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ECONOMICS &
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UNIVERSIDADE DE LISBOA

MASTER OF SCIENCE IN

FINANCE

MASTER'S FINAL WORK

DISSERTATION

THE DETERMINANTS OF EXCISE TAX REVENUES IN PORTUGAL

FRANCISCO MARIA VISEU GOMES DA SILVA

OCTOBER - 2019

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SUPERVISOR:

PROFESSOR DOUTOR JOAQUIM JOSÉ MIRANDA SARMENTO

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Abstract

Excise Tax are one of the oldest taxes in the world, however the analysis of this subject has been little explored by worldwide authors, compared to other taxes. In Portugal, studies on the determinants of Excise Tax revenues have received little attention from academic world, with the exception of some studies in the field of Taxation. Through this study we seek to explain the worldwide historical context of the introduction of this type of tax, as well as to answer our starting question: "What are the main determinants of Excise Tax revenues in Portugal?".

A differentiating analysis and probably the first on this subject in Portugal. We pursue to contribute to the analysis of these taxes and broaden the discussion of the topic for future studies. We believe that the conclusions obtained can help policy makers better understand the dynamic of Excise Tax in Portugal and optimize them.

For this study, we worked with monthly data of several variables between January 2002 and December 2018 due to the introduction of Euro. We used time series analysis using two methods, Ordinary Least Squares (OLS) and Prais-Winsten and Cochrane-Orcutt, to estimate the determinants of revenue for Excise Tax. The final results are clear about the nature of this tax. GDP, Consumption and Consumers' Confidence Index and Unemployment rate have a significant impact on revenues. The first three have a positive sign and the last one negatively influences the Excise Tax revenues.

JEL Classification: C22; H25; H27

Key Words: Excise Tax determinants; Excise Tax revenues; time-series analysis; regression analysis

Resumo

Os Impostos Especiais de Consumo são um dos mais antigos impostos no Mundo, contudo a análise deste tema tem sido pouco explorada pelos autores a nível mundial, comparativamente a outros impostos. Em Portugal os estudos sobre as determinantes da receita dos Impostos Especiais de Consumo receberam pouca atenção do meio académico, com excepção de alguns trabalhos na área de Fiscalidade. Através deste estudo procuramos explicar o contexto histórico a nível mundial da introdução deste tipo de impostos, assim como responder à nossa pergunta de partida: "Quais são as principais determinantes da receita dos Impostos Especiais de Consumo em Portugal?".

Uma análise diferenciadora e provavelmente a primeira sobre esta temática em Portugal. Procuramos contribuir para a análise destes impostos e alargar a discussão do tema para estudos futuros. Acreditamos que as conclusões obtidas podem ajudar os decisores políticos a perceberem melhor a dinâmica dos Impostos Especiais de Consumo em Portugal e optimizarem os mesmos.

Para a realização deste estudo, trabalhámos com dados mensais de diversas variáveis entre Janeiro de 2002 e Dezembro de 2018 devido à introdução do Euro. Utilizámos análises de séries temporais com recurso a dois métodos, Mínimos Quadrados (OLS) e Prais-Winsten and Cochrane-Orcutt, para estimar as determinantes da receita dos Impostos Especiais de Consumo. Os resultados finais são claros quanto à natureza deste imposto. O PIB, o Consumo, a Confiança dos Consumidores e o Desemprego têm um impacto significativo nas receitas obtidas. Os três primeiros apresentam um sinal positivo e o último influencia negativamente as receitas dos Impostos Especiais de Consumo.

Classificação JEL: C22; H25; H27

Palavras-Chave: Determinantes dos Impostos Especiais de Consumo; Receita dos Impostos Especiais de Consumo; Análise de séries temporais; Análise de regressão

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List of Abbreviations

ADF - Augmented Dickey-Fuller

BP - Breusch-Pagan

BG - Breusch-Godfrey

CPI – Consumer Price Index

DF – Dickey-Fuller

DGO – Direção Geral do Orçamento

EEC – European Economic Community

EU – European Union

GDP – Gross Domestic Product

GLS - Generalized Least-Squares

IT - Imposto sobre o Tabaco

ISP - Imposto sobre os Produtos Petrolíferos

IABA - Imposto sobre o Álcool e Bebidas Alcoólicas

INE – Instituto Nacional de Estatística

OECD – Organization for Economic Co-operation and Development

OLS – Ordinary Least Squares

RESET - Regression Specification Error Test

UK – United Kingdom

US – United States

VAT – Value Added Tax

1. Introduction

OECD stated that Excise Tax have existed since the dawn of civilisation and in recent years attention on this topic has been growing. We hope that this paper can contribute to the discussion and understanding of this specific tax.

Excise Tax are levied on alcoholic beverages, petroleum and energy products and also on tobacco. This tax represents an important share of state revenues but have not yet been the object of theoretical analysis.

The main purpose of this work is to study the determinants of Excise Tax revenues in Portugal between 2002 and 2018. Additionally, it is also important to analyse the relationship between the Excise Tax and several economic indicators.

From the tax point of view, the analysis of Excise Tax has been little explored. On the other hand, it is a very specific tax which means that the incidence is limited. The excise duties are less significant in terms of revenue compared to other taxes but still with a considerable economic and social impact. Regarding tax revenue, Value Added Tax (VAT) represents the largest share of revenue for the state with regard to general Excise Tax. Historically, the Excise Tax has been one of the earliest ways to obtain revenue and finance for countries.

Over the last several years, many countries across the world shifted their tax model. The focus is now in the consumption taxes instead of income taxes. Nowadays, Governments are restructuring direct taxes and decreasing corporate and income tax rates, while searching for a new source of revenue through indirect taxes, such as VAT and Excise Tax. Governments are adopting Excise Tax to sustain tax revenues and to cover the costs related with the externalities regarding the use of certain goods and services.

According to EY in an article about Indirect Tax, Excise Tax are one of the oldest taxes and they are very popular with Governments because they are a major revenue-generator. Lately, what is considered an excisable good has expanded beyond the traditional types of excise goods that formed the definition of this tax. In recent years, Excise Tax seem to have been on a collision course between the need to raise revenue and the desire of Governments at all levels (federal, state and local) to control the behaviour of consumers.

In Portugal, the Excise Tax was classified in the national law on 22 of December of 1999 in Decreto-Lei nº566/99: "The 1999 State Budget Law authorized the Government to codify in a single statute the regime of Excise Tax on alcohol and alcoholic beverages, petroleum products and manufactured tobacco".

Fusco (2016) confirmed that in addition to the main and traditional component as a source of revenue, the excise duties have an extra-fiscal aspect to conditionate, through taxation, the consumption of the goods which they incur because they have negative effects on health and the environment. The social cost of excise duties is not noticeable in the final price of goods, thus becoming a tax with weak opposition from consumers as they can not assess their weight in the final price. Thus, the Excise Tax is a good source of revenue. The low elasticity of consumption in relation to changes in the price of goods is the justifying factor for taxation of these goods.

The fundamental purpose of the Excise Tax is not limited to the obtaining of revenue since they serve as a tool to fight the negative externalities of economy. We can consider the Excise Tax as a social mechanism with moral effects on consumers given its extra-fiscal nature due to the side effects of the consumption of goods that cover this tax.

Fusco (2016) advised that the Government intervenes in the market through the application of the Excise Tax as a fiscal policy medium. Its taxation makes the consumption of the goods subject to this tax to be conditioned. The tax increase has as a direct consequence of the increase in the price of goods. The welfare state as a social promotion agent and organizer of the economy seeks to dissuade the consumption of goods associated with the Excise Tax through this tax, even indirectly.

The purpose of this paper is to present the definition of the Excise Tax, its historical context, the particular case of taxation in Portugal and also the extra-fiscal importance of the Excise Tax as a measure of quality control and promotion of social welfare. There are a few studies about the determinants of Excise Tax, but none of them is related with Portugal Excise Tax revenues. Understanding the dynamic of the determinants of Excise Tax revenues can be important to policy makers in order to optimize the revenues. We expect that this study can support their decisions. The revenues can be increased due to a raise in the rates but also through adjustment of economic and fiscal policies that are

linked to the variables that have a significant impact in this tax. In the following chapters we will look at the complexity of Excise Tax, particularly about the relationship between independent variables and the tax since 2002.

Excise Tax is an important source of revenues for all countries. In the last 12 years, the revenue increased 20% in Portugal, from 4114,7 million euros to 4949,5 million euros in 2018.

We collected monthly data on several indicators between January 2002 and December 2018. To analyse the impact of our explanatory variables on the Excise Tax revenues, we performed ten regression models. We used two methods to estimate our results, Ordinary Least Squares and Prais-Winsten and Cochrane-Orcutt. The conclusions are in line with the literature that we studied and with the economic rationality.

GDP, Consumption and Consumers' Confidence Index have a positive impact in the revenues while Unemployment rate has a negative impact. Exports, Imports and Public Deficit do not influence Excise Tax revenues. This can be explained by external factors or due to the specific incidence of Excise Tax. Our results demonstrated that Governments may be more effective when adjust the significant variables rather than the Excise Tax rates.

2. Literature Review

2.1 Excise Tax

The exercise of commercial activity goes back to early days of the Humanity. Man, as a social being wants to obtain the goods that he does not dispose of in exchange for the goods he has in excess.

In modern society, as a result of the division and specialization of the labour factor, the satisfaction of individual needs is achieved by exchanging each other's work. According to Adam Smith in the book Wealth of Nations: “Every man thus lives by exchanging, or becomes in some measure a merchant, and the society itself grows to be what is properly a commercial society.”. Following this it is not simple to identify the origin and the cause of adoption of Excise Tax for specific goods as an instrument to provide more financial resources to the Governments perform their social functions.

The European Commission (EC) defines the Excise Tax as "indirect taxes imposed on goods that damage consumer health or pollute the environment. The duties increase the price paid by the consumer, thereby discouraging the consumption or waste of the products concerned.". In accordance with Directive 2008/118/EC the general arrangements for movement and storage of goods subject to excise duty covers mineral oils, manufactured tobacco, alcohol and alcoholic beverages.

For tax purposes it should be noted that "The taxable products are subject to excise duty upon their production (wherever in the EU) or upon importation (from non-EU countries). However, the excise duty is only payable upon release for consumption. If the product is imported into an EU country but transported to and supplied to another EU country, excise duties are due in the EU country where the products will eventually be consumed or used. Excises duties paid on alcoholic beverages can be claimed back, subject to certain conditions and in specific cases, such as when goods are finally exported to non-EU countries."

Organization for Economic Co-operation and Development (OECD) confirmed in the report published with the title "Consumption Tax Trends 2014" that: *"Whilst VAT was first introduced about 60 years ago, excise duties have existed since the dawn of civilisation.".* They are assessed based on different characteristics such as weight, volume, strength or quantity of the product, combined in some cases with ad valorem taxes.

Although they have a wide incidence for alcoholic beverages, tobacco products and fuels in all OECD countries, calculation method and rates vary widely between countries, depending on local cultures and historical context. Excise Tax are being used in the last years to influence consumer behaviour to achieve health and environmental objectives.

According to Simões (2015), the shift from a rudimentary organization to an efficient administrative structure took place from the Absolutist Era with the introduction of more efficient and extended taxation measures. There are some Britain cases that Simões (2015) raised in his thesis. In 17th century, the United Kingdom (UK) Government imposed the window tax. King William III created this tax and it was intended to be a progressive tax. It was a significant social, cultural, and architectural force in England, France, Ireland and Scotland during the 18th and 19th centuries. To avoid the tax some

houses from the period can be seen to have bricked-up window-spaces. In 1795 the Prime Minister of the United Kingdom, William Pitt decided to create the Hair Powder Tax. Dowell (1888) wrote that "The Act stated that everyone wishing to use hair powder must, from 5 May 1795, visit a stamp office to enter their name and pay for an annual certificate costing one guinea.". There were certain exemptions included in this tax. Vasques (2001) revealed an interesting tax that was implemented for Frederick I of Prussia in 1698. The wigs tax or *Peruckensteur* were levied in all the wigs imported or produced, 6% for national wigs and 25% for the ones that were imported.

Simões (2015) stated that during the 16th, 17th and 18th centuries the economic history provided us a wide range of goods that were taxed: beer, textiles, salt, soap, alcoholic beverages or meat, among many other products. These types of taxes were used and diversified among the nations with the greatest commercial development, where the transaction and consumption of new and multifaceted products opened up new opportunities for taxation. Portugal, the pioneer nation of the Discoveries and international trade, filled the public coffers with the richness obtained by opening the sea lanes. The difficulties experienced after the 1383-1385 Crisis were overcome by customs duties and fiscal monopolies as the main sources of public revenue.

Simões (2015) gave a detailed analysis of the context of the 20th century. Throughout this period, the role of the State in the economy was increasing and it assumed important social functions. The new theoretical and practical perspectives of public finances provided adequate justification and ethical rationale to tax collection activity. Arthur Cecil Pigou was an English economist that contributed to the Fiscal Policy with the Pigouvian Tax which is a tax on any market activity that generates negative externalities. His economic thesis provided more evidence to indirect taxation, in particular Excise Tax, as it compensates or represses economic behaviours whose social costs, outweigh the social benefit of this activity. Gradually, various goods, such as sugar, salt, coffee, tea, matches and lighters, clothing or jewellery, or, more recently, vehicles, appliances or photocopies, were subject to Excise Tax. More or less broadly, all European Union (EU) Member States subject several products to excise duties, in particular if they are likely to harm the environment or health.

Excise duties are the most recent taxes in the concept that we know but if we go back to the 18th century, it is possible to identify the period where the excise duties were first

introduced. The information points to the year 1791 when the tax was first used in the United States (US) for the purpose of taxing whiskey.

In order to better understand the context of the introduction of the Excise Tax, it is vital to provide insight about the economic situation of the United States. Chernow (2004) specified that The War of Independence between 1775 and 1783 left a trail of financial destruction in the country's coffers. The Government was unable to collect taxes and to finance the war had to ask some bank loans. The national debt was over 54 million dollars and 25 million dollars for state debt. A new Federal Government took office in 1789 and immediately began thinking of alternatives to repaying the debt it had. George Washington, President of the United States, appointed Alexander Hamilton as First United States Secretary of the Treasury to create and implement a financial system capable of promoting prosperity and national unity.

It was therefore necessary to create revenue to pay debt holders. Chernow (2004) referred that in December 1790 Hamilton recognized that import duties, the state's main source of revenue, had been raised as high as possible. He reported to Congress that a new tax had to be created. Following this, Hamilton promoted the creation of an Excise Tax on whiskey and other domestic spirits. This was the first tax levied by the National Government on a domestic product. Whiskey was the most popular distilled beverage in America in the late 18th century, so the tax became known as the "Whiskey Tax".

Chernow (2004) mentioned that taxes were politically unpopular and difficult to collect, but Hamilton believed that the whiskey tax was a luxury tax and would be less objectionable. This was supported by some social reformers who hoped that a sin tax[1] would increase public awareness of the destructive effects of alcohol. According to Adams (1992) the nation drank too much so this tax would also be a preventive measure of health. Besides, there had been taxes on whiskey before and the experiences had not been bad.

The whiskey tax, better known as the Whiskey Law, became law in March 1791. George Washington defined the revenue districts, appointed supervisors and inspectors, and established their payment based on American State Papers.

[1] Excise levied on certain goods measured harmful to society and individuals

Shughart (1997) observed that Hamilton referred to whiskey as a luxurious commodity that corrupted the nation's morals and damaged the health of its citizens. For Adams (1992) the initial idea that whiskey was a luxury tax was not true. In some areas of the United States, whiskey was a drink for the lower social classes and served as a basic medium of exchange. The money hardly existed. In more developed areas whiskey makers were able to transfer the amount of tax to consumers in the final price and thus maintain the profit margin. The same was not possible in states such as Pennsylvania, Maryland, Virginia, and North Carolina where manufacturers were forced to discount the amount of tax and thereby reduce the profit margin. In addition to these problems and resistance to this new tax, many opponents, especially farmers, believed that the adoption of this duty helped legislators avoid increasing property. That would have hit the more developed states like New England as opposed to rural areas.

Chernow (2004) confirmed that the Government had difficulty collecting taxes and for that reason they appointed tax collectors to do this work. Hamilton recognized the resistance to this new tax and prepared a small army of inspectors with firm powers. They were allowed into homes and warehouses at any time to search for untaxed whiskey. All producers had to have certificates and keep records of their transactions. In 1791 in order to make tax control more effective, Hamilton promulgated very detailed laws, especially in a country unwilling to tax collectors. Alexander Hamilton wanted inspectors to visit all distilleries “at least twice a day” and to complete weekly reports: “specifying in these returns the name of each owner or manager of a distillery, the city, town or village…and the county in which such distillery is situated, the number of stills at each, and their capacity in gallons…the materials from which they usually distil, and the time for which they are usually employed.”.

Chernow (2014) also mentioned that these measures led to some riots in the Pennsylvania area. Once the tax took effect in July 1791, locals began to avoid, threaten, insult, and even attack inspectors. Hamilton figured it had been too meticulous since the inspectors' methods were seen as too bullies and intrusive to the distillers. Protestants began to raise the tone of criticism and to question Hamilton's policies that got into a dilemma. To support the Government, he had to restore public credit. In order to do so, he had to institute unpopular taxes that were critical of the Government. Yet the alternatives to alcohol tax were even more unpopular. He knew that he had to implement unpopular but

necessary measures and was determined to put them into effect even if it affected his reputation. The population did not approve this solution. However, the Secretary of the Treasury did not tolerate breaking the law and showed that he was able to implement his policies, even if he had to rely on military support to end the protests.

Slaughter (1988) argued that after some years of demonstrations against the new tax and attempts by petitions to end it, the resistance peaked in 1794 with the civil order collapsing. In May of that year, District Attorney William Rawle issued subpoenas to more than 60 Pennsylvania distillers who had not paid Excise Tax. The people who received these letters were required to travel to Philadelphia to appear in Federal Court. For farmers from low social class the trip was expensive, time consuming and beyond their means. This whole situation generated a revolution. Many of the resistors were war veterans who believed they were fighting for the principles of the American Revolution, particularly against unrepresented taxation, while the Federal Government maintained that taxes were the legal expression of Congressional taxation powers.

Shughart (1997) wrote about the factors that triggered the Revolution. There was a preconceived idea and an unpopular definition regarding the Excise Tax. In 1641 a temporary consumption tax was introduced in England and led to some riots. In 1734, another proposal for a consumption tax was rejected at the House of Commons. In the 18th century, in the Dictionary of English Language, Samuel Johnson defined excise as "a hateful tax levied upon commodities, and adjudged not by common judges of property, but by wretches hired by those to whom the excise is paid."

Adams (1992) mentioned that England had already imposed some excise duties on liquors, tea, coffee, soap and salt and this was one of the main reasons that led immigrants to return to the United States. Chernow (2014) confirmed that the whiskey tax was destined to be unpopular, as it inevitably reminded Americans of the Stamp Act and the entire British tax collection system. Nevertheless, the tax was the second largest source of federal revenue and was indispensable to Hamilton. If he were deprived of this crucial tax, he would have to raise other tariffs that would encourage further smuggling, tax evasion and spur trade retaliation from abroad. The Government also needed to finance military expeditions against the Indians. This was a very popular policy in the affected areas, such as Western Pennsylvania. Slaughter (1988) stated that the climax of the Whiskey Rebellion took place in July 1794 when a US Marshall arrived in Western

Pennsylvania to deliver letters to distillers who did not pay the excise. The alarm went off and more than 500 gunmen attacked the fortified home of tax inspector General John Neville.

Adams (1993) detailed that Hamilton persuaded Congress to authorize President Washington to call out the militia from four adjacent states to make a show of force. According to Rorabaugh (1979), "Washington responded by sending peace commissioners to Western Pennsylvania to negotiate with the rebels, while at the same time calling on governors to send a militia force to enforce the tax. Washington himself rode at the head of an army to suppress the insurgency, with 13,000 militiamen provided by the governors of Virginia, Maryland, New Jersey, and Pennsylvania.". Weisberger (1991) confirmed that "a military confrontation was averted at the last minute. The rebels surrendered and an antitax committee signed a "solemn promise" to submit to all US laws in the future in exchange for pardons of any past offenses."

Shughart (1997) mentioned that these events regarding the first sin tax were important for several reasons. "First, the new Government demonstrated its ability to enforce the law. Second, taxpayers displayed their willingness to fight what they believed were unjust taxes. Third, and possibly most important, Congress discovered a new source of revenue through the Excise Tax.". Adams (1993) confirmed that this was the first and only time a US President has assumed his position as commander-in-chef and led troops in the field, in full dress uniform.

US Department of Treasury within the page of Alcohol and Tobacco Tax and Trade Bureau published an article in their website about The Whiskey Rebellion. The author of this topic, Michael Hoover, revealed that there was a connection between the tax opposition and political disagreement. While the violence regarding whiskey tax ended, political opposition to the tax continued. Opponents of internal taxes united around the candidacy of Thomas Jefferson and helped him defeat President John Adams in the election of 1800. By 1802, Congress revoked the Excise Tax and all other internal Federal taxes. Until the War of 1812, the Federal Government would rely exclusively on import taxes for revenue, which quickly grew with the Nation's increasing foreign trade.

Shughart (1997) revealed that the tax on whiskey opened the door for additional Excise Tax on luxury items. For example, in 1794 a similar tax was imposed on carriages. Later

on, the Excise Tax system was expanded to be include on the sale of certain liquors, tobacco, the refining of sugar, the proceeds of auction sales and the purchase of salt. Originally the Excise Tax were created with the justification that the Government can levy in luxury items or in products harmful to individuals. In fact, Congress had gone far beyond Hamilton's original plan. They created an elaborate system of Excise Tax to increase Government revenues. This objective was not met due to the difficulty to collect tax in United States of America. The Excise Tax were extremely unpopular in the population. Thomas Jefferson used the abolition of internal taxes as one of his key campaign promises and he became president of United States in 1801.

Shughart (1997) also confirmed that history reveals that Excise Tax were predominantly enacted as wartime emergency measures. When the war ended, Government customarily repealed the majority of the taxes. In 1812, the United States were in war again against Britain. Congress hesitated to enact internal taxes to help finance the war effort but in the end customs duties were doubled. This policy had consequences in the international commerce as the revenues from this source declined by half in 1813. Congress realized that it was impossible to rely on tariff revenues to pay for the war. In the same year Congress approved new Excise Tax with a similar structure to that imposed under Alexander Hamilton's financing plan. They widen the products subject to this new tax and included excised duties on carriages, sugar refining and distilled spirits.

Adams (1884) contended that the major difference between the Excise Tax of 1813 and their predecessors was the definition and the way that Government presented this tax to the public. In 1813 the excises taxes were presented as war taxes. In the legislation it was stated that taxes were automatically to be repealed within one year following the end of the war. The nation was more willing to pay these taxes due to their nature and because the country was facing a war. During this second period of Excise Taxation, the collection process was subjected to some slight modifications. The tax farmers were replaced by tax collectors "who should be a respectable free-holder and reside in the district.".

During the following years, as a result of this new figuration of Excise Tax, they became a funding measure to suppress countries needs. Different approaches were used but with the same purpose. Increase revenues on Excise Tax whose goods generates negative externalities. Excises taxes are in fact selective taxes as they are confined to a particular commodity or a limited number of goods. Shughart (1997) advised that the assertion of

market failure is one of the leading justifications for the existence or creation of new Excise Tax. Market failure refers to situation in which private market is not able to sustain desirable activities or to stop undesirable activities. These situations arise when the benefits or costs of an activity in the individual level diverge from the benefits or costs of that same activity at the level of society. Excise Tax can compensate the social costs on society regarding the consumption of certain products. Alcohol and tobacco, imposes costs that the consumers do not themselves bear and consequently they do not take into account when making decisions about how much they should consume. Government intervention with the excises taxes is required to help align private costs with social costs. The taxes force consumers to internalize the externality. Therefore, the selective taxes should be called corrective taxes. There are significant social costs associated with the consumption of certain products and Governments can intervene to reduce or eliminate these residual externalities cost-effectively.

2.2. Determinants of Tax Revenues

Rao (1979) analysed the factors that affect the changes in tax revenues based on taxable capacities and tax efforts of Governments. The author examined and quantified the changes in tax revenues for the following topics.

i. Economic factors on changes over time in individual and aggregate tax revenues of the states;

ii. Political factors, principally the influence of ideological of the parties in power and the impact of political stability;

iii. Behaviour of the additional tax efforts over different development plans.

Based on the above report, we can confirm that the analysis of tax revenue in general is a complex study due to several aspects that can determine the incidence and the evaluation of each tax. Regarding the Excise Tax, European Commission defined them as “indirect taxes on the sale or use of specific products, such as alcohol, tobacco and energy. The revenue from these excise duties goes entirely to the country to which they are paid.”. The specific incidence of Excise Tax and the three categories make this analysis very rich and complex from a tax point of view.

Ferreira (2015) alleged that Excise Tax have a dual function: raising revenue and achieving extra-fiscal objectives. The extra-tax nature of the Excise Tax is based on the repression of the consumption of selected products, as an alternative to their prohibition.

Santos (2017) wrote that the growth of international trade has led to the creation of the single currency and to harmonize legislations of all Member States. This growth was due to factors such as the widening of public budgets and the increasing importance of taxes in the economies. Taxes represent always a very significant weight in our economic and social reality. OECD stated that in 2016, the Excise Tax in Portugal represented 12,9% of Gross Domestic Product (GDP) and near one fifth of the total tax revenue.

Santos (2017) also referred based in Lorenz (2007) that globalization resulted in the increase of competition, exports, consumer market and investment mobility. As a result, companies started to locate their investments in more tax-attractive regions. The traditional mechanisms became ineffective and it was necessary to reformulate the tax structure to face with this new context.

Raposo (2005) argued that the idea of a tax harmonization policy goes back to the tax divergences between Member States since the creation of the European project. The elimination of tax distortions has been the main objective since the beginning of the harmonization process of the Member States of the EU. The term "distortion" has become a congregating factor and a determining element in the understanding of tax policy in Europe. Santos (2017) confirmed that the variation in rates and structures of these taxes between Member States affected competition, leading to fraud and loss of revenue. These were the major reasons that led to the harmonization process of rates and structures of the Excise Tax in the early 1970s.

Due to the scope of each product taxed on excise duties, it was necessary to create a community system in EU to define the incidence of this tax on the various product types. In 1992 it was published the Directive 92/12/EEC that specify the arrangements for products subject to Excise Tax. European Economic Community (EEC) adopted new directives regarding the Excise Tax for alcohol and alcoholic beverages, 92/83/EEC and 92/84/EEC. Tobacco tax was also subjected of a specific directive, 2011/64/EU. In 2003 it was released the directive for the taxation of energy products and electricity,

2003/96/EC. Korečko *et al* (2017), advised that in 2008 Directive 92/12/EEC was replaced by a new, Directive 2008/118/EC on the general arrangements for excise duty.

Alcohol/Alcoholic Drinks	**Energy Products and Electricity**	**Tobacco Products**
Beer or mixtures of beer with non-alcoholic drinks	Motor fuel	Cigarettes
Wine	Fuel for heating	Cigars
Other fermented drinks such as cider	Mineral oils	Cigarillos
Intermediate products such as sherry or port	Solid fuels: coal, coke, lignite	Smoking tobacco (such as fine cut rolling tobacco)
Ethyl alcohol	Natural gas	
Spirits	Electricity	
	Alcohols, if they are intended for use as heating fuel or motor fuel	
	Animal or vegetable oils, if they are intended for use as heating fuel or motor fuel	

TABLE I: PRODUCTS AFFECTED BY EXCISE TAX (EC 2016)

Santos (2017) mentioned that only minimum rates were set for these three taxes. European Commission stated in their website that "EU countries agreed on common EU rules to make sure that excise duties are applied in the same way and to the same products everywhere in the Union. For example, by applying at least a minimum rate of excise

duty. This helps prevent trade distortions in the Single Market, ensures fair competition between businesses, and reduces administrative burdens for companies.".

According to Constitution of the Portuguese Republic, the purpose of the tax system is to obtain resources to meet the financial needs of the State and other public entities and by the redistribution of income and wealth. Decreto-Lei n.º 73/2010 divided the Excise Tax in Portugal into three categories:

- Imposto sobre o álcool e bebidas alcoólicas (IABA) – for alcohol and beverages;
- Imposto sobre os produtos petrolíferos (ISP) – for energy products and electricity;
- Imposto sobre o tabaco (IT) – for tobacco.

Bronchi & Gomes-Santos (2001) wrote a paper about the reform of Portuguese tax system. In 1998, Portugal had a specific characteristic that defined the tax system. The consumption taxes had a relatively heavy importance in tax revenue. 41,3% of total tax revenue was related with consumption taxes, much above OECD and EU averages.

In a generic point of view, several authors researched about the determinants of Excise Tax and some other general topics about this subject. Lyon & Schwab (1991) studied Excise Tax in a life-cycle framework to confirm if sin taxes were regressive[2]. They compared life-cycle with annual data and concluded that there was no difference between incidence measures calculated on the basis of current consumption and income and those calculated for a lifetime basis. For alcohol, the consumption was slightly less regressive when measure with lifetime income rather than measure with annual income.

Ehrlich (2004) studied the inflationary developments in Estonia, Latvia and Lithuania after the accession to the EU. The author confirmed that all three Baltic States increased the prices of goods and services after of 1 May 2004. There was a gradual harmonisation of VAT and excise rates between national and EU legislation. Consequently, this factor contributed to boosted the inflation rate of the three countries.

[2] Tax applied uniformly, taking a larger percentage of income from low-income earners than from high-income earners

Salaber (2007) observed 18 European countries over the period 1975-2006 and explained the determinants of sin stock returns[3]. This topic is not directly linked to Excise Tax but with this study we can understand that the Excise Tax revenues depend on legal and cultural characteristics such as religious preferences. The evidence demonstrated that Protestants are more "sin averse" than Catholics.

Vasques (2001) confirmed that the Excise Tax in Portugal are an important source of revenue to the Government, although with less weight that VAT, Income Tax and Corporate Tax. Over the time Excise Tax became an important strategy in Portuguese economic and fiscal reality. In the next chapters we analyse the impact of variables of Excise Tax revenues in Portugal and focus our study in the relationship between that data and the tax himself.

2.3. Studies

European Union stated that there are three different sections in Excise Tax and all EU Member States cover the below taxes.

I. Alcoholic Beverages

II. Energy products and Electricity

III. Manufactured Tobacco

2.3.1. Alcoholic Beverages

Several authors approached this topic in the past years as Grossman *et al* (1993), Cook & More (2000), Chaloupka *et al* (2002) and Cnossen (2007).

Grossman *et al* (1993) analysed the effects on consumption and the evaluation of Government revenue due to alcohol tax. Bill Clinton administration's proposed program of health care reform based on an increasing of Excise Tax on cigarettes and alcohol. This was the solution suggested as a means to finance the program. The authors provided three perspectives regarding the application of this tax. The alcohol tax was appealing from a public health perspective because the abuse of the consumption has detrimental health effects. From an economic efficiency perspective sin tax may be justified because alcohol abusers impose costs on others which exceed the tax levels. From a revenue raising view,

[3] Returns on publicly-traded companies involved in producing tobacco, alcohol and gaming

higher tax rates would be justified if the demand functions for alcohol was relatively inelastic. Based on a few analyses, the authors concluded two scenarios. “The estimates indicate either that heavy drinkers greatly reduce their consumption when alcohol becomes more expensive or that the number of heavy drinkers is sensitive to the price of alcohol.”.

Yen & Jensen (1996) analysed the determinants of household expenditures on alcohol expenditures. Income, region, education, and household demographics were some of the determinants examined. Household characteristics play a relatively important role in explaining expenditures on alcohol.

Cook & Moore (2000) confirmed that the demand for alcohol consumption alcohol decreases when excise duties on alcohol increase. These taxes can be used as an effective control policy alcohol.

Decker & Schwartz (2000) analysed the income effects in alcohol and tobacco. The results indicated that alcohol is a normal good with an income elasticity of 0.19 and women's consumption is more responsive to income than men's consumption.

Chaloupka *et al* (2002) provided some insights regarding the youth alcohol consumption. He stated that whereas the frequency of alcohol consumption in young people is decreased when there is an increase on alcohol taxes. Youths are more sensitive to changes in money prices of addictive goods and they have more strict budget constraints. This topic was also analysed in Grossman *et al* (1993) research.

Ståhl *et al* (2006) mentioned that the countries of the European Union achieved historically unprecedented levels of health and wealth. Recently, life expectancy has grown substantially. People now live longer and better. Simultaneously the wealth of the EU countries also raised gradually since 1980. However, in some countries wealth and health inequalities have largely remained or even grown in the past years. These two concepts are related. In their study, authors provided an overview of the consequences of an increase of excise duty. This will lead to an increase in smuggling and consequently a decrease in law abiding. On the other hand, the tax revenue will raise which means more money for health and welfare. In result of that, the ill health will decrease and well-being will increase. With a raise of Excise Tax, the overall consumption will decline as the alcohol employment, income and social interaction. This will generate a rise in ill health

and a reduction of well-being. Authors presented a report about health policies and the above causal links in alcohol policy gave the health outcome for a possible tax increase.

Cnossen (2007) analysed alcohol consumption, taxation and regulation in the EU. In the article the author estimated the cost-of-illnesses to measure the external costs of harmful alcohol use. There is a detailed comparison between countries for a wide range of data and according to the study, alcohol excise duties are not a major source of revenue for the EU Member States, except in Finland, Ireland, Poland and the UK. The tax is particularly heavily taxed in these countries and the consumption is also very frequent.

Rabinovich *et al* (2009) investigated the affordability of alcoholic beverages in the European Union. EU recorded high levels of alcohol consumption and this was linked to public health and other problems, including violence and crime, diseases, lost productivity and absenteeism, family breakdown and accidental deaths. Despite of the empirical information that increasing alcohol taxes reduce consumption, the trend moved in the opposite direction and the real value of alcohol taxation were decreasing across the EU during the period of observation.

2.3.2. Energy Products and Electricity

Oliveira (2001) developed a study with the purpose to analyse the variation in demand for petroleum products in Portugal and the evolution of energy products and in the tax revenues. The conclusions were that Portugal presents very similar results to those found in other studies in several countries. For gasoline, demand for price is inelastic[4] in the short term and elastic[5] in the long term. Regarding the income, consumer behaviour adjusts to higher income for longer terms. Demand for diesel in terms of price and income is quite inelastic in the short term. In the long term both functions have a high elasticity.

Fonseca (2009) wrote a thesis about this topic with a detailed overview of Portuguese economy and the demand of gasoline between 1960 and 2008. The author estimated for the mentioned period the gasoline demand elasticities related to price and income in the short and in the long run. The result for the price elasticity of demand for gasoline in the

[4] Low demand sensitivity for a variation of price

[5] High demand sensitivity for a variation of price

models approached confirmed that gasoline is a normal good. The same conclusion was obtained in the income elasticity of demand for gasoline.

Wadud *et al* (2009) analysed the gasoline demand in the United States from 1949 to 2004 regarding three variables, gasoline consumption, gasoline price and income in US. The main conclusion of the results confirmed that there is no stable and meaningful long run relationship between these three variables for the whole period.

Acaravci & Ozturk (2010) investigated the long-run relationship and causality issues between electricity consumption and economic growth in 15 Transition countries (Albania, Belarus, Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russian Federation, Serbia, Slovak Republic and Ukraine) by using the Pedroni panel cointegration method for the 1990–2006 period. Tests did not confirm a long-term equilibrium relationship between electricity consumption and real GDP. Authors also confirmed that the policies related with electricity consumption have no effect or relation on the level of real output in the long run for above countries. As a conclusion, they advised that the literature studied has different results and there is no consensus for the existence or the direction of causality between electricity consumption and economic growth.

Fuinhas & Marques (2012) examined the relationship between energy consumption and growth in Portugal, Italy, Greece, Spain and Turkey (PIGST), from 1965 to 2009. Evidence suggested bidirectional causality between energy and growth in both the long-run and short-run.

2.3.3. Manufactured Tobacco

Barnett *et al* (1992) wrote a report about the oligopoly structure and the incidence of cigarette Excise Tax in United States between 1995 and 1989. They approached the historical difference between federal and states tax rates and how consumers behaviour depends in the incidence of the tax. Federal Excise Tax had a greater effect on the price of cigarettes than state Excise Tax. Some consumers responded to an increase in a state or local Excise Tax by shopping the product in the adjacent areas to avoid the new price. Thus, federal taxes were more successful in discouraging smoking.

Adda & Cornaglia (2006) demonstrated that smokers compensate tax hikes by extracting more nicotine per cigarette. Smoking more intensively a given cigarette is detrimental to health and this can lead us to some questions about the usefulness of tax increases.

Several authors used the double-hurdle approach to modelling tobacco consumption. The main conception of this model is that participation and consumption decisions are assumed from two separate individual choices and the determinants of these decisions are allow to differ. Aristei & Pieroni (2008) analysed the tobacco consumption in Italy based on this model. According to them the double-hurdle model was proposed originally by Cragg (1971) and it assumes that two separate hurdles must be passed before a positive level of consumption can be observed. In this context, the first hurdle involves the participation decision which is the choice to smoke or not. It is reasonable to consider that this choice is not only an economic decision, but also influenced by social, cultural and demographic factors and this is independent of quantity consumed. The second hurdle concerned about the consumption and the level of tobacco that individuals choose. The results confirmed that decisions to smoke are related to income and demographic characteristics. There is a complementary between tobacco and alcoholic beverages consumption. Authors suggested "that anti-smoking policies and public health strategies aimed at reducing alcohol abuse should be jointly addressed towards those households with higher levels of alcohol and tobacco expenditures.".

Yu & Abler (2008) wrote a similar report for cigarette smoking of the adults in China, using the same methodology. The main result was that family members can affect the participation decision of smoking but can not influence the consumption. People that live with singles parents or divorced are more likely to smoke.

In the two previous papers, authors cited Labeaga (1999) study of Spanish case. Afonso (2013) mentioned that Labeaga (1999) advocated that prices are not a good tool to reduce tobacco consumption, although consumers have a rational behaviour. Results showed tobacco as an addictive good with price elasticity of demand very low.

Gallus *et al* (2006) observed 52 countries in Europe and analysed the variation in demand for tobacco according to price of cigarettes. Data were collected on annual per adult cigarette consumption, smoking prevalence, retail price of a pack of local and foreign brand cigarettes, the gross domestic product adjusted by purchasing power parities, and

the adult population. The result was that in Europe smoking consumption decreases 5–7% for a 10% increase in the real price of cigarettes. This evidence strongly supports an inverse association between price and cigarette smoking.

According to World Health Organization, the income elasticity is usually positive, signifying that tobacco is a normal good. If the income increase, consumers tend to switch to higher-priced tobacco products. This was also confirmed by Mindell & Whynes (2000) for the cigarette consumption in The Netherlands during 1970 and 1995. Both authors stated that if the income falls as a result of unemployment, the desired product may be unaffordable and for that reason the consumers demand an inferior good as substitute. They suggested that hand-rolled tobacco is an inferior good in relation to manufactured cigarettes which are considered a normal good.

Chaloupka *et al* (2012) focused his study in tobacco taxes as a tobacco control strategy. The conclusion was that tobacco Excise Tax are a powerful tool for reducing tobacco use though at the same time providing a consistent source of Government revenues. Increases in tobacco taxes lead consequently to significant improvements in public health if the Governments apply the revenue correctly.

3. Methodology and Data

Following the studies that we mentioned in the previous topics it is important to understand the context of Excise Tax in Portugal and understand what are indicators that influence the revenues of this tax. For that reason, the objective of this thesis is to answer the main question "What are the main determinants of Excise Tax revenues in Portugal?".

The purpose of this analysis is to estimate the variables that have a potential impact and can influence the collection of Excise Tax revenues. The economic data and tax variables were collected from several sources, such as Banco de Portugal, Direção-Geral do Orçamento, Instituto Nacional de Estatística and the European Commission. Monthly data was collected for the period starting in January 2002, up until December 2018, with a total of 204 months. We follow the same structure in the econometric analysis that Silva (2017) did. The author provided a detailed overview about the econometric model behind her analysis for Value Added Tax revenues. We applied the same approach for Excise Tax revenues as both taxes are considered consumption taxes with a very similar structure.

It is important to mention that we aggregated the three types of Excise Tax in our analysis due to lack of information for the specific goods that are levied with this tax.

3.1. Hypotheses

Based on the previous topics, we decide to formulate some hypotheses to test our model and then validate the conclusions.

Hypothesis I: Economic growth is positively associated with Excise Tax revenues.

Hypothesis II: Private consumption is positively associated with Excise Tax revenues.

Hypothesis III: Unemployment rate is negatively associated with Excise Tax revenues.

Hypothesis IV: Exports are negatively associated with Excise Tax revenues.

Hypothesis V: Imports are positively associated with Excise Tax revenues.

Hypothesis VI: Public deficit may be positively or negatively associated with Excise Tax revenues.

GDP is a measure of economic growth, and it is expected that an increase in GDP leads to an increase in Excise Tax revenues. Additionally, because Excise Tax consists of a rate applied over the price of specific goods, an increase in prices is expected to lead to an increase in Excise Tax revenues.

As Excise Tax is a consumption tax, an increase in private consumption is expected to lead to an increase in Excise Tax revenues. Furthermore, an increase in consumers' confidence is indicative of higher optimism regarding the economy and individuals' financial situation. Thus, private consumption is expected to be positively associated with an increase in Excise Tax revenues.

Because unemployed individuals do not receive a salary, their monthly income is expected to drop substantially, resulting in lower purchasing power which, in turn, is expected to ultimately result in lower Excise Tax revenues.

Exports are exempt from Excise Tax which means that is expected that an increase in exports leads to a decrease in Excise Tax revenues.

Imports are not exempt from Excise Tax which means that is expected that an increase in imports leads to an increase in Excise Tax revenues.

Regarding the public deficit variable, the expected results are not straightforward. An increase in the public deficit increases the need for revenues which may lead the Government to adjust its tax policy in order to generate higher revenues. In this sense, an increase in the public deficit may lead to an increase in Excise Tax rates and consequently in the Excise Tax revenues. On the other hand, an increase in the public deficit may be the result of a decrease in Government revenues, including those from Excise Tax. Following this idea, an increase in the public deficit may lead to a decrease in Excise Tax revenues.

In the Appendixes, Table II presents a summary of the hypotheses presented, the explanatory variables used to confirm those hypotheses, the source where data of each variable were collected and the expected sign and the reasons. Table III presents the descriptive statistics of both dependent and explanatory variables.

3.2. Some Econometric Considerations

The collection of monthly data means that we analysed several time series. In economic applications, time series may present several characteristics that we need to consider before we introduce our variables and proceed to an econometric application. When studying econometric models, we need to take in consideration any trend, cycle or seasonal component present in the time series that prevents the time series from being stable[6].

Tsay *et al* (2001) stated that the main objectives of time series modelling and analysis are understanding the dynamic for univariate time series analysis and ascertaining the relationships among several series in multivariate time series analysis. In this paper, our study is based in multivariate time series analysis.

[6] Stable or weakly dependent, which means stationary (in covariance or second order) time series

In this subsection, we will explain the theoretical background of our econometric model. We use monthly data in our analysis which means that we may find a seasonal component in the time series. Seasonality exists when it is possible to predict if the series will increase or decrease based in past behaviours at the same time of the year. Seasonality can mask the deterministic trend in the long-run time series if time period in analysis is too short. Since we are working with a time series with a strong season component, we will not be allowed to understand the real relationship between variables as the long-term behaviour will be masked by this factor, unless we adjust the seasonality accordingly.

In order to perform regressions, it is necessary to follow some steps to adjust the seasonal component of the time series and ensure that seasonality will not influence the econometric analysis. However, in our study we work generally with homologous variation rates and data already adjusted to seasonality by the source which help us to have a time series deprived of seasonality effect.

According to Silva Lopes (2015) there are two types of trends: deterministic and stochastic. While the deterministic trend explains the long-term behaviour of the variables, stochastic trend is related with the presence of a unit root. In this case, long-term behaviour changes slowly, smoothly and not deterministically, with the accumulation of temporary shocks. The presence of a unit root in the autoregressive polynomials of the respective time series can create problems for empirical work, but can also bring opportunities. On the other hand, Silva Lopes (2015) mentioned that in many regressions OLS estimators do not even converge probability to (true) parameter values, that is, are not even consistent. But, on the other hand, in other regressions the OLS estimators are (super) consistent and converge to parameter values at even greater velocity than in regressions with stationary variables, which in later phases of modeling allows to estimate another type of relationships between variables, namely long-term relationships in which case the variables are said to be cointegrated.

In any case, the usual theory of asymptotic estimator distributions and test statistics is not applicable, in particular the T and F statistics, which allow us to perform the tests of individual significance (t-test) and joint (F-test) of variables. A regression between two

or more variables with this characteristic estimation will not be consistent[7] and this leads to the spurious problem.

Silva Lopes (2015) also described time series characteristics. In the characterization of stationary series - I (0) - or non-stationary series - I (1) – without deterministic components (seasonality and trend), it is observed that if series I (0) has a very mild or very erratic behaviour with well-marked fluctuations but a mean reversal behaviour. Series I (1), in contrast, the behaviour is much smoother and less nervous, which means that there is no value to which series are drawn or tend to return often.

However, these characteristics can be analysed with three options:

- Visual inspection of the time series plot;
- Observing and analysing the theoretical autocorrelation function (in the case of series I (0) it decreases rapidly from a certain order of offset, contrary to the series I (1);
- Running a unit root test.

Silva Lopes (2015) wrote that a time series can be, stationary in covariance or in second order if: i) the mean and the variance are finite and constant over time and ii) if the covariance between any two terms of the sequence depends only on the relative positions of the two terms and not on time, that is, on how far apart they are located from each other, and not on their absolute position. Mathematically, a stochastic process $X_1, X_2, \dots, X_T$ is stationary (in covariance or second order) if:

$$E(X_t) = \mu < \infty, \forall\, t \quad (1)$$

$$Var(X_t) = E[(X_t - \mu)^2] = \gamma_0 < \infty, \forall\, t \quad (2)$$

$$Cov(X_t, X_{t-k}) = E[(X_t - \mu)(X_{t-k} - \mu)] = \gamma_k < \infty, \forall\, t \quad (3)$$

[7] A regression between two or more non-stationary variables is noun as a spurious regression. In this case, even if the relationship between variables is apparently significant, estimator is not be consistent

If there is a unit root in a time series, we are in presence of a non-stationary time series as the autoregressive polynomial has a root that is equal to the unit. We can analyse if a time series x_t that follows a generic autoregressive process of order *p:*

$$x_t = \beta_0 + \beta_1 t + \rho_1 x_{t-1} + \cdots + \rho_p x_{t-p} + \varepsilon_t \ (4)$$

Where p is the number of lags of x_t. The series has a unit root if $x = 1$ is a solution to the equation of the autoregressive polynomial:

$$\rho(x) = 1 - \rho_1 x_{t-1} - \cdots - \rho_p x_{t-p} = 0 \ (5)$$

The unit root test for a time series is a test about the deviations from the trend. In fact, to analyse the time series stationarity the correct question should be about the errors or deviations: are the deviations from the trend stationary? Silva Lopes (2015) also confirmed that the correct approach should not be about the unit root. The author argued that the analysis should be if over a finite time horizon, the shocks have a significant effect on the series. With this question, the issue can be solved in two steps. The first one to estimate and remove the deterministic trend and the second is to analyse the deviations or errors. With the Dickey-Fuller (DF) test it is possible to find a direct solution. Initially, we just consider the DF test, without the Augmented version. This is valid if the errors are non-correlated. In order to accommodate an eventual error autocorrelation derived from a lack of dynamic, we can use the Augmented Dickey-Fuller (ADF) version of DF test. We can consider that the autoregressive representation of the series and auxiliary test regression has an intercept or an intercept and a trend. The decision should be based in economic reasons and/or visual inspection of the time series plot. Generally, the test auxiliary regression is:

$$\Delta x_t = \beta_0 + \beta_1 t + \phi x_{t-1} + \sum_{i=1}^{p-1} \gamma_i \, x_{t-i} + \varepsilon_t \ (6)$$

Where $\phi \equiv -\rho(1) = \rho_1 + \cdots + \rho_p - 1$. Mathematically, the test is the following:

$$\begin{cases} H_0: \phi = 0 \\ H_1: \phi < 0 \end{cases} \Leftrightarrow \begin{matrix} x_t \sim I(1) \\ x_t \sim I(0) \end{matrix} \quad (7)$$

In the null, we consider that time series is highly persistent with the presence of a unit root; in the alternative hypothesis, time series is weakly dependent, stable or stationary. The test statistics is: $t_{\phi} = \frac{\hat{\phi}}{se(\hat{\phi})}$, with $se(\hat{\phi})$ the standard error. Giving that, under the null, the time series is non-stationary, the usual theory about asymptotic distributions of estimators and test statistics is not valid. Thus, it is not possible to call the Limit Central Theorem and use the normal distribution to perform this test (it is neither possible to use t-student distribution because, as the lagged dependent variable figures as a regressor, strict exogeneity is not satisfied and classical theory and statistical inference can not be used). So, the test statistics follows a DF distribution.

Following Silva Lopes (2015), the test is performed following the general-to-specific t-sig mechanism, considering a maximum order of lags given by the rule $l_4 = k_{max}(T) = \left[4\left(\frac{T}{100}\right)^{1/4}\right]$ (8).

If we consider a significance level and the correspondent critical value, it will be possible to take a decision about the presence of a unit root, depending on the deterministic components included: **for the test with intercept,** the rejection of the null hypothesis indicates that time series is already stationary and, therefore, no transformations are needed; **for the test with intercept and trend,** the rejection of the null indicates that time series is trend-stationary (stationary over a deterministic trend and not over a constant). In both cases, the non-rejection of the null hypothesis indicates the presence of a unit root and, consequently, time series is difference stationary[8].

In sum, the Augmented Dickey-Fuller can lead to three different results, depending on the characteristics of the time series under analysis and, therefore, on the deterministic components included in test auxiliary regression. In concrete, the time series in analysis can be a) stationary and we do not need to perform any transformation to guarantee the stability of the series, b) difference-stationary and it is needed to perform the

[8] The test admits an error margin of error that corresponds to type 1 error (probability of rejecting the null with the null being true). This probability, noun as the level of significance or test dimension, is usually fixed in 5%.

differentiation transformation[9] to guarantee time series' stability or c) trend-stationary. In the last case, time series is stationary around a trend and not a constant (as the stationary series) and, therefore, the constant and finite mean over time condition is not satisfied as Silva Lopes (2015) mentioned.

In multivariate time series modelling, the necessary transformations should be applied correctly to each of the time series, otherwise there is a high probability that the model reveal the presence of autocorrelation of the errors. No autocorrelation means:

$$Corr(\varepsilon_t, \varepsilon_s) = 0 \; \forall \, t, s, t \neq s. \quad (9)$$

Autocorrelation of the errors is a typical problem when using time series and this may happen because the order in which data is presented is insufficient (autocorrelation seen as a lack of dynamic symptom) or functional form is misspecified. Therefore, it is necessary to ensure that there is no autocorrelation when performing a regression analysis, otherwise estimation will not be efficient and standard statistical inference methods are invalid, even asymptotically[10]. To test the existence of autocorrelation we can use the statistical test of Breusch-Godfrey (BG), a test of autocorrelation until order p[11]. The BG tests if the error terms are independent from each other. Formally, the test assays the hypothesis:

$$\begin{cases} H_0: \rho_1 = \cdots = \rho_p = 0 \\ H_1: \exists \rho_j \neq 0, j = 1 \ldots, p \end{cases} \quad (10)$$

The test auxiliary regression is:

[9] In order to transform a non-stationary in a stationary time series we should take the first difference. Considering Xt as a non-stationary process, the right transformation to apply is the following: $\Delta x_t = x_t - x_{t-1}$.

[10] In the presence of error autocorrelation, one part of estimator variance is neglected; thus, estimator variance is underestimated, precision is overestimated and estimator is not efficient (it is not minimum variance estimator). As a result, type 1 error higher than 5% – over-rejection problems.

[11] The order of autocorrelation in test is related with series frequency. So, with monthly series it is usually considered a test until autocorrelation until order 12.

$$e_t = \delta_0 + \delta_2 x_{t1} + \cdots + \delta_k x_{tk} + \sum_{i=1}^{p} \gamma_i \, e_{t-i} + v_t \ (11)$$

$e_t = y_t - \hat{y}_t$ which is the difference between the actual observed value and the value predicted by the model and corresponds to the residuals, and the related test:

$$\begin{cases} H'_0 : \gamma_1 = \cdots = \gamma_p = 0 \\ H'_1 : \exists \gamma_j \neq 0, j = 1 \ldots, p \end{cases} (12)$$

This test uses the following test statistic:

$$LM(p) = BG(p) = TR^2 \xrightarrow{p} \chi^2_{(p)} \ (13)$$

If we reject the null at the level of significance considered, the statistical evidence suggests that there are evidences of autocorrelation in errors until order *p*. If not, there are no evidences of autocorrelation until order *p*.

The Gauss-Markov Theorem tells us that if a certain set of assumptions are met, the Ordinary Least Squares (OLS) estimate for regression coefficients gives you the best linear unbiased estimate (BLUE) possible. However, for our study, The Gauss-Markov Theorem should not be applied as time series violate the condition about strict exogeneity.

Autocorrelation is a typical problem when using time series and this happens because the order in which data is presented is relevant. In time series analysis it is important to ensure that the residuals of the regression are white-noise and confirm the no autocorrelation. This means that the process has zero-mean, constant variance and that the correlation between residuals is always zero over time. If the residuals follow a white-noise process this will guarantee that the estimated parameters of the model are efficient. The error terms follow a white-noise process if:

$$E(e_t) = 0, \forall t \ (14)$$

$$Var(e_t) = \sigma^2, \forall t \ (15)$$

$$Corr(e_t, e_{t-s}) = 0, \forall s \neq 0 \ (16)$$

To test if the residuals follow a white-noise process we can run the Ljung-Box test, also known as Q-test of Portmanteau. We will be testing the following:

$$\begin{cases} H_0: corr\ (\hat{\varepsilon}_{t,}\hat{\varepsilon}_{t-k)} = 0 \\ H_1: corr\ (\hat{\varepsilon}_{t,}\hat{\varepsilon}_{t-k)} \neq 0 \end{cases}, k = 1, 2, \ldots \quad (17)$$

The test statistics for null hypothesis is the below:

$$Q = n(n + 2)\sum_{k=1}^{m} \frac{\hat{r}_{k^2}}{n-k} \xrightarrow{p} \chi^2{}_m \ (18)$$

Where $\hat{r}k$ is the sample autocorrelation at lag k:

$$\hat{r}_k = \frac{\sum_{t=k+1}^{n} \hat{u}_t\, \hat{u}_{t-k}}{\sum_{t=1}^{n} \hat{u}^2{}_t} \ (19)$$

Q-test converges to a chi-square distribution of order m at a certain confidence level. We reject the null hypothesis if the p-value is smaller than the significance level and the conclusion is that the residuals are not white-noise. If the p-value is higher than the significance level we do not reject the null hypothesis and conclude the residuals are white-noise.

We processed the Breusch-Pagan (BP) test which is one of the most common tests for heteroskedasticity. It begins by allowing the heteroskedasticity process to be a function of one or more of your independent variables, and it is usually applied by assuming that heteroskedasticity may be a linear function of all the independent variables in the model. This assumption can be expressed as:

$$\varepsilon_i{}^2 = \alpha_0 + \alpha_1 X_{i1} + \cdots + \alpha_p X_{ip} + u_i \ (20)$$

BP tests the null hypothesis that the error variances are all equal versus the alternative that the error variances are a multiplicative function of one or more variables. A large chi-square would indicate that heteroskedasticity was present.

To detect general functional form misspecification we used the Regression Specification Error Test (RESET). The intuition behind this test is that if non-linear combinations of

the explanatory variables have any power in explaining the response variable, the model is misspecified. This means that the data generating process might be better approximated by a polynomial or another non-linear functional form. Wooldridge (2009) stated that the null hypothesis is that function is correctly specified. Thus, RESET is the F statistic for testing the below:

$$H0: \vartheta_1 = 0, \vartheta_2 = 0 \ (21)$$

A significant F statistic suggests some sort of functional form problem. However, the author also provided some limitations about this test. If the functional form is properly specified, RESET has no power for detecting heteroskedasticity. The bottom line is that RESET is a very general test for model misspecification.

We also performed the Wald test which is a way to find out if explanatory variables in a model are significant. Significant means that they add something to the model. The generic expression is:

$$W_j = \frac{\hat{\beta}_1}{\widehat{se}(\hat{\beta}_j)} \xrightarrow{p} F\ (q, T-k-1)(22)$$

The hypotheses for this test are the following:

$$\begin{cases} H_0: \beta_j = 0 \\ H_1: \beta_j \neq 0 \end{cases}, j = 0, \dots, K \ \ (23)$$

If the null hypothesis is rejected, it suggests that the variables in question can be removed without much harm to the model fit.

3.3. Dependent Variable

Our purpose is to estimate the determinants of Excise Tax revenues, it is clear to think that Excise Tax revenues in millions of Euros as the main candidate for the dependent variable.

Excise Tax revenues (in millions of euros): are the total monthly revenues collected from the tax on the subject goods in Portugal.

Figure 1 represents the monthly Excise Tax revenues in millions of Euros from January 2002 through December 2018. We can observe a strong seasonal component which means that we first need to seasonally adjust it. To adjust the seasonality, we applied a simple moving average smoother. With this method, data is transformed so that the adjusted values will be the simple unweighted average (the mean) of the past n observations. In our case, the movements in the monthly Excise Tax revenues have a pattern that repeats every year. We applied a simple moving average smoother using the last 12 terms. After that, our dependent variable will be adjusted in the following way:

$$\hat{X}_t = \frac{1}{12}\sum_{i=0}^{12} X_{t-i} = \frac{X_t + X_{t-1} + \cdots + X_{t-12}}{12} \quad (24)$$

In Figure 2 we can see the seasonally adjusted time series plot.

After running the ADF test on the seasonally adjusted variable, we concluded that the variable is difference-stationary and therefore we took the first-difference in order to make it stationary. In Figure 3 we obtain the time series with the seasonally adjusted variable.

Now we have a stationary variable. Our dependent variable is the first-difference of the seasonally adjusted monthly Excise Tax revenues (in millions of euros).

In Figure 4 we present the histogram of this variable, where we can see that it is normally distributed.

3.4. Explanatory Variables

The objective of this study is to estimate the determinants of Excise Tax revenues, so it is important to select the candidate variables to test. It was only possible to select explanatory variables with monthly data as we explained in the previous subsections. We grouped six categories and also six hypotheses to reply to our main question of this paper. The variables were chosen based on Silva (2017) as both taxes are very similar as stated previously. We can see below the explanation for each selected variable:

GDP growth is the growth rate of the Gross Domestic Product. It was used as a measure of economic growth. Given the unavailability of monthly data on GDP, the index of economic activity from Banco de Portugal was used as a proxy for GDP. This variable was adjusted to seasonality as it is a year-on-year rate of change.

Monthly Inflation is given by the Consumer Price Index (CPI) and is an indicator of the evolution of the price level of all goods and services in a given economy. We collected data on this variable from Instituto Nacional de Estatística. This variable was adjusted to seasonality as it is a year-on-year rate of change.

Consumption is the general level of expenditures made by private entities. As no data on monthly consumption was available, the index of private consumption from Banco de Portugal was used as a substitution for private consumption. This variable was adjusted to seasonality as it is a year-on-year rate of change.

The Consumers' Confidence Index is a measure of optimism regarding the economic and financial situation of the economy and personal financial situation. Data on the Consumers' Confidence Index can be found in the database from Banco de Portugal. This variable was adjusted to seasonality as it is a year-on-year rate of change.

Unemployment rate measures the percentage of the active population that is searching for a job, but has still not found one. Information on this variable can be found at Instituto Nacional de Estatística. This variable was adjusted to seasonality.

Exports are the share of all internally produced goods and services that are sold to another country. Data on this variable was collected from Banco de Portugal and after that we produced the year-on-year rate of change.

Imports are the share of goods and services produced in another country, but finally consumed in national territory. We collected data on this variable from Banco de Portugal and then we created the year-on-year rate of change

Public deficit is a measure of how much Government expenditures exceed Government revenues. This information is available in the monthly reports from Direção Geral do

Orçamento. In the same way as Exports and Imports, we formed the year-on-year rate of change.

Similarly to the dependent variable, we applied the ADF test and therefore our set of explanatory variables includes all the variables presented above. Table V presents the ADF results for each variable that we tested.

3.5. Regression Models

After the necessary corrections the variables can now be used to perform econometric regressions. It is possible to observe from the correlation matrix in Table IV that there is some multicollinearity between some variables, which means that some explanatory variables are linearly related with each other. Using two related explanatory variables in the same regression will lead to large standard errors and insignificant estimations. There are some potential warnings for this situation like the multicollinearity between the variables. If there is a perfect multicollinearity it is not possible to use OLS method.

Consequently, it is not possible to run a regression using all the explanatory variables at the same time and we have to run several regressions. Each regression uses four explanatory variables.

We ran two sets of regression models, one performing simple OLS estimator and the other using the Prais-Winsten and Cochrane-Orcutt method. The Prais-Winsten is an extension of the Cochrane-Orcutt method and it applies a Generalized Least-Squares (GLS) method instead of an Ordinary Least Squares method to estimate the parameters of the regression and it assumes that the errors follow a first-order autoregressive process.

Hayashi (2000) advised that GLS transform the regression model in a model that satisfies all hypothesis of the classical model, using algebraic manipulation. Although the OLS estimator continues to be biased by not checking the spherical variance of the errors hypothesis (no serial autocorrelation and homoskedasticity hypothesis joined), the GLS estimator, by conditioning the violation of this same hypothesis, becomes more efficient.

Wooldridge (2009) presented the two methods. Cochrane-Orcutt estimation omits the first observation while the Prais-Winsten uses the first observation. Asymptotically, it

makes no difference whether or not the first observation is used, but many time series samples are small, so this could be notable when applicable. Both methods are used in an iterative scheme. Applying these methods may improve the efficiency of the estimated coefficients and residuals comparable to those obtained through the OLS method.

Thus, in order to answer our research question, we will apply both the OLS and the Prais-Winsten and Cochrane-Orcutt methods. The reason why we apply two methods is to reinforce the conclusions obtained. Conclusions based in just one method could originate some distrust regarding the results. Applying two methods strengthens the results and validates the conclusions.

Considering y_t the dependent variable, and x_{tj} the explanatory variable, the regression model after the necessary adjustments is the following:

$$1st\ \Delta Seasonally\ Adjusted\ Excise\ Tax\ rev_t = \beta_0 + \beta_1 GDPg_t + \beta_2 Consumptg_t + \beta_3 \Delta\ Consumers\ Confidence_t + \beta_4 \Delta\ Month\ Inflation_t + \beta_5 \Delta\ Unemployment_t + \beta_6 Total\ Exports_t + \beta_7 Total\ Imports_t + \beta_8 Public\ Deficit_t + \varepsilon_t \quad (25)$$

Table VI presents the results given by the OLS method and Table VII presents the results given by the Prais-Winsten and Cochrane-Orcutt method.

4. Results

4.1. The Evolution of Excise Tax Revenues in Portugal

Excise Tax was classified in the national law in 1999 and it is increasing over time due to the changes of consumption patterns in the Portuguese Economy.

Nowadays it is an important source of revenues for the Portuguese Government. In Figure 5 we can see the annual evolution of Excise Tax in millions of euros from 2002 to 2018. In this period the revenues increased 20%, from 4114,7 million euros to 4949,5 million euros in 2018. Without any significative increase in the rates, we can explain this due to a change in consumption patterns in the last years. The Portuguese are consuming more alcoholic beverages, energy products and/or tobacco.

It is visible a decrease in the revenues after 2008 which is related with the subprime crisis. The lowest value was in 2013 but in the next years there was a recovery and in 2017 and 2018 the Portuguese Government collected the biggest revenue ever for the Excise Tax.

4.2. Analysis of the Results

In this topic we will answer the question "What are the main determinants of Excise Tax revenues in Portugal?". The econometric results obtained through the regression models are presented in Table VI and Table VII. The p-values of Breusch-Godfrey, Breusch-Pagan, Ramsey RESET, Wald and Portmanteau Test are shown in Table VI. Table VII only includes the results of the Portmanteau Test, as it is not possible to apply the remaining tests in the Prais-Winsten and Cochrane-Orcutt method. All regressions passed both Breusch-Godfrey and Portmanteau tests for a 5% significance level, meaning that there is no autocorrelation, and that the residuals are white-noise.

There is a significant relationship between GDP and Excise Tax revenues in OLS and Prais-Winsten and Cochrane-Orcutt method. This is evident in the first and second regressions of both methods. The positive impact of GDP on Excise Tax revenues is expected according to the literature review. Economic growth creates conditions to people consume more goods and consequently pay more taxes. However, this is not applied to Monthly Inflation. We used this variable in all the regressions of both methods and in none of them it has a strong impact in Excise Tax revenues. The coefficient signal also changed in some regressions. Despite of that, Inflation means Economic Growth which is ultimately verified by the GDP indicator. This variable already includes the effects of Inflation on the Economy. Saying this, we can validate our first hypothesis and confirm that economic growth leads to an increase in Excise Tax revenues.

Consumption is also expected to have a strong impact in the revenues. Due to multicollinearity, we only use this variable in regression 3 but the results were in line with the literature review. Excise Tax is a consumption tax so this variable has a significant influence in our model. Consumption is significant at a 5% confidence level in OLS method and only significant at a 10% value in the Prais-Winsten and Cochrane-Orcutt method. Following the same idea, Consumers' Confidence Index is significant at a 10% confidence level in both methods. This explanatory variable is linked to the optimism

regarding Economy and Finance context. Our analysis period could influence negatively this variable due to the crisis after 2008 but despite of that, Consumers' Confidence Index presents a positive relationship with Excise Tax revenues, although an insignificant one. Nonetheless, consumption is positively related with Excise Tax revenues which means that we can confirm that the Hypothesis II is valid and Consumption leads to higher revenues. This assumption was also referred in the literature review by several authors.

Regarding the unemployment, the results are in line in the expectations and with the papers that we analysed. There is a negative relationship between this variable and Excise Tax revenues which means that if the unemployment rate increases, the revenues tend to decrease. An economy with high unemployment rate has consequences to the consumption. People have low income and consequently they optimize their needs with necessary goods instead of alcohol, oil and tobacco. In both methods, unemployment variable has a significant impact in the tax revenues. These results validate the Hypothesis III.

Based on the literature review, it was expected a negative impact of exports and a positive impact of imports on Excise Tax revenues. However, our results were inconclusive. Imports were statistically significant in both methods but the impact was negative which contradicts the initial idea that since Imports are not tax exempt, an increase in this variable will result in an increase of revenues. Probably, due to the specific incidence of Excise Tax there is no relationship between Exports and Imports regarding the tax revenues and saying this we reject the Hypotheses IV and V.

Lastly, the impact of public deficit on Excise Tax revenues is not linear. An increase in deficit may indicate an increase in Government expenses or a decrease in revenues and the other way around also occur, a decrease in deficit indicates that there was a decrease in the expenses or an increase in revenues. However, this is a generic assumption and public deficit may be related to many factors other than Excise Tax. In our model the relationship is negative but it is not significative to explain the revenues which means that we reject the Hypothesis VI.

5. Conclusions and Future Research

The introduction of Excise Tax in United States during the 18th century created new opportunities for Government increased their revenues. Nowadays, this is an important instrument to finance Government activities.

Consumption taxes have gained notoriety in the political, economic and social context. Beyond the fiscal objective there is also an extra-fiscal purpose that allows Governments to control the harmful effects of population consumption and to tax the negative externalities of the economy.

The importance of these taxes in today's society has attracted the attention of some authors. In recent years, studies on Excise Tax have increased but very specifically with analyses of certain goods for some countries and with an application outside the scope of Finance, more linked to Law, Taxation and even Health. There is little or no empirical papers that focus on the determinants of Excise Tax in Portugal. We expect that with this dissertation we can contribute to the set of studies in the specific case of Portugal.

We collected monthly data from January 2002 and December 2018 for several economic indicators. With this data we performed a time series analysis by running two methods, the OLS and the Prais-Winsten and Cochrane-Orcutt.

We completed a very detailed analysis but there are some limitations on our study due to the availability of some data. We used data from 2002 after Euro implementation. Monthly data also means an issue in our analysis as there are few variables in Portugal with this frequency. This assumption leaves out of our model some explanatory variables that can provide a more accurate result. We adapted our model in a more generic regression but we suggest future researchers to repeat this study with a wider dataset, using quarterly or yearly data and to decompose it in the three taxes. An analysis to Alcoholic Beverages, Energy Products and Energy and Manufactured Tobacco, using specific variables for each product will provide an overview about Excise Tax in Portugal. We made several researches to find potential variables that can help us to explain the goods separately but the data is not well specified and there is lack of information in the official sources.

Based on the results obtained, we expect that Tax Authority can understand the impact of each variable of Excise Tax in Portugal and optimize the revenues.

Finally, the results are very clear and in line with the literature review that we studied for other countries. GDP, Consumption and Consumers' Confidence Index have a positive impact in the revenues while Unemployment rate has a negative impact.

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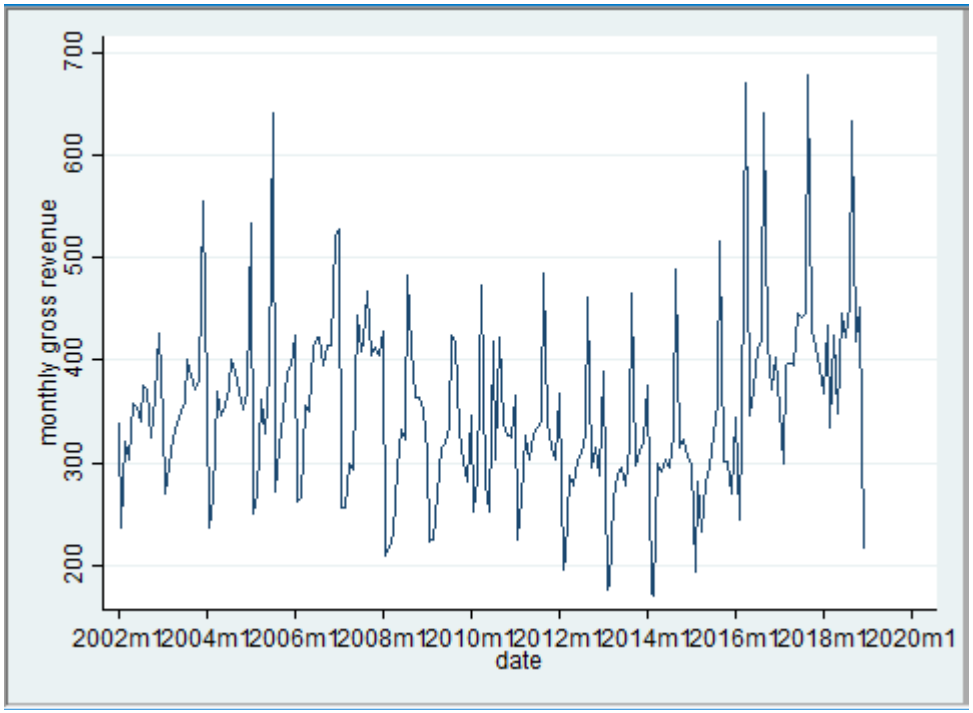
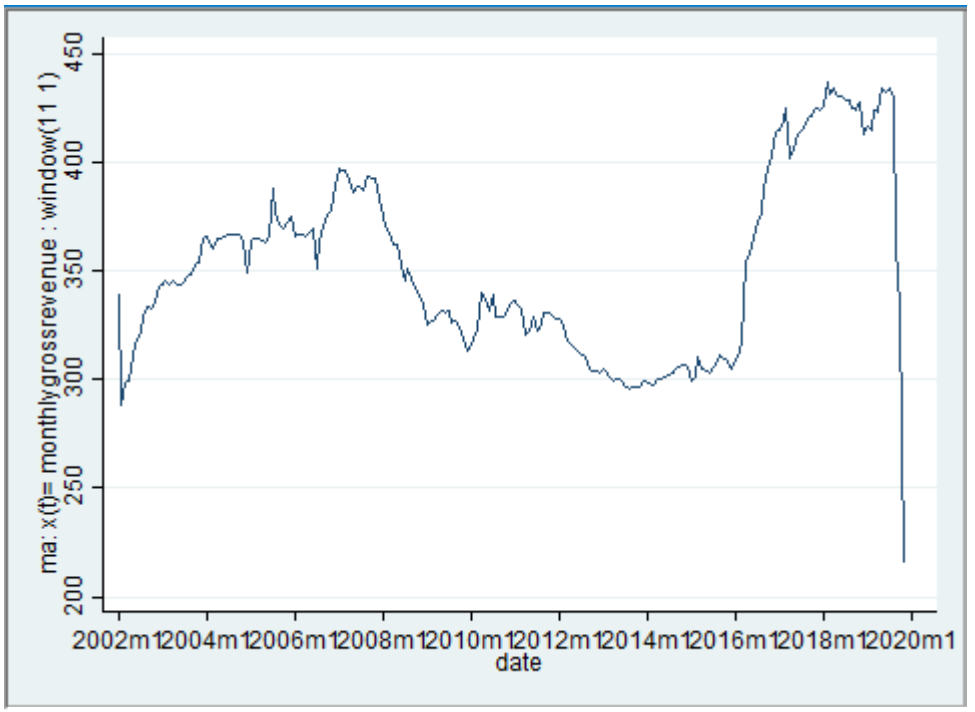
Appendixes

Figure 1 - Monthly Excise Tax revenues (in millions of Euros)



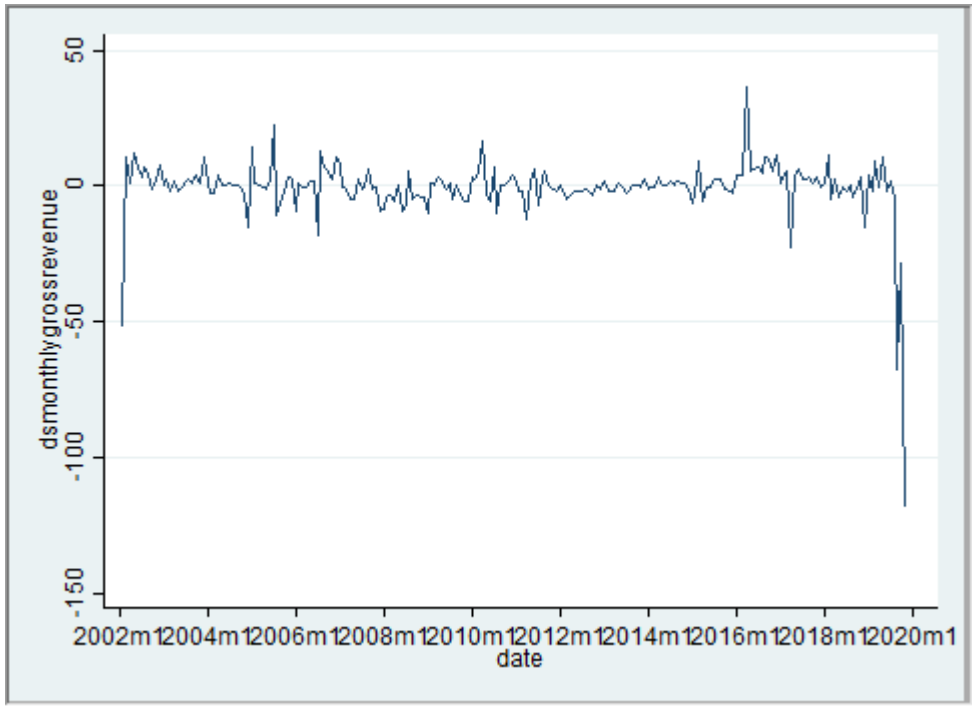
SOURCE: STATA 14 OUTPUT

Figure 2 - Seasonally adjusted Monthly Excise Tax revenues (in millions of Euros)



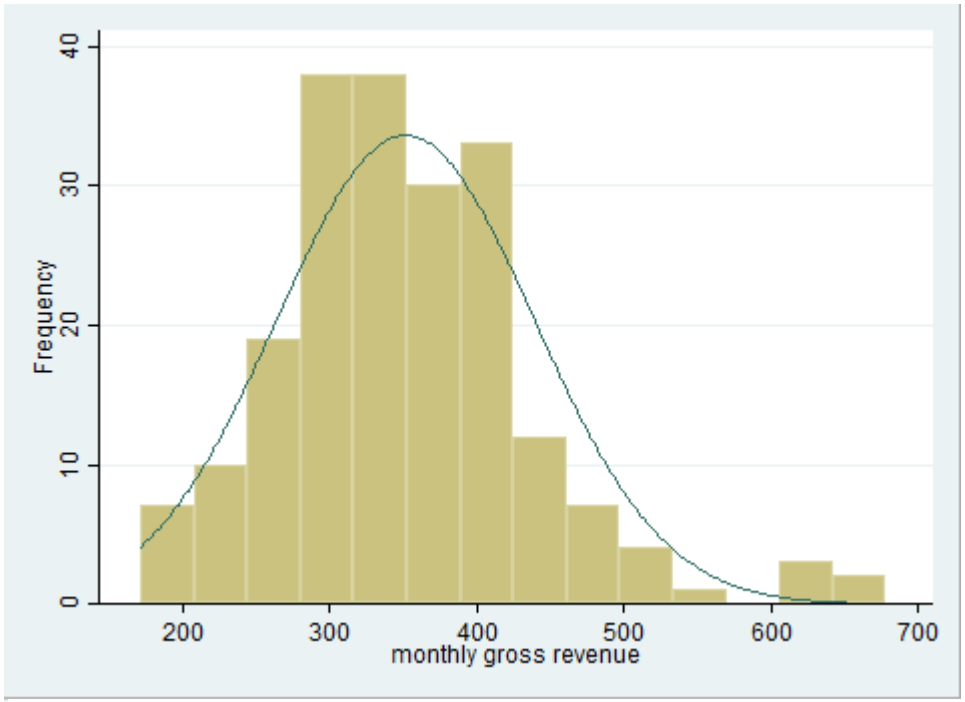
SOURCE: STATA 14 OUTPUT

Figure 3 - First difference of seasonally adjusted Monthly revenues (in millions of Euros)



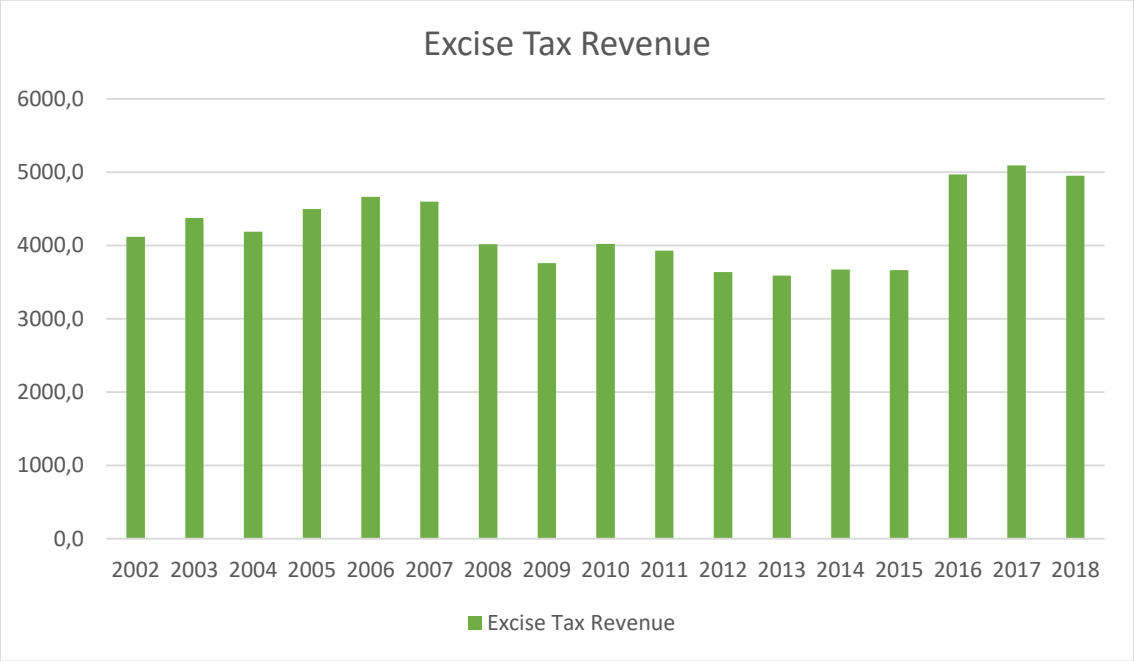
SOURCE: STATA 14 OUTPUT

Figure 4 - Histogram of first difference of seasonally Excise Tax revenues (in millions of Euros)



SOURCE: STATA 14 OUTPUT

Figure 5 - Evolution of Portuguese Excise Tax revenues (in millions of euros)



SOURCE: DIRECÇÃO GERAL DO ORÇAMENTO

Table II - Hypotheses and Explanatory Variables

Hypotheses	Source	Expected Sign	Reasons
Hypothesis 1:			Economic growth is linked with improvement of financial situation and consequently more consumption
GDP	Banco de Portugal	+	
Monthly Inflation	INE	+	
Hypothesis 2:			Excise Tax is a consumption tax
Consumption	Banco de Portugal	+	
Consumers' Confidence Index	Banco de Portugal	+	
Hypothesis 3:			Unemployment decreases income and purchasing power
Unemployment rate	INE	-	
Hypothesis 4:			Exports are Excise Tax exempt
Exports	Banco de Portugal	-	
Hypothesis 5:			Imports are subject to Excise Tax
Imports	Banco de Portugal	+	
Hypothesis 6:			Increase means that Excise Tax revenues are low
Public Deficit	Direção Geral do Orçamento	+/-	Decrease means that Excise Tax revenues are high

Table III - Table of Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
1st Dif Sa Monthly Excise Tax Revenue	203	0.3619	7.0492	-51.1000	36.39166
GDP	204	0.4471	1.9278	-4	3.1
Consumption	204	0.6691	2.4832	-6.4	3.4
1st Dif Consumers' Confidence Index	203	0.0330	2.2870	-11.1	5.4
1st Dif Monthly Inflation (CPI)	203	-0.0153	0.4193	-1.7	1.2
1st Dif Unemployment rate	203	0.0064	0.2017	-0.6	0.5
Exports	192	0.0583	0.0880	-0.2462	0.2449
Imports	192	0.0427	0.0979	-0.2845	0.2616
Public Deficit	192	-0.1651	3.9877	-43.3487	23.5102

SOURCE: STATA 14 OUTPUT

Table IV - Correlation Matrix

Variables	1)	2)	3)	4)	5)	6)	7)	8)	9)
1) 1st Dif Sa Monthly Excise Tax Revenue	1								
2) GDP	0.1617	1							
3) Consumption	0.1454	0.9439	1						
4) 1st Dif Consumers' Confidence Index	0.1312	-0.0165	0.0007	1					
5) 1st Dif Monthly Inflation (CPI)	0.0200	0.1688	0.1549	-0.1099	1				
6) 1st Dif Unemployment rate	-0.1162	-0.4721	-0.4515	-0.1104	-0.0895	1			
7) Exports	0.0124	0.3473	0.1783	-0.0323	0.1981	-0.1320	1		
8) Imports	-0.0491	0.6317	0.5524	-0.0718	0.1690	-0.2679	0.7568	1	
9) Public Deficit	-0.0367	-0.0832	-0.0185	0.0953	-0.0455	-0.0168	-0.0556	-0.0327	1

SOURCE: STATA 14 OUTPUT

Table V – ADF Tests

ADF Test	Stationary	Non-Stationary	Transformation	Stationary	Non-Stationary
Sa Monthly Excise Tax Revenue		X	1st Dif Sa Monthly Excise Tax Revenue	X	
GDP	X		-		
Consumption	X		-		
Consumers' Confidence Index		X	1st Dif Consumers' Confidence Index	X	
Monthly Inflation (CPI)		X	1st Dif Monthly Inflation (CPI)	X	
Unemployment rate		X	1st Dif Unemployment rate	X	
Exports	X		-		
Imports	X		-		
Public Deficit	X		-		

SOURCE: STATA 14 OUTPUT

Table VI – Regression models using Ordinary Least Squares method

	1st Dif Sa Monthly Excise Tax Revenue				
	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5
GDP	0.5447** (0.2380)	0.9769*** (0.2820)			
Consumption			0.3502** (0.1755)		
1st Dif Consumers' Confidence Index				0.3675* (0.1963)	
1st Dif Monthly Inflation (CPI)	-0.0157 (1.0441)	0.1133 (1.0166)	-0.0197 (1.0496)	0.5764 (1.0406)	0.2972 (1.0371)
1st Dif Unemployment rate					-4.1985* (2.2626)
Exports	-3.4599 (5.3400)		-1.0735 (5.1309)		
Imports		-15.5629*** (5.6549)		-2.9529 (4.5363)	-5.6434 (4.6898)
Public Deficit	-0.0375 (0.1096)	-0.0274 (0.1077)	-0.0528 (0.1098)	-0.0749 (0.1101)	-0.0622 (0.1098)
Constant	0.3213 (0.5272)	0.6008 (0.4691)	0.1869 (0.5337)	0.4593 (0.4792)	0.5853 (0.4806)
Breusch-Godfrey (Prob > LM)	0.6423	0.7421	0.5909	0.2971	0.4832
Breusch-Pagan (Prob > LM)	0.0001	0.0000	0.0009	0.7304	0.1365
Ramsey RESET (Prob > F)	0.8272	0.7544	0.8593	0.2902	0.2979
Wald (Prob > F)	0.2378	0.0136	0.3687	0.3593	0.3669
Portmanteau Test (Prob > Q)	0.7856	0.8501	0.7117	0.3278	0.5841
Observations	192	192	192	192	192
R-Squared	0.0289	0.0646	0.0225	0.0229	0.0226
Root MSE	6.0196	5.9079	6.0394	6.0382	6.0391

STANDARD ERRORS IN PARENTHESES
*** P<0.01, ** P<0.05, * P<0.1
SOURCE: STATA 14 OUTPUT

Table VII - Regression models using Prais-Winsten and Cochrane-Orcutt method

	1st Dif Sa Monthly Excise Tax Revenue				
	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5
GDP	0.5483** (0.2471)	0.9808*** (0.28861)			
Consumption			0.3515* (0.1832)		
1st Dif Consumers' Confidence Index				0.3845* (0.1969)	
1st Dif Monthly Inflation (CPI)	-0.0229 (1.0439)	0.0850 (1.0181)	-0.0221 (1.0484)	0.5232 (1.0341)	0.2534 (1.0351)
1st Dif Unemployment rate					-4.0943* (2.3143)
Exports	-3.6040 (5.4619)		-1.2784 (5.26716)		
Imports		-15.6339*** (5.7310)		-3.9283 (4.7838)	-6.0280 (4.8409)
Public Deficit	-0.0390 (0.1100)	-0.0272 (0.1080)	-0.0539 (0.1102)	-0.0760 (0.1102)	-0.0606 (0.1101)
Constant	0.3198 (0.5453)	0.5969 (0.4829)	0.1918 (0.5552)	0.4888 (0.5232)	0.6000 (0.5088)
Wald (Prob > F)	0.2675	0.0160	0.4094	0.2979	0.3892
Portmanteau Test (Prob > Q)	0.7843	0.8487	0.7095	0.2917	0.5666
Observations	191	191	191	191	191
R-Squared	0.0274	0.0631	0.0210	0.0259	0.0218
Root MSE	6.032	5.922	6.051	6.0373	6.0476

STANDARD ERRORS IN PARENTHESES
*** P<0.01, ** P<0.05, * P<0.1
SOURCE: STATA 14 OUTPUT