa-Santaulària and Gómez (2008) who calculate long-term buoyancy of the main taxes in Mexico —income tax (ISR), special tax on production and services (IEPS) and value added tax (IVA)—, using GDP as a proxy of the tax base, with the objective of inferring the possible resources the subnational governments of this country may obtain from federal transfers. The work is based on a VEC model and cointegration vectors, thus obtaining buoyancies of 1.15; 1.12 and 1.20 for the ISR, IEPS and IVA, respectively. The author reaches the conclusion that greater economic growth rates are not translated into more resources for the subnational governments, since the three main taxes of this country account for 61% of the federal tax revenue subject to sharing (RFP)[5] and a GDP growth of 1% would increase the RFP by only 0.68 pp, because on average these 3 elasticities increase by 0.1 pp.

On the other hand, in 2017 Cardona calculates the total tax buoyancies in the short and long term for 16 countries in Latin America and the Caribbean, among which Bolivia. The methodology is based on a VEC model —under the standard specification— and cointegration vectors with time series. The used data are different for every country, depending on their amplitude and frequency; the quarterly data cover years 2006-2014, while the annual data cover years 1990-2014: for Bolivia, the author uses the latter. The results show that most countries have buoyant tax revenues, except for Brazil, Mexico and Guatemala. This means that a GDP increase of 1% amplifies tax revenues by more than 1%. Bolivia displays a buoyancy of 1.85, the second highest after El Salvador. Additionally, the tax buoyancy is calculated globally for the income

[5] The federal tax revenue subject to sharing is the whole of resources collected by the Mexican Federation, which is made up of 32 federal bodies —31 states and the city of Mexico—, from federal taxes, mining rights and part of the oil revenues from the Mexican Petroleum Fund.

tax, the corporate income tax and the tax on capital gains, and for the consumption tax; for Bolivia, the first one of these estimations is not shown, but the second one reaches 1.44.

In Bolivia few studies have been conducted to calculate this tax indicator. Cossio (2001) estimates the tax buoyancies and elasticities of IVA, IT, ICE, RC-IVA, the Simplified Tax Regime (RTS) and the Integrated Tax System (STI) to analyze sustainability of the Bolivian Tax System in years 1988-2000. The methodology used to measure both indicators is the calculation of the average growth of tax collection for every tax and of GDP, to then calculate the ratio of both. The elasticity was estimated on the basis of the proportional adjustment method to calculate the series net of discretionary changes. The results show that the IVA, ICE and IT display buoyancies of 2.64; 2.58 and 4.27; and elasticities of 1.55; 1.83 and 1.41, respectively, which is why the author suggests that these taxes are sustainable. On the other hand, since the RC-IVA has a buoyancy and elasticity below the unit, it is not sustainable due to this tax is complementary to the IVA and not a tax in itself. In the case of the RTS and the STI, both indicators are negative; the author says that this shows that there is tax evasion in these taxes. The author concludes by pointing out that the elasticities are overestimated since they did not take into account all discretionary changes.

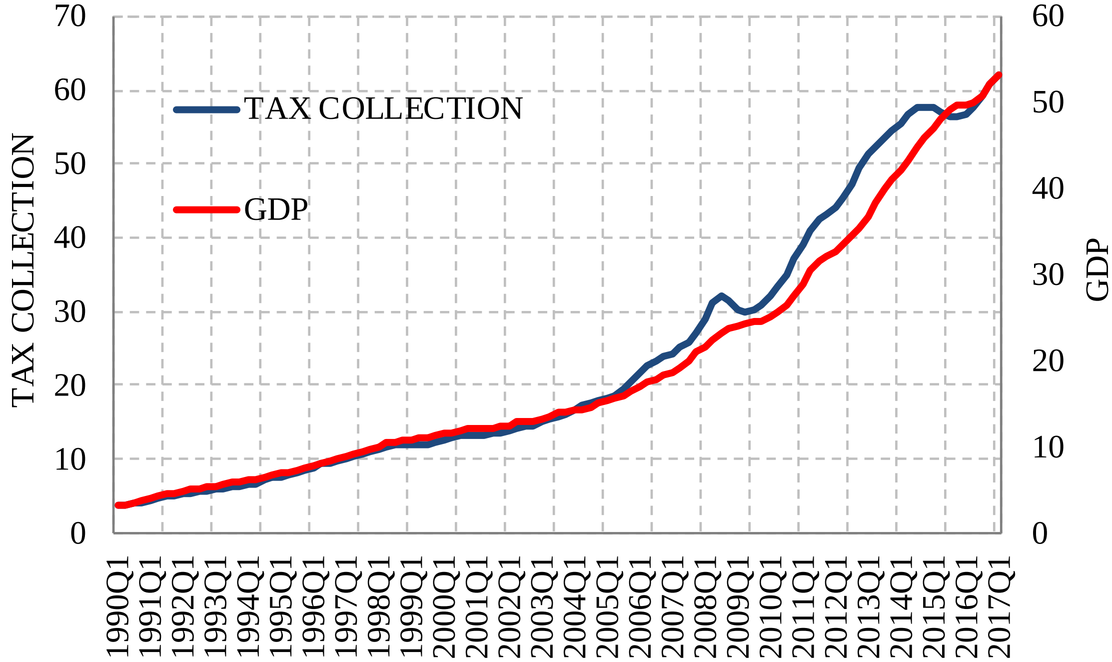
Just like in the foregoing case, in a section of the document entitled *Análisis de los Ingresos Tributarios 2008*, the Vice Ministry of Tax Policy (2009) analyzes sustainability of the tax system by calculating total tax buoyancy, as well as the main taxes, using a VEC model. The proxies for the tax bases are: GDP for total collection and the ICE, consumption for the IVA and IT, the gross operating surplus for the IUE and imports for the GA. The results show that the buoyancies, except for the RTS, are statistically significant and elastic. The report concludes that the tax system is sustainable.

III. STYLIZED FACTS

Tax collection is the whole of current revenues which the national treasury receives from the payment of taxes to deal with development of the fiscal policy, especially public investment. The sources of this total collection are, on the one hand, the taxes linked to the domestic market and, on the other hand, the revenues collected in the import process, which are administered by the Internal Revenue Service (SIN) and the National Customs of Bolivia (ANB), respectively.

Tax Collection (TC) has displayed a growing evolution since 1990. Still, as from 2006 the change of trend is remarkable, parallel to the evolution of GDP (Graph 1).

Graph 1: Tax Collection and Gross Domestic Product
1990 QI - 2017 QI
(In billion bolivianos)



Note. Deseasonalized series with the Arima X13 filter.
Source: Internal Revenue Service, National Customs of Bolivia and National Statistics Institute.
Elaboration: Own.

This change of trend is largely explained by eight factors: i) the constant increase of the production, ii) strengthening of the domestic demand, iii) capture of the economic surplus for redistribution[6], iv) Bolivia's macroeconomic stability in this period of time, v) the greater volume of foreign trade, primarily of capital goods and inputs for the production, vi) broadening of the tax base and of the universe of taxpayers[7] by incorporating sectors that did not pay taxes before, vii) nationalization of the hydrocarbons, and viii) a greater efficiency, control and use of incentives for paying taxes by the entities responsible for tax collection (SIN and ANB). Likewise, this behavior is explained by the good economic situation in terms of the international commodity price in some years, which did not only have a positive spillover effect for the government but for society as a whole.

Therefore, the changes observed in tax collection are largely associated to the economic context generated after application of the so–called Economic Social Comunitarian Productive Model (MESCP) as from 2006, of which the factors mentioned above are an essential part.

In a more general sense, the MESCP focused on broadening the universe of taxpayers and the tax base, as well as on supporting policies to increase public sector revenues in a real and sustainable

[6] See Ugarte and Bolivar (2015).
[7] Between 2005 and March 2017, the universe of taxpayers increased by 79.8%, from 211,519 to 380,313 taxpayers.

manner, aimed at redirecting these resources through public investment to reduce volatility of the economic cycle through a countercyclical policy —see Ugarte (2016) on this point-.

Within the same framework, but with a breakdown into Bolivia's main taxes, which are selected according to their weight in total collection (Table 1), the next graphs show that the growth of these taxes has changed as from 2006 in parallel of their tax bases, narrowly expanding consistent with aggregate tax collection. In addition to the factors already mentioned, these stylized facts seem to respond to more specific measures for every tax, which will be detailed in the results section of the paper.

Table 1: Average percentage share of main taxes of Tax Collection, 1990 Q1 - 2017 Q1
(In percentage)

Tax	Average	Standard Deviation	Minimum	Maximum
IVA	20.6	5.7	11.3	34.5
IT	11.2	3.7	4.7	20.8
IUE	9.7	9.4	0.0	33.7
ICE	4.4	1.9	1.9	13.1
RC-IVA	2.4	1.7	0.5	6.9
IVA Imports	19.3	3.7	12.4	29.4
ICE Imports	1.9	1.1	0.4	7.5
Customs Tariff	7.8	3.5	3.3	20.1
Others	22.7	12.7	2.8	43.8

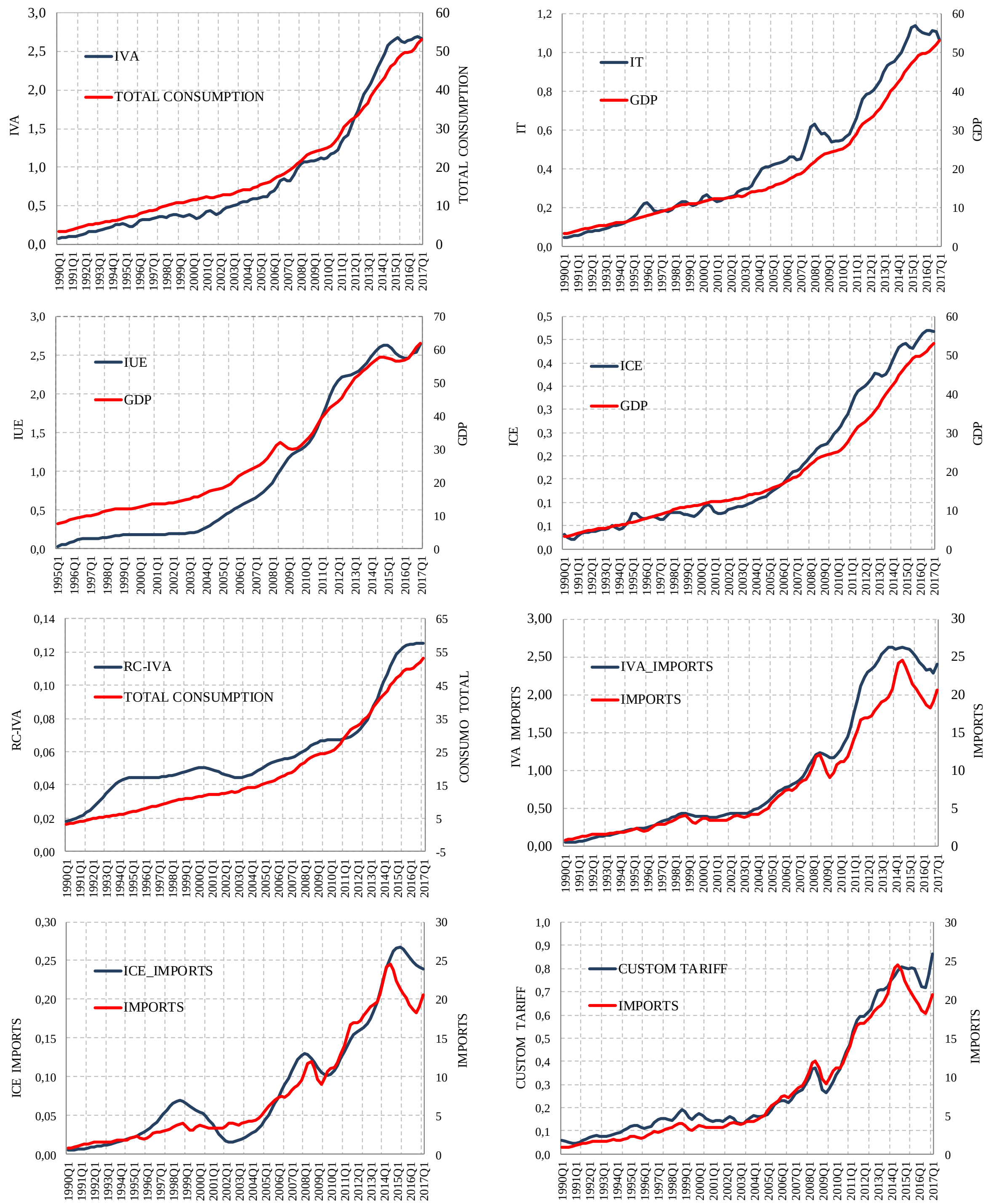
Source: Internal Revenue Service and National Customs of Bolivia.
Elaboration: Own.

Based on the explanation provided in the foregoing paragraphs, this paper intends to compare information on tax collection in 1990-2005 to that of 2006-2017, whereby the difference between both analyzed periods is that the second period displays an economic scenario resulting from the policies implemented within the framework of MESCP —mentioned above— and the external price context[8,9]. Thus, the comparative results in terms of tax buoyancies primarily will reflect the impact of the prevailing economic conditions in the tax system on tax collection as a result of the change of the economic paradigm in Bolivia as from 2006 compared to the one prevailing between 1990 and 2005.

[8] However, the WTI (West Texas Intermediate) price of one barrel of oil —used for the annual forecasts of the General Budget of the Bolivian State— started to move upward as from September 2003, with a monthly price of $us 28.28 per barrel up to $us 49.58 per barrel in March 2017. Likewise, from September 2003 until December 2005 the monthly price per barrel averaged $us 46.30, and between January 2006 and March 2017 the average price of this commodity was $us 76.82.

[9] It should be noted that the taxes that are directly sensitive to the oil price are the Direct Hydrocarbons Tax (IDH) and the Special Tax on Hydrocarbons and Derivatives (IEDH), which tax the production of hydrocarbons in the territory. These two taxes are not kept in mind in this study.

Graph 2: Collection of the Main Taxes and their Tax Bases
1990 Q1 - 2017 Q1
(In billion bolivianos)



Total Consumption: Final Consumption of the Public Administration and Final Consumption of the Households and ISFLSH (non-profit institutions serving households).
Note 1. Deseasonalized series with the Arima X13 filter.

Note 2. With regard to the IUE, there is information available as from 1995, since this tax was created through Law No. 1606 of 22 December 1994 and the regulation thereof through Supreme Decree No. 24051 of 29 June 1995.
Source: Internal Revenue Service, National Customs of Bolivia and National Statistics Institute.
Elaboration: Own.

IV. VARIABLES AND DATA

The main variable to be used to measure the impact of the economic conditions generated by the prevailing economic models before and after 2006, is tax buoyancy. This estimation will be made in each period for both aggregate tax collection and for each individual tax. This indicator quantifies the change in collection of a tax in response to a change in the tax base.

The information provided by the data of a tax collection implicitly has information of the impact of the prevailing economic conditions after the application of policy changes or reforms by the economic authority, on the tax system and the overall economic context. Thus, if the buoyancy is greater than the unit, this seems to show that the changes made by the policymaker had an impact on the collection of that tax —or the aggregate—[10] and, the other way around, a buoyancy lower than the unit seems to show that the economic and tax context are not allowing a greater revenue collection from that tax.

Following Jenkins, Kuo and Shukla (2000), we formally define tax buoyancy as follows:

$$E_{T,B}^{Boyanza} = \frac{\Delta T}{\Delta B} * \frac{T}{B} \tag{1}$$

where:

$E_{T,B}^{Boyanza}$	=	Buoyancy of the tax revenue in relation to its tax base.
T	=	Total revenues from the tax
ΔT	=	Change in the total revenues from the tax
B	=	Tax base
ΔB	=	Change in the tax base

According to the definition of the equation (1), tax buoyancy is an elasticity that quantifies the percentage change in tax collection as the result of an increase of 1% in the variable chosen as a proxy for its tax base.

The taxes and their bases considered for calculating the buoyancies are the ones detailed in the following table, which is in line with Table 1 of the previous section. In this sense, most works measuring this tax indicator use GDP as the tax base of all taxes. Nonetheless, in this paper the proxy variables of this base are both GDP and others that respond better to the characteristic of every tax, without altering the estimated results.

[10] Since this fiscal indicator is of an aggregate —or general— type, it has a major disadvantage: it does not allow for specifically determining the contribution of each one of its determinants to its performance.

Table 2: Variables of the model[11]

Tax	*Proxy Tax* Base
Tax Collection	GDP
IVA	Consumption
IT	GDP
IUE	GDP
ICE	GDP
RC-IVA	Consumption
IVA Imports	Imports
ICE Imports	Imports
Customs Tariff	Imports

Consumption is the sum of Final Consumption of the Public Administration and Final Consumption of the Households and NPISHs, extracted from the breakdown of GDP by type of expenditure, as well as Imports. Following Haughton (1998), we took the two previous variables and GDP in real terms. Tax collection in real terms was obtained by using the Consumer Price Index (CPI) for deflation purposes.

All these variables were taken at a quarterly frequency for periods 1990-2005[12] (64 observations) and 2006-First Quarter of 2017 (45 observations). With respect to the tax bases, the source was the National Statistics Institute (INE) and with respect to the taxes, the information was provided by the Internal Revenue Service (SIN) and the National Customs of Bolivia (ANB).

Considering the high seasonality of these series, the Arima X13 filter was used to isolate this component.

V. ESTIMATION STRATEGY

In order to address calculation of the tax buoyancy, various methodologies were explored. Initially, the work of Haughton (1998) reveals that the use of time series and econometrics is the most appropriate approach to estimate this fiscal indicator, unlike central tendency statistics applied to the growth rates of tax collection and the bases thereof, which are sensitive to the presence of outliers. Next, in support of the development of this calculation Sobel and Holcombe (1996) show that the standard estimation techniques used to calculate buoyancy, particularly Ordinary Least Squares (OLS) and the combination of Dynamic Ordinary Least Squares (DOLS) and the Newey-West correction (1987), give rise to presence of the asymptotic bias of estimators and inconsistent

[11] The activities that are subject to each tax are as follows: IVA: habitual sales and rental of movables and real estate; IT: income accrued and obtained from performing any profit-seeking and non-profit activity; IUE: net income generated by companies or individual professionals; ICE: sales in the domestic market of goods for specific final consumption; RC-IVA: wages and salaries of dependent workers, and rental, subletting of movables or real estate; IVA M: final imports of goods; ICE M: final imports of specific movables; GA: rate applicable on imports of goods. A more detailed overview of these taxes can be found in Law No. 843.

[12] Since the IUE was created in December 1994 through Law No. 1606, for this tax we used information as from the first quarter of 1995.

standard errors, which is why they suggest Vector Error Correction (VEC) as the most adequate approach to avoid these problems.

Recently, by way of their contribution to this measurement and as part of a paper seeking to determine the degree of buoyancy of the fiscal systems, Dudine and Jalles (2017) have pointed out that when the data on tax revenues and tax bases —both of which expressed in logarithms— display evidence of a stable long-term relationship (subject to prior verification that both series are integrated of order one), cointegration techniques should be used to estimate it. Finally, in a paper for Latin America and the Caribbean promoted by the Inter-American Center of Tax Administrations (CIAT), Cardona (2017) calculates long-term buoyancy by using cointegration vectors and VEC models, with the objective of obtaining unbiased estimations.

Thus, following the authors mentioned above and the works mentioned in the literature review, this paper intends to capture the long-term relationship between taxes and their tax bases —tax buoyancy— through parameter β_1 (called the cointegration vector in a multidimensional approach) in the cointegration equation (2) mentioned below, where $\tau^B_{t,i}$ is the logarithm of the tax in year t which corresponds to period i, which could be 1990-2005 or 2006-2017, $B_{t,i}$ is the logarithm of the proxy regressor variable tax base of year t for period i and $u_{t,i}$ is the error term.

$$\tau^B_{t,i} = \beta_0 + \beta_1 B_{t,i} + u_{t,i} \tag{2}$$

There are different methodologies to calculate the cointegration vector[13]. This paper will use the cointegration method based on autoregressive models of Johansen[14]. Therefore, the equation (2) can be expressed in general through a VAR model of order p and dimension $n = 2$:

$$y_{t,i} = A_1 y_{t-1,i} + \ldots + A_p y_{t-p,i} + \epsilon_{t,i} \tag{3}$$

where:

$y_{t,i}$	=	Vector of non-stationary endogenous variables I(1): $\tau^B_{t,i}$ y $B_{t,i}$
$A_1,\ldots,A_p$	=	Matrices of 2×2 of lags to be estimated
$\epsilon_{t,i}$	=	Vector of innovations ($\epsilon_{1t,i},\epsilon_{2t,i}$) which are $N\left(0,\Sigma_\epsilon\right)$ and $E\left(\epsilon_{1t,i},\epsilon_{2t,i}\right) = 0$

Rewriting the VAR model of equation (2) as a VEC model:

[13] Namely, Fully-Modified Ordinary Least Squares, Canonical Cointegration Regression and Dynamic Ordinary Least Squares.
[14] See Johansen (1991, 1995).

$$\Delta y_{t,i} = \Pi y_{t-1,i} + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j,i} + \varepsilon_{t,i} \quad (4)$$

where:

$$\Pi = \sum_{j=1}^{p} A_j - I \;, \quad \Gamma_j = -\sum_{k=j+1}^{p} A_j$$

Next, using the Granger representation theorem, if the matrix of coefficients Π has a reduced range $r < n$, we see that it can be rewritten in terms of the vector of adjustment parameters α and of the cointegration vector β, as:

$$\Pi = \alpha\beta' \quad (5)$$

In this way, r will be the number of cointegration relationships or the cointegration rank and, in addition, $\beta' y_{t,i}$ will no longer have a unit root, i.e. it will be I(0).

The method of Johansen consists of estimating matrix Π and performing a test to see if it is possible to reject the restrictions implied by the reduced rank of Π, i.e. reject:

$$\text{Ho: rank } (\Pi) = r = 0 \quad (6)$$

If the variables are cointegrated, and rank $(\Pi) \neq 0$, r is the number of cointegration relationships or the number of cointegration vectors. In this regard, it happens that the latter is lower than or equal to the number of variables n and strictly lower than n if the variables have a unit root.

To test the hypothesis of equation (6), the method of Johansen considers that if the rank of Π is lower than n, then the determinant of this matrix is zero since one or more eigenvalues may be zero. So to determine this rank, it is possible to use the matrix property that indicates that the determinant thereof is equal to the product of its eigenvalues. However, Johansen does not apply the calculation of the eigenvalues directly to Π, but through previously transformed data, aimed at the eigenvalues representing a linear combination of data with maximum correlation (canonical correlation). The purpose of this transformation is for the eigenvalues to be non-negatives and real.

In the case of $n = 2$, the maximum number of cointegration vectors is 2; likewise, there will be this quantity of eigenvalues, which are λ_1 and λ_2, and if $\lambda_1 > \lambda_2$, this would imply that λ_1 is the maximum eigenvalue. If $\lambda_1 = 0$, then there are no cointegration relationships, since both eigenvalues are zero. If $\lambda_1 \neq 0$ and $\lambda_2 = 0$, then there is a cointegration vector. Finally, if $\lambda_1 \neq 0$ and $\lambda_2 \neq 0$ then the rank of the matrix is not lower than n and the variables have no unit root.

Johansen presents two tests, namely the Maximum Eigenvalue Test and the Trace Test, both of which likelihood ratio tests that initially test the null hypothesis of absence of cointegration versus the alternative of presence thereof; what differentiates both is the alternative hypothesis.

VI. RESULTS

Before proceeding to estimate the buoyancies, as detailed in the methodology described in the previous section, it is important to know the order of integration of each of the variables used, since this information is an indispensable requirement in application of the econometric methodology. The order of integration is obtained by applying, on the one hand, the augmented Dickey-Fuller (ADF) unit root test and, on the other hand, the Dickey-Fuller GLS (DF-GLS) test on deseasonalized series in logarithms. Annex 1 shows the results of these tests for the series, both on levels and in first differences.

The results of the tests show that for both groups of variables that correspond to both periods of time, there is not sufficient evidence to reject the existence of a unit root, considering up to a level of confidence of 10%; on the other hand, with a confidence level of 1%, 5% and 10%, the null hypothesis of the unit root for all series in first differences is rejected. In other words, all series are I(1) (non-stationary) in level and I(0) (stationary) in first differences.

In parallel, the Granger Causality Test was performed, obtaining a partial result of the work for almost all models corresponding to both periods, i.e. that the tax bases cause their respective taxes in the sense of Granger; in other words, there is empirical evidence that there is a statistical functional relationship which suggests that the evolution of the different taxes, as well as the aggregate, can be explained through the proxies of their tax bases, which have a useful predictive content in relation to their respective taxes (Table 3).

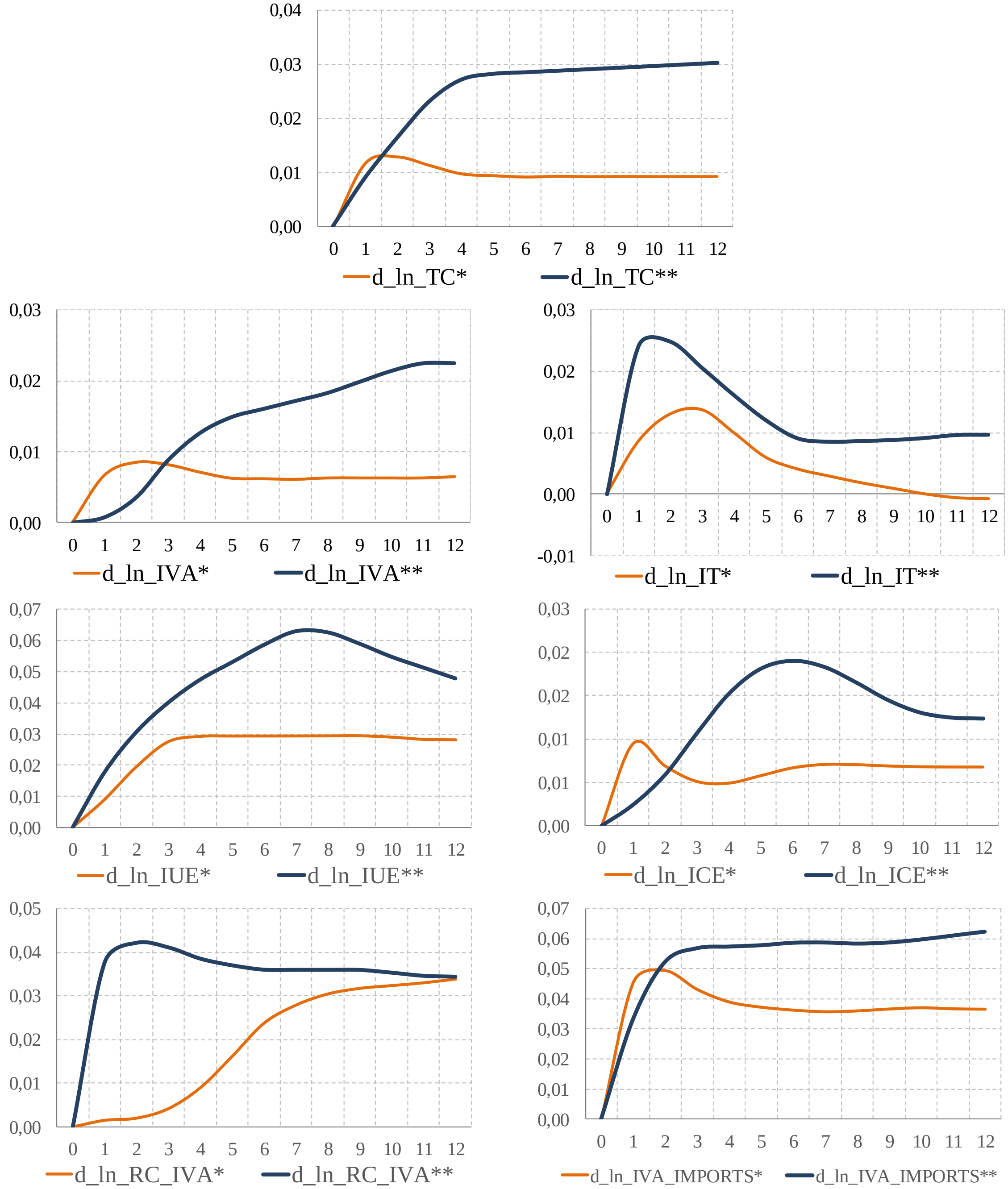
Furthermore, this result is complemented with a short-term model that makes estimations of the impulse response functions for every type of tax relative to both periods of time through a Vector Autoregression (VAR), thereto using smoothing through a Hodrick - Prescott filter of the studied series. In this sense, simulating a shock of an increase of 1% on every tax base, it is found that, except in some cases, the shock produces greater increases in the tax collection in the models associated to period 2006-First Quarter of 2017, as opposed to the ones developed for the years between 1990 and 2005 (Graph 3). This finding is important when emphasizing that the response in the second period is greater because of the new conditions associated to implementation of the MESCP, both in the macroeconomic conditions and in the adjustments of the tax policy variables.

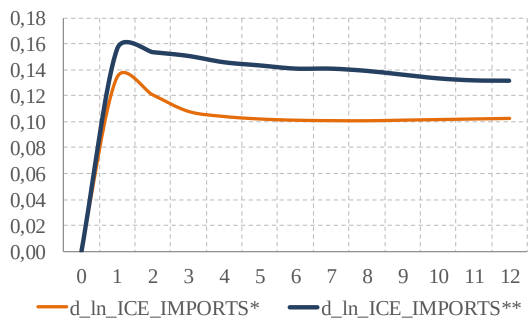
Table 3: Granger causality test
1990-2005 and 2006-First Quarter of 2017

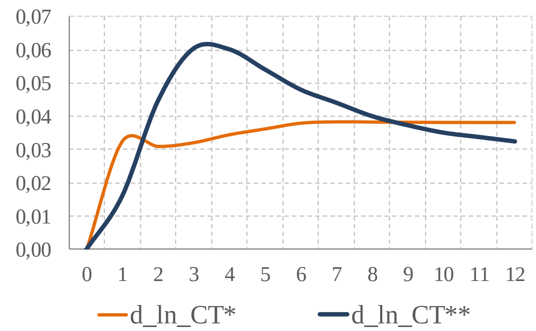
Ho: Does not cause, in the sense of Granger: Variable 1	Variable 2	Optimal Lag	Statistic F	Probability
Tax Collection	GDP	3	1.67	0.20
GDP	Tax Collection	3	6.87***	0.00
IVA	Consumption	3	0.69	0.50
Consumption	IVA	3	3.92**	0.03
IT	GDP	4	0.58	0.56
GDP	IT	4	6.94***	0.00
IUE	GDP	6	0.31	0.74
GDP	IUE	6	10.2***	0.00
ICE	GDP	3	2.07	0.11
GDP	ICE	3	5.93***	0.00
RC-IVA	Consumption	6	0.32	0.81
Consumption	RC-IVA	6	1.52	0.22
IVA Imports	Imports	4	0.93	0.40
Imports	IVA Imports	4	4.00**	0.02
ICE Imports	Imports	4	1.10	0.34
Imports	ICE Imports	4	1.69	0.19
Customs Tariff	Imports	3	0.75	0.53
Imports	Customs Tariff	3	3.25**	0.05

Ho: Does not cause, in the sense of Granger: Variable 1	Variable 2	Optimal Lag	Statistic F	Probability
Tax Collection	GDP	5	1.10	0.34
GDP	Tax Collection	5	2.69*	0.08
IVA	Consumption	6	1.40	0.25
Consumption	IVA	6	3.11**	0.02
IT	GDP	3	1.26	0.29
GDP	IT	3	6.85***	0.00
IUE	GDP	4	1.42	0.25
GDP	IUE	4	4.91***	0.00
ICE	GDP	3	0.57	0.56
GDP	ICE	3	3.50**	0.04
RC-IVA	Consumption	3	1.87	0.15
Consumption	RC-IVA	3	3.42**	0.04
IVA Imports	Imports	3	0.74	0.53
Imports	IVA Imports	3	2.97**	0.04
ICE Imports	Imports	4	1.74	0.14
Imports	ICE Imports	4	4.42***	0.02
Customs Tariff	Imports	3	1.39	0.26
Imports	Customs Tariff	3	2.74*	0.10

Graph 3: Impulse response functions
Periods 1990-2005 and 2006-First Quarter of 2017







(d): Variables in difference.
(ln): Natural logarithm.
(*): Models concerning period 1990-2005.
(**): Models concerning period 2006-First Quarter of 2017.
Every impulse response function corresponds to a shock of a change of 1% on its respective tax base.

Continuing with the calculation of long-term buoyancy, as mentioned previously, validity is ensured only if evidence is found in the data that the variables used in each regression are cointegrated. In this understanding and as detailed in the foregoing section, we obtain these results through the Johansen cointegration test. They are included in Annex 2 of this paper. The results of this test, using the Maximum Eigenvalue and Trace statistics, show that, with a level of significance of 5%, the variables concerning each model for each time period are cointegrated.

In this context, Table 4 below shows the estimations of the tax buoyancies for each model, relative to the two periods of analysis and based on the above-mentioned methodology.

Table 4: Estimation of long-term tax buoyancies
1990-2005 and 2006-First Quarter of 2017

Tax	Tax Base	Period 1990-2005		Period 2006-2017		Difference
		Boyancy	R^2	Boyancy	R^2	(in pp)
Tax Collection	GDP	0.8***	0.65	1.1***	0.62	0.27
IVA	Consumption	1.3***	0.64	1.6***	0.86	0.31
IT	GDP	0.7***	0.83	0.8***	0.83	0.11
IUE[1]	GDP	0.9***	0.90	1.7***	0.83	0.74
ICE	GDP	0.9***	0.76	1.2***	0.85	0.36
RC-IVA	Consumption	0.5***	0.91	0.6***	0.81	0.06
IVA Imports	Imports	0.7***	0.78	1.2***	0.85	0.46
ICE Imports	Imports	0.9***	0.80	1.3***	0.90	0.41
Customs Tariff	Imports	0.9***	0.89	1.4***	0.88	0.53

(1): Considering that the IUE was created through Law No. 1606 of 22 December 1994, for analysis period 1990-2005 the information concerning this tax was as from the first quarter of 1995.
pp: percentage points.
Significance level: * p<0.1, ** p<0.05, *** p<0.01.

The results show that the estimations of the buoyancies for all cases are statistically significant at 1%. Likewise, through statistics R^2 in all of them there is a satisfactory adjustment of the specification that was made. In addition, all models[15] meet the underlying assumptions: normality, absence of serial autocorrelation and non-existence of conditioned heteroscedasticity. The results can be found in Annexes 4, 5 and 6 of this paper.

For period 1990-2005, the tax buoyancies are inelastic, except for the one linked to IVA[16], which seems to suggest that the economic conditions associated to the model in force in that period were not translated into greater increases in the tax collection, tending to a fiscal system that is not very sustainable over time. On the other hand, with regard to the time period between 2006 and the first quarter of 2017, the econometric results show that the main taxes of Bolivia, as well as total tax collection, are buoyant —or elastic—, i.e. the economic conditions generated by the Economic Social Comunitarian Productive Model (MESCP), both at the macroeconomic level and at the microeconomic level, seem to have somehow generated greater positive impulses in the collection of these taxes, as well as of the aggregate collection.

In a detailed manner, the statistical results for the main taxes of Bolivia can be explained by policy measures focusing thereon[17] through modifications in their particular scenarios, in addition to the eight factors associated to the MESCP mentioned in the stylized facts, which apparently produced a positive change in the prevailing conditions of the national economy as from 2006, according to the results of the foregoing paragraph; the IVA for both periods was buoyant; however, buoyancy in the second period was greater than in the first period, with an increase of 0.31 pp. The IT also displayed a buoyancy of 0.11 pp more than in the first period. The expansive behavior of the collection of these two taxes in years 2006-2017 can be explained by the enhanced control in the issuance of invoices by economic sectors, as well as greater payment related to the consumption of products and services linked to the telecommunications, energy, construction, commerce and financial services sectors.

On the other hand, the greater creation of companies, the increase of their profits —primarily in the hydrocarbons sector— and the greater insistence on complying with tax obligations seem to explain the IUE buoyancy of 1.7 between 2006 and 2017, i.e. 0.74 pp higher than between 1990 and 2005. Additionally, this expansion seems to be attributed also to the implementation of an additional rate for mining companies as from 2007, and for the financial sector as from 2011, which entailed high levels of profitability.

Buoyancy of the ICE increased as well, rising by 0.36 pp, which can be related to the increase of the rate as from 2010, as well as to the greater volumes and price of the beer production. With regard to the RC-IVA, in line with the result of Cossio (2001), it has been inelastic for both periods. Nonetheless, the buoyancy of the second period was slightly higher, by 0.06 pp compared to the first period, which may be explained by the dynamism of the financial sector; a greater volume of

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[15] The election of optimal lags for each VEC model can be found in Annex 3.

[16] This may respond to the increase of the rate of this tax from 10% to 13% in February 1992, through Law No. 1314.

[17] The document of the Vice Ministry of Tax Policy (2016), which details the tax revenues and expenditures and highlights the results for year 2015, contains a systematic overview of specific tax rules for all taxes issued as from 2006.

deposits and credits favored a higher collection. Moreover, there were more intense controls of remuneration made to consultants and payments of homes and business premises.

With regard to the taxes linked to imports -IVA M, ICE M and GA-, the estimations show that their elasticities were greater in the second period compared to the first one, suggesting that the greater economic dynamism associated to higher levels of public investment and the greater imports of intermediate goods seemed to have had a favorable impact. Particularly the IVA M improved its buoyancy by 0.46 pp, which is explained by the increased imports of raw materials, intermediate products and capital goods; on the other hand, the ICE M increased by 0.41 pp thanks to the increase of rate of the excise tax on tobacco and beverages, and the higher value of imports of new vehicles[18]. This last element also impacted the GA result, which increased by 0.53 pp, which was partly explained by the greater imports of capital goods and electronic devices.

All these results are robust when using GDP as the tax base for all taxes, following the standard methodology for calculating tax buoyancies. These estimations can be found in Annex 7.

VII. CONCLUSIONS

This paper quantifies and compares the long-term tax buoyancies both at an aggregate level and with regard to Bolivia's main taxes for two periods: 2006-First Quarter of 2017 and 1990-2005, taking into account the notable change of trend of these taxes and their tax bases as from 2006. To avoid problems of biased estimators with inconsistent standard errors, as suggested by Sobel and Holcombe (1996) and Dudine and Jalles (2017), cointegration vectors and Vector Error Correction models (VEC) are used.

The results show that the estimations are significant at a statistics level and are within the range of other buoyancies calculated in different studies for Bolivia —Vice Ministry of Tax Policy (2009) and Cardona (2017)—. Furthermore, considering that since buoyancy is an indicator of the higher or lower tax collection as a result of the prevailing circumstances in an economic context and a tax system, associated to reforms and/or policies thereof at the macro and micro level, the estimations suggest that the increase in total tax collection and with regard to the main taxes could be attributed to the new economic conditions and changes after implementation of the MESCP as from 2006, since the measurements of the buoyancies are elastic and higher than the ones obtained in years 1990-2005, when they are lower than the unit in almost all cases. These results are robust when using GDP as a proxy of the tax base for all taxes, as is done in most documents calculating tax buoyancy.

Likewise, the impulse response functions modeling a short-term scenario show that increases in the tax bases seem to favor tax collection to a greater extent as from 2006.

These results complement each other when finding evidence of a statistical functional relationship, showing that evolution of the different taxes and of the aggregate tax collection can be explained

[18] In December 2008, through Supreme Decree No. 29836, disincentives and restrictions were applied through the ICE on imports of old vehicles.

to a large extent through their tax bases, which have a useful predictive content to determine future behavior in the collection of these taxes.

Finally, it should be noted that the methodology developed and therefore the results of this work display an important constraint. Since buoyancy is an aggregate indicator, it is not possible to reach conclusions on the specific contributions of each determinant, which is a pending task for future research.

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ANNEX 1
UNIT ROOT TEST

Table A.1: Models Period 1999-2005

Variable	Series in Levels			Series in First Difference		
	ADF P-Value	DF-GLS Statistic-t	Decision	ADF P-Value	DF-GLS Statistic-t	Decision
GDP	0.67	-1.47	Unit Root	0.09*	-1.80*	Stationary
Consumption	0.08*	-1.53	Unit Root	0.08*	-2.30**	Stationary
Imports	0.30	-1.67	Unit Root	0.01**	-3.39***	Stationary
Tax Collection	0.75	-3.04*	Unit Root	0.03**	-2.90**	Stationary
IVA	0.22	-0.95	Unit Root	0.00***	-3.69**	Stationary
IT	0.24	-0.71	Unit Root	0.01***	4.17***	Stationary
IUE	0.62	-2.46	Unit Root	0.00***	8.71***	Stationary
ICE	0.26	-0.80	Unit Root	0.06*	-1.69*	Stationary
RC-IVA	0.30	-1.75	Unit Root	0.05**	-1.61*	Stationary
IVA Imports	0.13	-1.49	Unit Root	0.08*	1.88*	Stationary
ICE Imports	0.64	-1.62	Unit Root	0.00***	-7.28***	Stationary
Customs Tarrif	0.50	-1.75	Unit Root	0.07*	-1.78*	Stationary

ADF: Augmented Dickey-Fuller.
DF-GLS: Dickey-Fuller Generalized Least Squares.
Significance level: * p<0.1; ** p<0.05; *** p<0.01.

Table A.2: Models Period 2006-First Quarter of 2017

Variable	Series in Levels			Series in First Difference		
	ADF P-Value	DF-GLS Statistic-t	Decision	ADF P-Value	DF-GLS Statistic-t	Decision
GDP	0.65	-0.79	Unit Root	0.09*	-1.79*	Stationary
Consumption	0.71	-0.18	Unit Root	0.00***	-4.30***	Stationary
Imports	0.62	-0.06	Unit Root	0.05**	-2.07**	Stationary
Tax Collection	0.27	-0.26	Unit Root	0.10*	-1.65*	Stationary
IVA	0.34	-1.15	Unit Root	0.21	-2.70*	Stationary
IT	0.66	-0.31	Unit Root	0.05**	-3.01***	Stationary
IUE	0.26	-1.60	Unit Root	0.00***	-3.16***	Stationary
ICE	0.15	-0.06	Unit Root	0.00***	-2.79***	Stationary
RC-IVA	0.94	-0.34	Unit Root	0.05**	-2.65***	Stationary
IVA Imports	0.23	-0.15	Unit Root	0.00***	-4.50***	Stationary
ICE Imports	0.94	-1.15	Unit Root	0.04**	-3.78***	Stationary
Customs Tariff	0.84	-0.34	Unit Root	0.01**	-2.72***	Stationary

ADF: Augmented Dickey-Fuller.
DF-GLS: Dickey-Fuller Generalized Least Squares.
Significance level: * p<0.1; ** p<0.05; *** p<0.01.

ANNEX 2
JOHANSEN COINTEGRATION TEST

Table A.3: Models Period 1999-2005

Tax	Tax Base	t-Statistic		Decision
		Trace	Maximum Eigenvalue	
Tax Collection	GDP	22.32**	20.26**	Cointegrating
IVA	Consumption	20.51**	17.33**	Cointegrating
IT	GDP	30.79**	23.70**	Cointegrating
IUE[1]	GDP	28.55**	23.16**	Cointegrating
ICE	GDP	26.79**	22.52**	Cointegrating
RC-IVA	Consumption	19.29**	28.12**	Cointegrating
IVA Imports	Imports	20.87**	16.68**	Cointegrating
ICE Imports	Imports	15.89**	16.05**	Cointegrating
Customs Tariff	Imports	17.18**	15.90**	Cointegrating

Significance level: ** p<0.05.

Table A.4: Models Period 2006-First Quarter of 2017

Tax	Tax Base	t-Statistic		Decision
		Trace	Maximum Eigenvalue	
Tax Collection	GDP	21.75**	19.06**	Cointegrating
IVA	Consumption	35.14**	30.74**	Cointegrating
IT	GDP	16.32**	16.30**	Cointegrating
IUE	GDP	19.05**	16.94**	Cointegrating
ICE	GDP	17.23**	21.57**	Cointegrating
RC-IVA	Consumption	58.90**	47.17**	Cointegrating
IVA Imports	Imports	70.66**	57.87**	Cointegrating
ICE Imports	Imports	32.08**	28.67**	Cointegrating
Customs Tariff	Imports	16.09**	15.72**	Cointegrating

Significance level: ** p<0.05.

ANNEX 3
OPTIMAL LAG CHOICE[19]

Table A.5: Models Period 1999-2005

Tax	Tax Base	Number of Lags
Tax Collection	GDP	4
IVA	Consumption	4
IT	GDP	3
IUE	GDP	4
ICE	GDP	3
RC-IVA	Consumption	3
IVA Imports	Imports	4
ICE Imports	Imports	5
Customs Tariff	Imports	4

Table A.6: Models Period 2006-First Quarter of 2017

Tax	Tax Base	Number of Lags
Tax Collection	GDP	5
IVA	Consumption	5
IT	GDP	6
IUE	GDP	4
ICE	GDP	4
RC-IVA	Consumption	3
IVA Imports	Imports	3
ICE Imports	Imports	4
Customs Tariff	Imports	3

[19] For each model, the optimal lag choice was based on the information criteria of Akaike and Schwarz, as well as the sequential modified LR test statistic.

ANNEX 4
NORMALITY TEST[20]

Table A.7: Models Period 1999-2005

Component 1	Probability	Component 2	Probability	Joint Probability
Tax Collection	0.14	GDP	0.59	0.28
IVA	0.78	Consumption	0.77	0.91
IT	0.57	GDP	0.29	0.46
IUE	0.11	GDP	0.53	0.23
ICE	0.56	GDP	0.23	0.39
RC-IVA	0.57	Consumption	0.81	0.81
IVA Imports	0.23	Imports	0.61	0.41
ICE Imports	0.11	Imports	0.28	0.35
Customs Tariff	0.53	Imports	0.99	0.86

Table A.8: Models Period 2006-First Quarter of 2017

Component 1	Probability	Component 2	Probability	Joint Probability
Tax Collection	0.82	GDP	0.94	0.97
IVA	0.73	Consumption	0.50	0.73
IT	0.40	GDP	0.44	0.48
IUE	0.88	GDP	0.96	0.99
ICE	0.11	GDP	0.84	0.23
RC-IVA	0.53	Consumption	0.45	0.58
IVA Imports	0.62	Imports	0.73	0.81
ICE Imports	0.25	Imports	0.74	0.49
Customs Tariff	0.84	Imports	0.71	0.91

[20] The probabilities correspond to the Jarque-Bera statistic.

ANNEX 5
LM AUTOCORRELATION TEST[21]

Table A.9: Models Period 1999-2005

Model: Tax Collection - GDP

Lags	P-Value
1	0.25
2	0.11
3	0.12
4	0.56

Model: IVA - Consumption

Lags	P-Value
1	0.32
2	0.11
3	0.18
4	0.34

Model: IT - GDP

Lags	P-Value
1	0.56
2	0.12
3	0.29

Model: IUE - GDP

Lags	P-Value
1	0.54
2	0.29
3	0.86
4	0.76

Model: ICE - GDP

Lags	P-Value
1	0.29
2	0.13
3	0.31

Model: RC-IVA - Consumption

Lags	P-Value
1	0.14
2	0.15
3	0.74

Model: IVA Impor. - Imports

Lags	P-Value
1	0.20
2	0.64
3	0.75
4	0.90

Model: ICE Impor. - Imports

Lags	P-Value
1	0.55
2	0.22
3	0.13
4	0.54
5	0.13

Model: Custom Tariff - Imports

Lags	P-Value
1	0.42
2	0.85
3	0.67
4	0.35

[21] Ho: no serial correlation at lag h.

Table A.10: Models Period 2006-First Quarter of 2017

Model: Tax Collection - GDP	
Lags	**P-Value**
1	0.79
2	0.21
3	0.10
4	0.53
5	0.21

Model: IVA - Consumption	
Lags	**P-Value**
1	0.11
2	0.10
3	0.92
4	0.63
5	0.11

Model: IT - GDP	
Lags	**P-Value**
1	0.39
2	0.47
3	0.18
4	0.06
5	0.78
6	0.26

Model: IUE - GDP	
Lags	**P-Value**
1	0.49
2	0.05
3	0.53
4	0.18

Model: ICE - GDP	
Lags	**P-Value**
1	0.24
2	0.22
3	0.66
4	0.66

Model: RC-IVA - Consumption	
Lags	**P-Value**
1	0.11
2	0.81
3	0.19

Model: IVA Impor. - Imports	
Lags	**P-Value**
1	0.95
2	0.94
3	0.77

Model: ICE Impor. - Imports	
Lags	**P-Value**
1	0.58
2	0.59
3	0.47
4	0.98

Model: Custom Tariff - Imports	
Lags	**P-Value**
1	0.99
2	0.95
3	0.56

ANNEX 6
HETEROSCEDASTICITY TEST[22]

Table A.11: Models Period 1999-2005

Model	P-Value
Tax Collection - GDP	0.23
IVA - Consumption	0.20
IT - GDP	0.50
IUE - GDP	0.33
ICE - GDP	0.78
RC-IVA - Consumption	0.12
IVA Impor. - Imports	0.46
ICE Impor. - Imports	0.22
Customs Tariff - Imports	0.43

Level of significance: * p<0,1; ** p<0,05; *** p<0,01.

Table A.12: Models Period 2006-First Quarter of 2017

Model	P-Value
Tax Collection - GDP	0.51
IVA - Consumption	0.48
IT - GDP	0.30
IUE - GDP	0.12
ICE - GDP	0.45
RC-IVA - Consumption	0.38
IVA Impor. - Imports	0.40
ICE Impor. - Imports	0.46
Customs Tariff - Imports	0.16

Level of significance: * p<0.1; ** p<0.05; *** p<0.01.

[22] Corresponds to the extension to test of White (1980). Additionally, the No Cross Terms option was used.
Ho: no heteroscedasticity.

ANNEX 7
ESTIMATION OF LONG-TERM TAX BUOYANCIES WITH GDP AS THE TAX BASE, PERIODS 1990-2005 AND 2006-FIRST QUARTER OF 2017

Tax	Tax Base	Period 1990-2005		Period 2006-2017		Difference
		Buoyancy	R^2	Buoyancy	R^2	(in pp)
Tax Collection	GDP	0.8***	0.65	1.1***	0.62	0.27
IVA	GDP	1.4***	0.71	1.5***	0.75	0.10
IT	GDP	0.7***	0.83	0.8***	0.83	0.11
IUE[1]	GDP	0.9***	0.90	1.7***	0.83	0.74
ICE	GDP	0.9***	0.76	1.2***	0.85	0.36
RC-IVA	GDP	0.6***	0.73	0.6***	0.69	0.06
IVA Imports	GDP	0.9***	0.87	1.3***	0.78	0.45
ICE Imports	GDP	0.7***	0.59	1.3***	0.82	0.60
Customs Tariff	GDP	1.0***	0.81	1.5***	0.88	0.87

(1): Since the IUE was created in December 1994, the information on this tax is as from the first quarter of 1995.
pp: percentage points.
Significance level: * p<0.1; ** p<0.05; *** p<0.01.