

Effects of legal complexity on value-added tax (VAT) collection in Mexico from 1980 to 2019

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Abstract

In this paper we investigate the dependence between Value Added Tax (VAT) and Tax Complexity. Three models are analyzed: Least Squares (LS), Generalized Least Squares (GLS), Iteratively Reweighted Least Squared (IRLS). In all the models the dependent variable is the VAT as proportion of GDP from 1980 to 2019 and the independent variables included the Structured, Interdependence, Entropy (As the Complexity measure of VAT Law). Dummies area included representing change of law in different years (1983, 1992, 1995, 2010). The Three models showed consistency in the negative sign and statistical significance of entropy.

Keywords: tax, finance, entropy.

JEL classification: F38, H71, K34.

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Efectos de la complejidad Jurídica en la recaudación del impuesto al valor agregado (IVA) en México de 1980 a 2019

Resumen

En este trabajo investigamos la dependencia entre el Impuesto al Valor Agregado (IVA) y la Complejidad Tributaria. Se analizan tres modelos: Mínimos cuadrados (LS), mínimos cuadrados generalizados (GLS), mínimos cuadrados iterativamente reponderados (IRLS). En todos los modelos la variable dependiente es el IVA como proporción del PIB de 1980 a 2019 y las variables independientes incluyeron la Estructurada, Interdependencia, Entropía (Como medida de la Complejidad de la Ley del IVA). Se incluye el área de dummies que representa el cambio de ley en diferentes años (1983, 1992, 1995, 2010). Los tres modelos mostraron consistencia en el signo negativo y significación estadística de la entropía.

Palabras clave: impuestos, finanzas, entropía.

Clasificación JEL: F38, H71, K34.

1. Introduction

Ever since the earliest human societies came into being, rulers collected taxes as a way to pay tribute to them. This practice was kept through time in cultures like the Egyptians, the Greek and the Romans and it has lasted until today (Galindo, 2014).

Tributes, rates and other tax burdens constitute economic policy instruments implemented by world governments and their different administrations throughout history. Such measures are deemed essential for the correct operation of these entities.

Currently, public finance management entails two fundamental parts: the first one comprises the rules that regulate the income of the State, taxes being the most relevant; the second one refers to the correct expenditure of such income by the State.

The legal basis that grants the State the faculty of imposing such contributions can be found in the Public Financial Law or Tax Law- branch of Administrative Law- which studies the norms governing the State's financial activity.

The structure of a tax system is made up mostly by taxes that provide the resources to meet the needs of the expenditure budget, which must also fulfil certain requirements in order to become instruments of economic policy.

Therefore, being the main source of government revenue, these taxes can finance public spending, implement social programs, foster and support institutions, as well as provide infrastructure investment, among others.

The member states of the Organization for Economic Cooperation and Development (OECD), which clusters 34 countries representing 62% of the world GDP, classify the main taxes as a levy placed on income and profit, on consumption and on social security and ownership (OECD 2020).

Consumer taxes are a particularly important source of tax revenue for all OECD member states. In 2018, they represented less than 6% of the GDP in countries like the United States, Canada and Mexico and more than 15% in countries like Greece and Hungary (OECD 2020).

The share of consumer taxes in the total tax revenue of OECD member states has kept relatively stable since 1995, with the exception of the Great Financial Crisis (GFC). During the GFC, the consumer tax revenue share in the GDP decreased 0.36 percentage points in average (between 2007 and 2009) and have registered their lowest level since 1992 (OECD 2020).

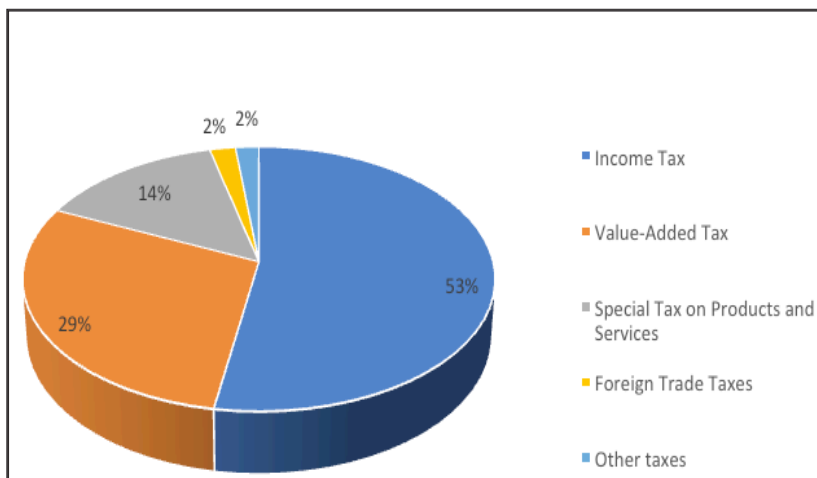
Value-Added Tax (VAT) is currently being collected in more than 150 countries worldwide, including all member states in OECD (except the United States), situation that is attributed to their high capacity for revenue collection and their neutrality with regard to the structure of production and cross-border trade (Bickley, 2011).

Furthermore, VAT dissemination has been the most significant event in the field of taxation for the last sixty years. It went from being a rather unknown tax outside France in the 1950's to being adopted by around 136 countries, where it normally represents one quarter of tax revenue's total share (Galindo, 2014).

In terms of the tax rate established by different countries, it is known that Denmark, Norway and Sweden apply 25% VAT collection to consumer goods and services, while Guatemala, Honduras and Venezuela keep a 12% rate. Mexico currently implements a general tax rate of 16% and, as of 2019, differentiated rates were adopted again to foster an 8% rate in the northern border of our country (SHCP 2011).

In Mexico, tax collection relies primarily on four different taxes: income tax (ISR in Spanish), VAT collection, special tax on production and services (IEPS in Spanish) and foreign trade regulation (SAT 2019).

Graph 1
Tax revenue in Mexico (2019) percentage structure



Source: own elaboration with data from SHCP/SAT (2019)

During 2019, tax revenue reached 3.20 billion pesos, figure that is higher in 140 317 million pesos to that of 2018, thus representing an increase of 0.9% in real terms. According to the Federation Income Law, during 2018 such revenue amounted to 108 723 million pesos below the expected figure, that is 3.3% lower than programmed, due to a decreased economic activity and also due to a greater VAT balance return during 2018 (SAT, 2019).

In 2019, VAT collection in Mexico amounted to 933.3 billion pesos, figure that represented 29.1% of tax revenue. Thus, VAT is ranked as the second most prominent tax at a federal level, surpassed only by Income Tax (ISR), (SAT, 2019).

Having a tax collection equivalent to 3.9% of the GDP during 2019, VAT is one of the main tax pillars in Mexico. Even though the income due to VAT is the second source of revenue for the Mexican state, such revenue has not surpassed this percentage share in the GDP since 1980, year in which it came into force (see graph No. 2). This figure ranks below international standards, as previously mentioned when referring to the United States, Canada and Mexico registering less than 6% as share of the GDP, while Greece and Hungary registered more than 15% in 2018 (OECD, 2020).

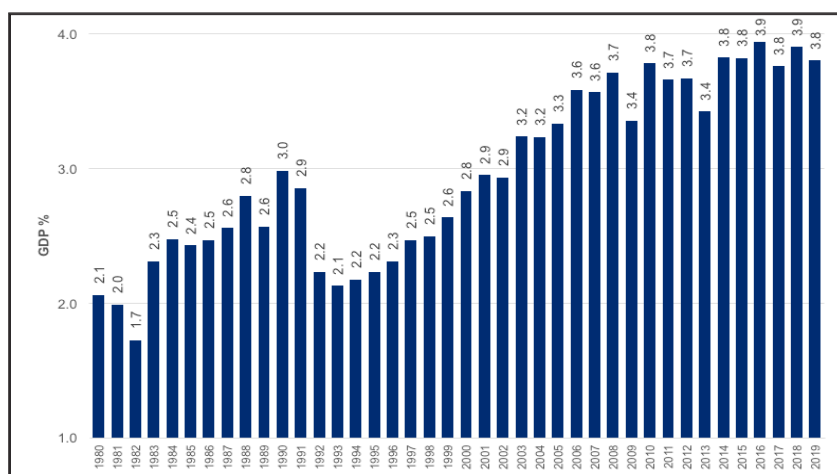
Value-added tax (VAT) stands out as a the key pillar of indirect taxation in the Mexican tributary system. Due to its mandatory nature, it directly

impacts on a passive subject's consumption, as well as on the end consumer who actually pays taxes. This is a tax that is generally applied to all operations and phases of the production-distribution cycle, an essential part of business and trade operations as well as professional ones, carried out by a passive subject (Quintana, 2012).

As a matter of fact, the main purpose of VAT law, published on December 29th, 1978 which entered into force on January 1st 1980, was to end cascading taxes, a key feature of Business Income Tax, immediate predecessor of VAT in Mexico. This tax, in turn, had previously replaced the Federal Stamp Duty on invoices (Betancourt, 2008).

In spite of the many reforms to VAT law, among which those carried out in 1995, 2009 and 2013 are noteworthy because tax rate increased from 10% to 15% in 1995; then, in 2009 a percentage point was added to this levy, reaching 16%; in 2013, differentiated rates were eliminated throughout our country, consolidating VAT's general rate in 16%. It must be said that the share of VAT collection in the GDP has never exceeded the 4% threshold (see graph No. 2).

Graph 2
VAT collection as percentage of the GDP from 1980-2019



Source: own elaboration with data from SHCP/SAT (2019).

Due to the key economic relevance of VAT collection in Mexican tax revenue, it is deemed extremely significant to ponder the impact that certain variables might have on this tax collection.

The framework of this document is as follows: the first part provides an introduction to this research paper, the second one shows a literature review on these matters, the third section describes the estimates and results that were achieved and the last part presents the conclusions, interpretations and limits of this paper, as well as future lines of research.

2. Literature review

Reviewing the published papers on this matter allowed us to identify some variables that condition VAT collection, which can be classified as economic and non-economic variables. The Gross Domestic Product (GDP), which for this research purposes will be considered as denominator in the VAT/GDP ratio, is economic in nature; it shall be addressed as a dependent variable so as to estimate the impact of the different components of the legal complexity index (structure, entropy and interdependence), accomplished by Katz and Bommarito (2014) theoretical model.

The reason why the VAT/GDP percentage ratio is being used as a dependent variable is because taxes are instruments of fiscal policy, deeply related to economic growth from the point of view of macroeconomics. In spite of not being an economic indicator in the strictest sense, VAT legal complexity stands out as a key issue and it can certainly condition tax collection.

This constraint results from modifying the text of a Law, which clearly complicates the understanding of such text and therefore conditions the compliance of tax obligations, directly affecting tax revenue. Accordingly, some authors like (Schuck, 1992), (Kades, 1997), (Epstein, 1997), (Katz and Bommarito, 2014) and (Krever and Mellor, 2015), assert that legal complexity within the legal tax framework is an obstacle to the increase of tax revenue.

Epstein (1997) defined legal complexity in terms of the cost of compliance; in other words, if rules are simple the cost of complying with them should be less. The core argument is that a Law is considered complex insofar as it generates regulatory obstacles which hamper the achievement of a given goal.

Accordingly, Kades (1997) affirmed that a compelling example of legal complexity is to be found in tax legislation, but he also claimed that such complexity goes well beyond the issues that may originate because of human coexistence in society.

Thus, Kirchler (2007) took a stand for Epstein's proposal and agreed upon the fact that the cost of compliance is notably increased when contributors

find it harder to understand a regulatory framework. They are forced to spend more time and resources trying to calculate their taxes or even look for professional advice, which of course would add to transaction costs. He concluded that when such complexity within a legal framework is increased, the index of contributors' compliance to their lawful obligations tends to decrease.

Furthermore, Epstein, Kades and Kirchler's statements require the fundamentals of a theory of law regarding the concept of legal complexity. Within this academic field, four academic approaches have been undertaken and they all agree on the concept of a legal standard: the structuralist approach proposed by Romano in 1917 (Bengoetxea, 2015), the positivist view on Law proposed by Kelsen in 1960 and Hart in 1963 (Tamayo, 2015), the realist approach to Law provided by Ronald Dworkin (Leiter, 2015) and the cultural juristic strand (Barrón, 2015).

To start with, the structuralist approach, proposed by the theorist Santi Romano in 1917, defined Law as a social body which resembles an organization or structure that takes form through legal workings, administration procedures and the many activities of state-run organs. Law is narrowed down to a social structure which coexists with other parallel structures, thus explaining their interactions. For this author, legal standards are irrelevant, which is why he does not assess their legitimacy (Romano, 1963).

La Torre (2006) analyzed the paper published by Santi Romano in 1917, known as "*L'ordenamento giuridico*", in which the legal order is compared to an institution, the latter being understood as an organized social body, that is, it is actually the institution that brings about the concept of Law.

However, Bengoetxea (2015) concluded that the two theorists mentioned above tried to define Law exclusively through their institutions, encompassing only one of the many features that constitute the notion of Law.

The positivist approach proposed by Hans Kelsen in 1960 and then resumed by H.L.A. Hart in 1963, establishes that legal standards must take into consideration internal and external elements. The science of Law is a system of interdependent norms (primary and secondary norms) which must be fulfilled under two criteria: *a*) their code of conduct must be valid: that is, most people must abide by these rules and *b*) the guiding principle to these norms must be accepted by public officials as a commonly accepted behavior. Hence, Hart's theory is considered positivist because legal standards are the guiding principle to address the core question: What is Law? (Tamayo, 2015). Therefore, the arguments provided by the structuralist

branch of Law oppose the assumptions of the positivist theory in the sense that it is not the structure that defines the concept of Law, but the mere concept of a legal standard.

On the other hand, the realist approach to Law, proposed by Ronald Dworkin, is one of the most recent ones and it aims at explaining what Law is. This academic thinking holds that Law is not determined rationally and its core assumptions sustain that it is judge decisions, defined by particular circumstances, and not reason and legal standards which drive them to make such decisions. Under this perspective, Law is understood as a response to psico-social stimuli that influence its definition in a given context (Leiter, 2015).

Hence, Ronald Dworkin criticized Hart's positivist theory and conceived his own theory of Law as a social phenomena, being an essential part of our lives but better understood as praxis, because it is deeply related to real social behavior. Accordingly, each individual understands what is permitted and what is forbidden. His main premise stems from the legal practice of lawyers, judges and public officials.

Dworkin's conclusions draw closer to a "general and descriptive analysis of the structure of national law systems, of a logical and empirical nature, which in the end represents Law as a complex set of rules" (Rojas, 2015).

By contrast, the cultural law perspective proposed by Barrón (2015) in the 1990's, states that Law can be considered as the object of discourse, in clear opposition to the notion of Law as a normative system that regulates conduct. This stance asserts that legal standards are valid only when every single individual is affected by them and must abide to them as participants of a rational discourse.

To sum up, the concept of Law is complex and although many theorists have contributed to building up a definition, they have never reached a consensus because Law can be studied from very different points of view. However, the concept of legal standard plays a key role in all the aforementioned approaches: the structuralist, the positivist, the realist and cultural strands.

Defining what a legal standard is faces the same challenges as figuring out the concept of Law because they both are interrelated and one cannot be conceived without the other. Accordingly, because this notion is the common element to all different schools of thought, some theorists have contributed to building up its definition.

From a linguistic point of view, a legal standard is defined as "the content of statements that conveys what is mandatory, forbidden or allowed"

(Sieckmann, 2015); nevertheless, it is not enough to consider a precept as a legal standard, the latter should belong to a law system and must have legal force as well. Kelsen (1988) affirms that the legal validity of a norm is determined when such rule stems from another belonging to a higher hierarchy, known as a founding norm; this, in turn, gives consistence to the social organization that created it in the first place. Therefore, from its very inception, the legal standard must show an upward or transversal interdependence with other legal codes. It is of the essence that such norms have a strong relation to the founding or supreme norm, so as to be considered valid.

According to Kelsen (1988), another fundamental aspect of the concept of legal standard is that of its efficiency; that is, if the norm is obeyed or not by its recipients, and if it is not complied with, whether it is fully enforced by the authorities.

It has been previously mentioned that the concepts of Law and legal standard are both deeply bound with each other, which is why analyzing them separately could lead to serious mistakes.

From the perspective of the positivist theory of Law, the definition of a legal standard refers to an act of human behavior that takes place in time and space. It is, therefore considered an act of Law because it is the outcome of a specific clarification, more specifically a normative clarification (Kelsen, 1988). This is how the norm works as an explication scheme.

Because tax laws are part of the legal system, understood as the set of valid legal norms, they are explicit statements in matters of taxation which stem from governmental procedures to create norms. Such statements are complex not only for authorities but also for taxpayers and this complexity translates into a higher cost to comply with them, for both parts (Kades, 1997).

Before addressing the complexity of the norm, it is key to have a definition of legal complexity. According to the Internal Revenue Service, it can be understood as the degree of ambiguity or vagueness in a legal norm, which in tax matters refers to the lack of clarity in the normative explicit reference of tax law.

Therefore, according to the aforementioned definition, the characteristics of a legal standard are: *a)* ambiguity in language and therefore inaccuracy in the wording which may end up causing different interpretations; *b)* variation in the semantic field: even though norms cannot do without ordinary language, they must phrase their texts in a properly normative way; *c)* unlike colloquial speech, normative language can only be created by a reliable source whose attributions appear in a founding norm; and *d)* coerciveness,

which grants the norm its binding nature, in other words: its compliance is not disputed. Moreover, breaching or violating these norms may lead to the appropriate sanctions (Centro de Capacitación y Estudios Parlamentarios, 2017).

The complexity of normative statements in tax matters forces the contributor to spend more time and resources to calculate his taxes or look for professional advice in order to fulfil his obligations, which also increases the costs of transaction.

Thus, this paper intends to measure the impact of legal complexity on VAT collection as a share of the GDP. For this purpose, a legal complexity indicator was built (Moreno, Beltrán and Mata 2017) based on the model created by Katz and Bommarito (2014), which aims at quantifying the difficulty that an individual faces when trying to understand the legal framework, under the premise that, the higher the complexity, the higher the cost of compliance.

It should be duly noted that this indicator does not pretend to measure the complexity resulting from explicit contents of the norm regarding differentiated tax rates, products and services exemption or regional taxation; neither does it intend to assess the taxpayer's behavior and reaction to the legal framework. Such measurements are subject to behavioral economics.

Katz and Bommarito's indicator is based on the premise that vagueness in the explanation of a norm, makes comprehension much more difficult and viceversa. This indicator is built up through a mathematical model that ponders three aspects: (1) the structure of Law, which refers to the legal hierarchy upon which a Law is organized; (2) the language used to express this norm: word length, use and frequency of technical jargon; and (3) the quotes to be found in the text or its interdependence to other legal codes about mandatory processes, according to the Law in question.

The underlying argument of this model is that when a legal system is more complex, while other factors remain constant, it simply produces higher costs of compliance that negatively affect the way in which taxpayers fulfil their obligations (Katz y Bommarito, 2014).

4. Estimation procedures

The classical model of linear regression, also known as the Ordinary Least Squares Method (OLS), dates back to 1805 in the appendix of Legendre's

publication on the orbit of comets: “Nouvelles méthodes pour la détermination des orbites des comètes”. Pioneers in astronomy based their geodesic estimations on the method found in this appendix (Gujarati, 2010).

The general formula to this model is:

$$Y = X\beta + u$$

Where Y is a vector that stands for the dependent variable, X is the matrix of information and holds the independent variables, u is the term for random disturbance and β stands for the vector of coefficients that are actually being estimated. Random disturbance is present due to several reasons, but the most relevant one is that it is impossible to assess the influence of an economic variable on a model as a whole, no matter how elaborate the latter may be. The net effect -positive or negative- of this skipped factors, is captured by the random disturbance.

The classical linear regression model yields the ordinary least square estimators. This model¹ is based on ten assumptions: (1) its parameters are linear; (2) X values (independent variables) are fixed in repeated sampling, X is supposed to be non-stochastic; (3) the average figure for disturbance u_i is equal to zero; (4) it is homokedastic or equals u_i variance; (5) there is no autocorrelation among disturbances; (6) the covariance between u_i and X_i is zero; (7) the number of n observations must be higher than the number of parameters to estimate; (8) variability of X values; (9) the regression model is correctly specified without any bias and (10) there is no perfect multicollinearity.

According to the premises of the classical linear regression model, the estimated values for the least squares have some optimal qualities, which stem from the Gauss-Markov theorem. This postulate establishes that, given the aforementioned premises, the estimated least squares have a minimal variance, which makes them the best unbiased indicators there are.

In this sense, the proposed model is as follows:

$$\ln \left(\frac{VAT_t}{GDP_t} \right) = \beta_0 + \beta_1 \ln (E_t) + \beta_2 \ln (S_t) + \beta_3 \ln (I_t) + \sum_{i=1}^m \delta_i X_{i,t} + u_t \quad (1)$$

¹ See also Greene (2002), Pindyck & Rubinfeld (1997), Maddala (2001) and Johnston (1991).

Where:

VAT_t/GDP_t = VAT collection as a share of the GDP.

E_t = Structure indicator for VAT Law.

S_t = Entropy indicator for VAT Law.

I_t = Interdependence indicator for VAT Law.

$X_{i,t}$ = Control variables, which represent shifts in the tax rate. More specifically, the following dummy variables were used:

$$\begin{aligned} d1983 &= \begin{cases} 1 & \text{if there is a shift in the tax rate in 1983} \\ 0 & \text{another case} \end{cases} \\ d1992 &= \begin{cases} 1 & \text{if there is a shift in the tax rate in 1992} \\ 0 & \text{another case} \end{cases} \\ d1995 &= \begin{cases} 1 & \text{if there is a shift in the tax rate in 1995} \\ 0 & \text{another case} \end{cases} \\ d2010 &= \begin{cases} 1 & \text{if there is a shift in the tax rate in 2010} \\ 0 & \text{another case} \end{cases} \end{aligned}$$

Equation (1) can be specified through different procedures. In this paper, estimations are based on ordinary least squares (LS), generalized least squares (GLS) and iteratively reweighted least squares (IRLS). Our main goal is to find evidence of the sign and magnitude of certain coefficients that relate independent indicators to the dependent variable.

It must be said that the model of ordinary least squares usually has certain issues: heterokedasticity, multicollineality, non-lineality in the mathematical expression of the model, errors in specification, autocorrelation, endogeneity, parameter instability and the presence of stochastic regressors (Pérez, 2006). Even so, there are many ways to restore the premises of this classical regression model, which also enable us to estimate parameters in a robust way.

The presence of non-spherical errors means that the premises of homoscedasticity and non-correlation have been breached. The generalized least squares (GLS) allow us to rectify such distortions and thus find the best estimator to the proposed model.

Accordingly, its main goal consists in calculating a more accurate estimator for such parameters without the bias that results from issues like heterokedasticity and autocorrelation. With this in mind, knowing the evolutionary patterns of such disturbances might be very helpful to focus on the relevance of residues that run more separately from the regression line, instead of pondering all observations together (Arce y Mahía, 2010).

On the other hand, there are some variations to the GLS models to restore the breaching of premises in regression models. One of them is the algorithm IRLS (Iteratively Reweighted Least Squares), which calculates coefficients through weighted least squares; these coefficients repeat iteratively until they all converge into a specific estimator (Fox, 2002) and (Huber, 1964).

Furthermore, Relles (1968) asserted that the estimations of such regression parameters result from minimizing the addition of square differences resulting from the observed values, on the one hand, and the estimated values, on the other, of a dependent variable. Such estimations can well be distorted due to atypical values. Therefore, in order to obtain estimators that are the least biased possible, it is necessary to minimize the alternative function of the differences resulting from the squares of those arguments which are lower than a given value (determined by the given data) and lineal for those arguments higher than the given value.

Following his line of research, in 1964 Huber (1972) determined that a robust estimator must have two main features, among others: a small and asymptotic variation somewhere along the line of data, particularly when it is related to its normal distribution. Additionally, he affirmed that the estimation distribution should be very slightly modified or showing no change at all, when facing small arbitrary variations of the underlying distribution. This condition should be present in all the n sample size.

Furthermore, while studying the general linear model with symmetric errors, Bickel (1973) concluded that when the error distribution is considered normal and has a median with value 0, the estimated ordinary minimal squares are efficient. When errors do not have a normal distribution, he proposed using the symptotic theory to improve the accuracy of these estimators. Hence, if such distribution is known, the robust regression estimators are efficient; if not, according to Huber (1972) the distribution should be slightly modified or not at all, when having small arbitrary variations.

In turn, Yohai (1974) studied the sensitivity of ordinary least squares estimators (OLS) in a multiple regression, concluding that these are highly sensitive to the normality of errors or disturbances in the proposed model, asserting that only a few atypical observations could increase substantially the mean squared error. The robust estimators allow us to obtain more reliable estimations than those obtained by MCO with atypical values. These estimators are 5% less efficient in absence of atypical values.

Accordingly, Ali y Qadir (2005) affirmed that the ordinary least squares method is highly sensitive to atypical observations. They proposed a new

density function belonging to the M estimators (maximum plausibility), which smoothly adjusts to the model. They concluded that when this function is applied to weighted least squares, the end results are quite good and resist atypical values. Thus, the final analysis will be more accurate because it simply ignores atypical values. This proposal is compatible with the robust regression as an alternative to other M-estimators.

To sum up, the ordinary least squares method is sensitive to the presence of atypical values. Therefore, apart from achieving the results of these estimations through this method, we also calculated these parameters while using GLS and IRLS, in such a way that it would allow us to compare estimators and confirm, through different procedures, that there is in fact a negative relation between structure, interdependence, entropy and VAT collection as a share for the GDP.

5. Estimations and results

To start with, in order to properly estimate model (1) for each of the three procedures mentioned above, we shall verify if the variable is dependent or stationary. With this in mind, we tested the hypothesis of augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin (KPSS).

In chart No. 1, it can be seen that the non-stationary null hypothesis is being rejected. Hence, there is a 5% evidence that the variable $\ln(\text{VAT/GDP})$ is stationary.

Nonetheless, when a least squares model is being estimated one must test multicollineality (VIF), as well as White's heterokedasticity and Breusch-Pagan's test so as to verify the serial correlation. The results shown in chart No. 2 lead to the conclusion that this regression model does not present collineality but it does have heterokedasticity, which means that the correlation is significant in 5%. For this reason, the MCO estimations with robust White's errors, the least generalized squares model (Prais-Winsten and Cochrane-Orcutt) and the iteratively reweighted least squares method results, are all shown as well.

Chart 1
Stationary testing for $\ln(\text{VAT}/\text{GDP})$

Test	Statistic	p-value
Augmented Dickey-Fuller	-3.1093	0.0278
Phillips-Perron	-3.0335	0.0339
Kwiatkowski-Phillips-Schmidt-Shin	1.1342	0.1074
Elliott-Rootenbergs-Stock Point Optimal	18.8230	0.0331

Source: own elaboration

In chart No. 2, it can be seen that the estimated coefficients for the independent variables of structure, interdependence and entropy clearly vary in each procedure. At the beginning, a negative sign in two variables was found in the MCO model, which has issues of multicollinearity, heteroskedasticity and serial correlation, but it must be said that the variable of interdependence was not significant, as opposed to other coefficients which had a 10% significance.

However, the three coefficients that were calculated with the generalized least squares method (Prais-Winsten and Cochrane-Orcutt) were all negative. Each one of them were significant in 10% and it can be noted that the independent variable, known as interdependence, showed a higher magnitude and therefore had a stronger effect on the $\ln(\text{VAT}/\text{GDP})$ variable.

It must be duly noted that the previous result can also be obtained through the iteratively reweighted least squares procedure (IRLS), where magnitudes are similar in scope and sign. These two procedures allow us to affirm with a 90% reliability that there is a negative relation between the independent variables and the $\ln(\text{VAT}/\text{GDP})$ variable.

Chart 2
Model estimations using LS, GLS and IRLS

ln(VAT/GDP)	LS	GLS	IRLS
Variables	Coefficients		
ln(Structure)	-0.2775 (0.1403)	-0.3394 (0.0412)	-0.3380 (0.0464)
ln(Interdependence)	0.6945 (0.1499)	-0.8656 (0.0499)	-0.6130 (0.0497)
ln(Entropy)	-0.3778 (0.0608)	-0.7657 (0.0381)	-0.7309 (0.0393)
d1983	1.9221 (0.0468)	2.4079 (0.0349)	2.8091 (0.0411)
d1992	2.0472 (0.0309)	-2.1091 (0.0268)	-2.6783 (0.0561)
d1995	-1.4206 (0.1226)	-1.5178 (0.1701)	-1.9182 (0.2546)
d2010	0.2317 (0.0574)	0.2412 (0.0316)	0.2827 (0.0612)
Constant	-9.4839 (0.0563)	-9.9789 (0.0383)	-10.9078 (0.0268)
R-squared	0.7748	0.7562	0.7572
R-squared adjusted	0.7634	0.7450	0.7449
Heteroskedasticity	72.808 (0.000)	2.731 (0.118)	1.673 (0.195)
Correlation serial	49.761 (0.000)	3.105 (0.123)	1.987 (0.214)
Multicolineality	6.10	6.10	6.10
Normality	0.970 (0.615)	1.256 (0.534)	3.928 (0.140)

Source: own elaboration.

In a nutshell, the set of estimations that are shown in chart No. 2 provide enough evidence to verify the research hypothesis that was formulated at the beginning of this document. Furthermore, these estimations highlight the relevance of studying legal complexity as an important issue in VAT collection in Mexico from 1980 to 2019.

6. Conclusions

This research paper clearly shows evidence of the inverse relation between the variables of legal complexity: structure, interdependence and entropy with VAT as a share of GDP. Three estimation procedures were carried out: ordinary least squares, generalized least squares and iteratively reweighted regression (IRLS). In each case, the coefficients all show a negative sign and are 10% robust in significance. Nonetheless, it is the variable of interdependence that shows the biggest magnitude, which clearly suggests that this component in the complexity index has a stronger effect on VAT collection.

Finally, the pertinence of other control variables and their analysis at State level, as well as the likely public policies that may stem from it, shall define our future line of research.

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