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The Determinants of Value Added Tax Revenues in Portugal

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THE DETERMINANTS OF VALUE ADDED TAX REVENUES IN PORTUGAL

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Abstract

Since VAT was first introduced, several authors have studied the determinants of VAT revenues in several countries, or group of countries, however Portugal has received little attention. The literature on the determinants of VAT revenues in Portugal is merely conceptual, with little empirical evidence. We therefore intend to study the determinants of VAT revenues in Portugal. This study is innovative, in the sense that it is probably the first study of the determinants of VAT revenues in Portugal and it contributes with additional insights to the study of VAT. Moreover, the results obtained can be useful for Portuguese policy makers as they help to understand how VAT revenues in Portugal can be optimized.

To perform this study, we collected monthly data on specific economic and tax variables from January 1998 to May 2015, and performed a time-series analysis through the use of regression models to estimate the determinants of VAT revenues. We developed two sets of regression models - one using the OLS method, and the other using the Prais-Winsten and Cochrane-Orcutt method. The results reveal that economic growth, consumption, the public deficit, and the level of the reduced and intermediate VAT rates all have a positive impact on VAT revenues, while unemployment has negative impact on VAT revenues.

Resumo

Desde que o IVA foi introduzido, vários autores têm estudado as determinantes da receita de IVA para vários países ou grupos de países, contudo pouca atenção tem sido dada a Portugal. A literatura referente às determinantes da receita de IVA em Portugal é meramente conceptual com pouca evidência empírica. Assim, pretendemos estudar as determinantes da receita de IVA em Portugal. Este estudo é inovador na medida em que é provavelmente o primeiro estudo empírico sobre as determinantes da receita de IVA em Portugal e contribui com conhecimentos adicionais para o estudo do IVA. Adicionalmente, os resultados obtidos podem ser úteis para os decisores políticos Portugueses na medida em que ajudam a compreender como a receita do IVA em Portugal pode ser optimizada.

De forma a efectuar este estudo, recolhemos dados mensais de variáveis económicas e fiscais específicas desde Janeiro de 1998 até Maio de 2015 e efetuámos análise de séries temporais através do uso de modelos de regressão para estimar as determinantes da receita de IVA. Desenvolvemos dois conjuntos de modelos de regressão, um usando o método dos Mínimos Quadrados (OLS) e outro usando o método de Prais-Winsten e Cochrane-Orcutt. Os resultados revelam que o crescimento económico, o consumo, o défice público e o nível das taxas reduzida e intermédia de IVA têm um impacto positivo na receita de IVA, enquanto o desemprego tem um impacto negativo na receita de IVA.

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<p align="center">Obrigada!!!</p>

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List of Abbreviations

ADF - Augmented Dickey-Fuller

CPI – Consumer Price Index

DGO – Direção Geral do Orçamento

EEC – European Economic Community

EU – European Union

GDP – Gross Domestic Product

IMF – International Monetary Fund

INE – Instituto Nacional de Estatística

IVA – Imposto sobre o Valor Acrescentado

OECD – Organization for Economic Co-operation and Development

OLS – Ordinary Least Squares

PIT – Personal Income Tax

SAP – Structural Adjustment Program

UK – United Kingdom

USA – United States of America

VAT – Value Added Tax

1 Introduction

Over the years, the number of countries adopting VAT has risen substantially, especially during the 1980s and the 1990s, with a huge spike in the number of countries adopting VAT after the dissolution of the Soviet Union (Ufier, 2014). The rate of adoption then decreased in the middle of the 2000s (Keen & Lockwood, 2010; Ufier, 2014). The introduction of VAT is considered to be the main tax reform for developing countries, and also the main tool for progress in tax policy and administration (Keen & Lockwood, 2010). In 2012, more than 150 countries had already introduced VAT (OECD, 2012). Through its history, only five countries withdraw VAT after introducing it: Vietnam, Grenada, Ghana, Malta, and Belize and three of those (Ghana, Malta and Vietnam) have now re-introduced VAT (Ebrill et al, 2001).

VAT became the most important source of revenue for government budgets (Bikas & Rashkauskas, 2011). Keen & Lockwood (2006) and Keen (2007) find a positive relationship between VAT revenues and total tax revenues. Countries introducing VAT experience increases in their tax ratios, that is to say, tax revenues as a fraction of Gross Domestic Product (GDP) (Keen & Lockwood, 2006; Nellor, 1987). Furthermore, the tax ratio does not decrease later on, but instead, it persists at higher levels (Nellor, 1987). Azaria & Robinson (2005) and Keen & Lockwood (2010) found that the presence of VAT has a positive and significant impact on total tax revenues.

In recent years, the increase of the percentage of the elderly population has revealed the need for pension and healthcare plans and, as a result, many countries are creating, or increasing their social programs. Consequently, governments' need for revenues has increased (Bikas & Andruskaite, 2013; Bikas & Rashkauskas, 2011; Lindholm, 1970; Maček, 2011; Ufier, 2014). To face this higher revenue need, many countries adopted VAT to take advantage of its revenue-enhancing capabilities.

In the face of these needs, most countries have been shifting their reliance on direct taxes to indirect taxes, more precisely, from Corporate Income Tax to VAT (Lejeune, 2010; Lindholm, 1970; Matthews, 2003). This shift has resulted in an increase of VAT revenues as a share of total tax revenues (Keen, 2013; Lejeune, 2010). This increase was made mainly through the increase of VAT rates in combination with a reduction in Personal Income Tax (PIT), which makes it more acceptable, and through

the improvement of VAT collection by implementing measures to increase compliance, fighting fraud and evasion. Such measures include the increase of the quality of auditing and the increase of penalties due to noncompliance (Le, 2003; Lejeune, 2010; Lindholm, 1970). However, Jenkins & Kuo (2000) mention that in some countries, mainly due to tax evasion and ineffective tax administration in developing countries, the actual VAT revenues collected are far below the potential revenues that could be collected with an effective system.

VAT is also considered to be a revenue stabilizer (Ebeke & Ehrhart, 2011; Lindholm, 1970). Firstly, VAT is collected in all stages of the production chain and therefore a break or a failure to pay VAT in one of the stages of the chain will not affect the revenue collected, as that revenue will be secured by the other stages. Secondly, the increase in VAT revenues has been accompanied by the reduction in revenues from tariffs that result from trade liberalization. Because VAT is a consumption tax, and as consumption is assumed to be more stable than exports or imports, more stability is expected (Ebeke & Ehrhart, 2011). Ebeke & Ehrhart (2011) show that the presence of VAT leads to around 40% to 50% less instability in tax revenues.

Tax harmonization has for a long time been one of the major objectives of the European Union (EU) concerning Fiscal Policy. One of the requirements to be an EU Member State is to have a VAT system (Ufier, 2014). The first regulations on VAT appeared in 1970, with the First and Second Derivatives from the European Economic Community (EEC). Later, in 1977, the Sixth Derivative introduced the first steps towards the harmonization of VAT among State Members of the EU (Bikas & Andruskaite, 2013; Cnossen, 2003). Currently, most EU countries have standard VAT rates between 19% and 23%. On average, the 27 Member States of the EU have a VAT rate of 21.4%. The weight of VAT in the economy makes it one of the most relevant taxes. On average, VAT revenues account for 7.1% of GDP, and for 22% of total tax revenues for the 27 Member States (Sarmento & Alvarez, 2015).

In Portugal, VAT, which is known as "*IVA – Imposto sobre o Valor Acrescentado*", was introduced in 1986 and its importance as a source of revenues has been increasing over the years. Observing the evolution of VAT in Portugal, it is possible to note that the main changes happened in the standard VAT rate. From 1998 until 2014, Portugal increased its standard VAT rate by 6%, from being 17% in 1998, to

being 23% in 2014 (Sarmento & Alvarez, 2015). Currently, in 2016, the standard VAT rate remains at 23%. During its history, the Portuguese standard VAT rate has only decreased once from 21% to 20%, in July 2008. In 2010 the standard VAT rate went back up to 21%.

Portuguese VAT revenues as a fraction of GDP increased from 7.6% in 1998 to 8.4% in 2012. However, from 2007 to 2009, VAT revenues as a fraction of GDP experienced a sharp decrease of 1.3%, being 7.1% in 2009. This result can be explained by the decrease of 13% in the VAT revenues that resulted from an abrupt fall in consumption and in the reduction of the standard VAT rate by 1% (Sarmento & Alvarez, 2015).

There are several empirical studies regarding the determinants of VAT, but none of them focusses on Portuguese VAT revenues particularly. In this dissertation, we intend to empirically determine the main economic and tax factors that influence VAT revenues. More specifically, we will estimate the determinants of VAT revenues in Portugal. Knowing the main determinants of VAT revenues can be helpful to policy makers in the sense that they can optimize the collection of VAT revenues through adjustment of economic and fiscal policies that have a direct impact on the determinants of VAT revenues. This way, increased VAT revenues can be achieved, not only by adjusting directly the fiscal policy on VAT, but also through the adjustment of other variables that have a direct impact on VAT. Moreover, this study contributes to the scientific community by adding some more insights on this subject.

To perform our study, we collected monthly data on several specific economic and tax variables from January 1998 through to May 2015. Then we built several regression models to estimate the impact of our explanatory variables on the collection of VAT revenues. We performed two sets of regressions, one using a simple Ordinary Least Squares method, and the other using the Prais-Winsten and Cochrane-Orcutt method. The results show that economic growth, consumption, the public deficit, and the level of the reduced and intermediate VAT rates all have a positive impact on VAT revenues, while unemployment has a negative impact on VAT revenues. Exports, imports and the standard VAT rate do not influence VAT revenues.

These results can be both expected and surprising. In fact, the sign of the impact of our relevant explanatory variables was expected. However, we did not expect exports

and imports to have no significant impact on VAT revenues. Even more surprising was the fact that we found the standard VAT rate to be statistically insignificant in explaining VAT revenues. This has some major implications regarding the regulation of fiscal policy. These results imply that adjusting the fiscal policy on VAT may not be very effective for increasing VAT revenues. Our results demonstrate that modeling other economic variables such as GDP, inflation, consumption, and unemployment may be more effective.

2 Literature Review

2.1 Concepts

Maurice Lauré was the first to put VAT in practice, implementing it in France in 1954 (Lejeune, 2010; Maček, 2011; Ufier, 2014).

VAT is essentially a consumption tax (Agha & Haughton, 1996; Godin & Hindriks, 2015). According to Bikas & Andruskaite (2013), VAT is "an indirect tax levied on public and private consumption". VAT is taxed when the product is sold by applying a percentage to the price (Lindholm, 1970). At each intermediate stage of production or distribution, the tax burden is transferred from sellers to buyers of the product until it reaches the final stage where products are sold to the final consumer. The final consumer is unable to claim tax credits and thus it is they who bear the tax burden (Bikas & Andruskaite, 2013; Godin & Hindriks, 2015; Jenkins & Kuo, 2000; Matthews, 2003). Producers pay VAT on the inputs used, however they are able to deduct VAT from their tax liability later on (Bikas & Andruskaite, 2013; Ebrill et al, 2001; Godin & Hindriks, 2015; Jenkins & Kuo, 2000; Lindholm, 1970). In the end, producers only pay tax on the actual value added during production (Desai & Hines, 2005; Jenkins & Kuo, 2000; Nellor, 1987).

Most countries use VAT by applying the "credit-invoice" method (Agha & Haughton, 1996; Keen & Smith, 2006). This method allows registered traders to ask for a credit or a refund for the difference between VAT paid on inputs and VAT charged on outputs (Keen & Smith, 2006). Invoices play a major role, as they are needed as proof of the VAT paid on inputs in order that registered taxpayers can claim a refund (Agha & Haughton, 1996; Keen & Smith, 2006; Le, 2003). In this way, registered traders have the incentive to request an invoice when they purchase inputs, to ensure that they can

claim a VAT credit later on (Keen & Smith, 2006; Le, 2003). Invoices can be used by the tax administration to check for fraud, by comparing reported inputs with reported sales, facilitating the auditing process (Agha & Haughton, 1996; Aizenman & Jinjarak, 2008; Le, 2003). In this sense, some authors suggest that VAT is somewhat "self-enforcing" as it reduces the incentives for tax evasion (Agha & Haughton, 1996; Aizenman & Jinjarak, 2008; Keen & Smith, 2006; Matthews, 2003; Nellor, 1987). Nevertheless, this method still generates opportunities for fraud and evasion (Agha & Haughton, 1996; Keen & Smith, 2006; Le, 2003). Even so, VAT compliance is still higher when compared to the alternatives, allowing for higher revenues (Le, 2003).

VAT can be classified into three types: consumption VAT; income VAT, and; gross product VAT. For the consumption type, only goods and services incorporate the base, and investment and intermediate goods are excluded. The consumption type is typically preferred by most countries, as it can boost investment, generate economic growth and it simplifies the tax system. For the income type, intermediate goods and depreciation are excluded from the tax base and for the gross product type, all goods and services, including investment, are included in the tax base, with the exception of intermediate goods (Le, 2003; Lindholm, 1970).

Another important concept is the one of "exemption". "Exemption" means that the seller does not charge VAT on the goods and services sold, and is not eligible to claim for a VAT refund for the inputs bought (Jenkins & Kuo, 2000; Keen & Lockwood, 2006; Le, 2003; Maček, 2011; Nishiyama, 2012). Exemptions are much used in services such as education, healthcare, and financial services, as they are considered to be originators of positive externalities, and are services that are mainly consumed by people with lower levels of income (Le, 2003). Additionally, exemptions are seen as being a way to reduce the regressive character of VAT (Le, 2003; Lejeune, 2010).

Exempt goods and services create an extra cost for businesses, as the cost of VAT paid on inputs cannot be imposed on customers but producers are also unable to claim its refund. VAT paid on inputs becomes a cost, which creates distortions in production by affecting producers' choices regarding inputs (Jenkins & Kuo, 2000; Nishiyama, 2012). Exemptions increase administration and compliance costs, and can harm tax collection efficiency, as they reduce the tax base (Cnossen, 2003; Lejeune,

2010). Thus, exemptions are considered by many authors to be a large problem, as they break the VAT chain and create distortions (Bikas & Rashkauskas, 2011; Cnossen, 2003; Crossley et al, 2009; Le, 2003; Nishiyama, 2012).

Exports are usually subject to a zero rate of VAT, meaning that the seller does not charge VAT on sales, but is able to deduct the VAT paid on inputs (Jenkins & Kuo, 2000; Keen & Lockwood, 2006; Le, 2003; Maček, 2011). Many countries use the "destination principle", under which goods and services are taxed at the place they are consumed, and not where they are produced or shipped. Translating into international trade, this means that exports are taxed at a zero rate VAT, and imports are taxed the same way as domestic goods (Agha & Haughton, 1996; Desai & Hines, 2005). Exporters are freed from the obligation of charging VAT, but are still eligible to claim for a refund regarding VAT paid on inputs (Le, 2003). If the zero-rate were to be applied at the final stage, then the final consumer would not pay VAT, and the tax revenues regarding the transaction would be lost (Jenkins & Kuo, 2000; Le, 2003).

Rate differentiation is very common among EU Member States. Some goods are taxed at higher or lower rates than others, given their characteristics. The common argument is that goods such as alcohol, petrol and foods with high levels of fat are considered to raise costs to society, namely through higher pollution and healthcare requirements, and therefore they should be taxed at higher rates (Crossley et al, 2009; Nishiyama, 2012). On the other hand, goods such as healthy foods and books may have positive effects on society and, therefore, should be taxed at lower rates, in order to stimulate their consumption (Bikas & Andruskaite, 2013; Crossley et al, 2009; Nishiyama, 2012). Additionally, lower rates also apply to some goods and services that are considered to be a necessity (Lejeune, 2010).

Redistribution is also a common argument for the use of differentiated rates (Crossley et al, 2009; Nishiyama, 2012). In fact, many countries apply multiple-rate structures, exemptions, and zero rates as a way of reducing the regressive character of VAT (Cnossen, 2003; Crossley et al, 2009; Le, 2003; Lejeune, 2010). VAT is a regressive tax, as low-income families spend a larger share of their income in VAT expenses, compared to high-income families (Bikas & Andruskaite, 2013; Bikas & Rashkauskas, 2011; Crossley et al, 2009). However, multiple rate structures add more complexity to the tax system, which then increases administration and compliance costs

(Agha & Haughton, 1996; Cnossen, 2003; Lejeune, 2010). Le (2003) questions the main purpose of VAT, arguing that its implementation and design has the objective of raising revenues, and does not have equity issues as a primary concern. Keen (2007) notes that the regressive effect of VAT would be maintained under any other type of consumption tax. Progressivity is better achieved through a well design and effective income tax, or through social benefits (Ballard et al, 1987; Crossley et al, 2009; Le, 2003; Nishiyama, 2012).

The use of reduced rates, zero-rates, and exemptions is thus unadvised. Reducing the range of goods and services exempted or taxed with reduced or zero rates and broadening the VAT base is usually recommended (Agha & Haughton, 1996; Bogetić & Hassan, 1993; Cnossen, 2003; Crossley et al, 2009; Jenkins & Kuo, 2000; Lejeune, 2010; Nishiyama, 2012). Legeida & Sologoub (2003) show that increasing the VAT base by 1%, leads to an increase of 0.64% in VAT revenues in Ukraine. Additionally, reducing zero and reduced rates would eliminate some of the distortions created, including those affecting consumption and production choices (Crossley et al, 2009). The use of a single VAT rate is frequently recommended (Agha & Haughton, 1996; Bogetić & Hassan, 1993; Jenkins & Kuo, 2000; Lejeune, 2010; Nishiyama, 2012). Ballard et al (1987) find that the welfare gains from introducing a differentiated rate structure would be 25% to 40% smaller when compared to a single-rate VAT. Additionally, this should be followed by the modernization of the mechanisms to improve enforcement and compliance (Bogetić & Hassan, 1993; Jenkins & Kuo, 2000; Nishiyama, 2012).

In the EU, the VAT Directive 2006/112/EC establishes a minimum standard VAT rate of 15%, and allows no more than two reduced rates of at least 5%. A list of goods and services that can be exempt is also provided in this Directive (Bikas & Andruskaite, 2013; Maček, 2011; Mathis, 2004). However, many exceptions are allowed for some Member States, which results in highly differentiated rate structures across Member States (Maček, 2011; Mathis, 2004). Some countries have an excessive number of reduced rates, and some are even allowed to have rates below the maximum permitted of 5%, known as super reduced rates (Mathis, 2004).

Mathis (2004) studied the share of the base that is being taxed using the standard and reduced rates for the 15 EU countries in 2000. He finds that, on average, the

standard VAT rate was only being applied to about 69% of the total taxable base, and that reduced rates were covering, on average, 23% of the taxable base, which is a large number. In Portugal, the percentage of the taxable base subject to the standard VAT rate was below the European average, being 63%, and 37% of the taxable base was being taxed with reduced rates. These results demonstrate that the application of reduced rates is not an exception, as it should be under the principles of the Sixth Directive, and that there is an excessive share of the taxable base subject to non-standard rates.

Another important issue is the level of revenues at which an individual or company is required to register as VAT payers - the threshold (Bikas & Rashkauskas, 2011; Le, 2003). In the EU, different Member States set different levels of thresholds (Bikas & Rashkauskas, 2011; Lejeune, 2010). In Portugal, *Decreto-Lei nº 71/ 2013, de 30 de Maio* establishes the *Regime de Contabilidade de Caix*a, under which VAT is only demanded for companies with a turnover of less than € 500,000, that have their tax affairs in order, and which have been in operation for over a year (Marques & Sarmento, 2015).

Thresholds are intended to remove the tax burden from small business. Furthermore, tax administrations would need to have the capacity to be able to collect VAT from all these small businesses, and even if this was possible, the revenues collected would be only a small share of the total VAT revenues, with the costs of collection being probably higher than the actual collection itself (Bikas & Rashkauskas, 2011; Le, 2003). However, most countries allow voluntary registration of small businesses with a turnover that is below the threshold level (Lejeune, 2010; Le, 2003). By allowing voluntary registration, there is the risk of a large number of small businesses to registering voluntarily, and this annuls the effect for which the threshold was designed, thus annulling its purpose (Le, 2003). Lejeune (2010) argues a common threshold for all Member States would be more efficient. Nishiyama (2012) argues against the use of thresholds, claiming that the different threshold levels applied in each country generate distortions in competition between countries.

Fraud and evasion are some of the major concerns regarding VAT. The most common forms of fraud involving VAT are: 1) under-reporting sales; 2) not registering as a taxpayer when reaching the threshold level; 3) misclassification of commodities, that is to say, applying reduced rates to those goods that do not fall into the category, in

order to reduce VAT liability, which is common when several VAT rates exist; 4) not declaring VAT on goods consumed by the owner or their employees; 5) collection of VAT, but this is not remitted to the tax authorities; 6) false claims for a credit or refund; and, 7) claiming VAT on non-creditable purchases, which usually happens when traders buy goods or services for their own personal use and then claim VAT credit on those goods or services as if they were inputs (Agha & Haughton, 1996; Keen & Smith, 2006; Nishiyama, 2012).

It happens very frequently that traders do not deliver the VAT to the tax authorities. In Portugal, the 2nd Article, No.1 of the *Regime Geral das Infracções Tributárias* states that the failure to deliver a tax that was not previously received cannot be considered a culpable fact ("facto culposo"). Thus, such traders are not considered responsible for not delivering what was not paid, but they are only accountable when there is proof that the failure to deliver the tax to the State was fraudulent and wrongful, that is to say, if the individual that received the tax does not deliver it to the State. Otherwise, retailers cannot be accused of the crime of fiscal abuse provided for in the 205th Article of the *Código Penal* (Marques & Sarmento, 2015).

In 1993, the EU abolished the commercial barriers between Member States (Godin & Hindriks, 2015; Keen & Smith, 2006; Sarmento & Santos, 2013) and, in the face of that decision, the EEC imposed a VAT regime in 1991, known as the *Regime do IVA nas Transações Intracomunitárias (RITI)* (so named in Portugal), which establishes the rules for taxing VAT on transactions between Member States (Sarmento & Santos, 2013).

The abolishment of controls on these transactions led to the appearance of a specific type of fraud - the carousel fraud (Keen & Smith, 2006; Sarmento & Santos, 2013). In Portugal, the *Tribunal Central Administrativo Sul* defined in the *Acordão de 22 de Abril de 2012 (proc. nº 05523/12)* a situation of "carousel fraud", as being one where several companies perform intracommunity transactions between themselves, and one of them deducts VAT but does not deliver the liquidated VAT to the tax authorities, thus generating a tax credit to the State. That company then disappears, leaving an unpaid credit, whereas the company that bought the goods from the one that disappeared still has the right to deduct the VAT paid on the transaction (Sarmento & Santos, 2013).

Basically, in this type of fraud, a company A, located in country A, exports goods to a company B (missing trader) in country B. As exports are zero-rated, no VAT is paid by the exporting company, A. The importing company, B, then sells the goods to company C, which is also located in country B, charging VAT on the operation, but the fails to deliver the charged VAT to the tax authorities, disappearing in the meantime. Company C then re-sells the goods back to company A, or to other companies that serve as buffers to cover the scheme, with the objective of reaching company A, and then asks for the refund of the VAT paid to the tax authorities when buying the goods. The goods reach company A, and the cycle is then repeated, creating a "carousel" (Keen & Smith, 2006; Sarmento & Santos, 2013).

Missing traders (in this example, company B) usually sell their products at prices below market price, in order to make sure that they sell the products and take benefit from their fraudulent activity (Keen & Smith, 2006; Sarmento & Santos, 2013).

Sarmento & Santos (2013) argue that carousel fraud has three main impacts: 1) the reduction of VAT revenues; 2) the legitimacy of those commercial sectors where carousel fraud is more common, and; 3) the distortion caused in market competition by fraudulent companies selling their products at lower prices, with the intention of practicing fraud.

Proposals to reduce the tax evasion problem pass through simple administrative actions, such as strengthening supervision on registration, making sure that companies register when reaching the threshold level, and also by creating rules under which traders are liable and responsible for the fraud that happens elsewhere along the production and distribution chain until the final consumer (Keen & Smith, 2006; Sarmento & Santos, 2013). Sarmento & Santos (2013) suggest that, given the weight VAT has in most countries as a major source of revenues, the harmonization of VAT procedures between Member States is essential to fight fraud. Member States should cooperate with each other, improving the capacity of their tax administrations.

Other proposals go deeper and require a redesign of the VAT system. These include: "reverse charging", where the buyer bears the VAT liability, instead of the seller; "reverse withholding", where the seller is liable for the VAT charged on the output, but it is the buyer that remits the VAT to the tax authorities, and; "VAT accounts", requiring taxpayers to open a bank account where the VAT charged is

deposited, and; a "third party guarantee" where the VAT payment would be guaranteed by a third party (Keen, 2007; Keen & Smith, 2006; Nishiyama, 2012; Sarmento & Santos, 2013).

To attenuate fraud and evasion resulting from international trade, Poddar & Hutton (2001) propose the "P-VAT", Versano (2000) proposes the "CVAT", and Keen & Smith (1996, 2000) propose the "VIVAT". Under the "P-VAT", goods would only leave customs after the tax authorities have confirmed that the VAT on the import has been paid. Under the "CVAT" proposal, exports would be zero-rated, but the importing country would have the right to a totally creditable VAT compensation. Under the "VIVAT" proposal, all business-to-business transactions (domestic and cross-country) of participating countries would be subject to a common single VAT rate, and the rate to be applied to the sales to the final consumer would be selected by each country (Keen, 2007; Keen & Smith, 2006; Nishiyama, 2012).

Currently, one of the tools used by the EU to increase enforcement and compliance is the attribution of an identification number for each taxable person. This control system, named the VAT Information Exchange Service (VIES), allows for a better control of intra-community trade and a better monitoring by tax administrations. Additionally, this system allows taxpayers to gather information about their business partners (Nishiyama, 2012).

Considering the wide list of arguments against VAT, one would question why countries still choose VAT over other options for consumption taxation. The choice of VAT as the main indirect tax is based on the argument that VAT is the type of tax that creates fewer distortions when compared to others (Matthews, 2003). In many countries, the main purpose of VAT was to replace other types of consumption tax that have some unpleasant characteristics, such as turnover tax, which created a "cascading effect" through its mechanism of applying tax to all stages of production, without allowing the deduction of the tax paid in previous stages, and a single-stage sales tax, which although it has low administrative costs, imples the need to apply high rates, in order to obtain sufficient revenues, as its base is usually narrow, which in turn creates incentives for tax evasion (Le, 2003).

2.2 Determinants of VAT Revenues

Bogetić & Hassan (1993) argue that although many countries have similar VAT rates, their revenue performance is different. This difference is explained by the rate structure adopted by each country, by the extension of the tax base, and by the capacity of the tax administration. Keen & Lockwood (2010) also note that the VAT design differs from country to country, not only regarding their rates, but also their base type, level of zero-rates and exemptions, and in the timing of refunds.

According to Keen (2013) VAT revenues as a percentage of GDP can be decomposed into three drivers: standard VAT rate; C-efficiency ratio, and; consumption as a percentage of GDP. For high-income countries over the 1996 to 2000 period, Keen (2013) estimated that when the standard VAT rate increased on average by 1%, then the C-efficiency ratio increased, on average, by 2.6% and consumption as a fraction of GDP decreased, on average, by about 0.6%, which results in a VAT revenue increase of 3%. These results show that the major driver of VAT revenues was the changes in the C-efficiency ratio.

Among the most studied determinants are those concerning the design of the VAT system, namely, the standard VAT rate and reduced rates. A positive relationship between the VAT rate and VAT revenues is usually found (Bikas & Rashkauskas, 2011; Bogetić & Hassan, 1993; Engel et al, 2001; Matthews & Lloyd-Williams, 2000; Pagán et al, 2001). Ebrill et al (2001) find the same positive relationship between the VAT rate and VAT revenues as a fraction of private consumption. Pagán et al (2001) found the opposite relationship to also be true, whereby increases in VAT revenues lead to increases in the standard VAT rate, which, according to Pagán et al (2001), means that governments might adjust VAT rates when expected revenues are not sufficient to cover the expected fiscal needs.

Sarmento & Alvarez (2015) find that the variation of the standard VAT rate and the variation of the effective VAT rate are positively related with the variation of VAT revenues as a fraction of GDP. Together, changes in the standard VAT rate and in the effective rate explain 56% of the variation in VAT revenues as a fraction of GDP. On the contrary, Matthews (2003) found that changes in the standard VAT rate, where most of the changes were increases, have a negative impact on VAT revenues. Matthews & Lloyd-Williams (2000) suggest there is a point - the revenue-maximizing VAT rate,

where further increases to the VAT rate will increase non-compliance, leading to lower levels of VAT revenues. They estimated this rate to be 20%. Matthews (2003) estimates the revenue-maximizing VAT rate to be between 18% and 19.3%.

Kaczyńska (2015) notes that, although the standard VAT rate in Poland was increased from 22% to 23% in 2011 in the face of the financial crisis, VAT revenues actually decreased. The efficiency rate also decreased from 2010 to 2013, reflecting a decrease in the effectiveness of the tax administration in collecting VAT revenues. Tagkalakis (2014) also notes that since measures of the the Economic Adjustment Programme were implemented in Greece, VAT revenues have decreased, even after the increase in the standard VAT rate. He advances the idea that such decreases in VAT revenues can be due to shifts in consumption towards necessity goods (those with lower VAT rate) and due to worse tax compliance, which is a common occurrence during recessions. Sarmento & Alvarez (2015) note that countries that received an intervention from the "Troika", such as Portugal, are those with the highest increases in the standard VAT rate, which reveals that countries increase their VAT rates in an attempt to reduce their deficits. In fact, the International Monetary Fund (IMF) (2014) reveals that most of those EU countries that increased their VAT rates in the face of the subprime financial crisis did not experience higher VAT revenues, but instead a decrease in VAT revenues that resulted from a reduction in collection effectiveness.

Artavanis (2015) demonstrates that a decrease in the Greek VAT rate during an economic crisis can generate benefits that largely compensate the fiscal costs. Firstly, retailers increase compliance and reduce under-reporting and the decrease in VAT revenues is compensated by an increase in sales revenues. Secondly, this can have a positive effect in the industry through an increase in competitiveness.

Bogetić & Hassan's (1993) results show that VAT revenues appear to be higher for countries with a single VAT rate than for countries with multiple VAT rates. With regards to rate dispersion, that is to say, the difference between the highest and the lowest VAT rates, contradictory results were found by different authors. Bogetić & Hassan (1993) found that rate dispersion has a negative impact on VAT revenues, while Bikas & Rashkauskas (2011) found that it has a positive impact on VAT revenues, and Ebrill et al (2001) found that it has a positive impact on VAT revenues as a fraction of private consumption.

The number of years since VAT introduction also has a positive impact on the ratio of VAT revenues to private consumption, demonstrating that as the years since the introduction of VAT pass, the higher experience and knowledge of the tax administration contributes to an increase in compliance, which translates into higher efficiency and a better administration of the tax. Furthermore, as time passes, it is expected that people become more comprehensive and understand and accept VAT more easily (Ebrill et al, 2001; Bikas & Andruskaite, 2013).

Economic variables were also tested as main determinants of VAT revenues. Bikas & Andruskaite (2013), Kaczyńska (2015) and Wawire (2011) find a positive relationship between GDP and VAT revenues. Bikas & Andruskaite (2013) also find that GDP per capita is also positively associated with VAT revenues. On the other hand, Azaria & Robinson's (2005) results show that as GDP per capita increases, tax revenues tend to decrease.

Regarding efficiency, a positive relationship between GDP growth rate and VAT revenue efficiency was found. However, when an economy is in recession, efficiency tends to be lower (Tagkalakis, 2014). GDP per capita has a positive impact on the C-efficiency ratio, which is a measure of VAT revenue efficiency, defined as being the ratio between VAT revenues to consumption and the standard VAT rate (Aizenman & Jinjarak, 2008). A contrary relationship is given by the share of agriculture of the economy that is negatively related with the C-efficiency ratio (Aizenman & Jinjarak, 2008). These results together imply a strong dependence of VAT revenues on the economic cycle, that is to say, on economic circumstances (Kaczyńska, 2015).

Godin & Hindriks (2015) note that international trade (or trade openness, measured as the sum of exports and imports divided by GDP) has a positive impact on the collection of goods and services taxes, which they argue to be expected, as it is easier to tax items when they arrive at the border. International trade is positively related to VAT revenues (Wawire, 2011) and with VAT revenues as a fraction of private consumption (Ebrill et al, 2001), which, according to Ebrill et al (2001), reflects a higher facility in collecting tax on imports. Ebrill et al (2001) find that, on average, 55% of VAT revenues are collected on imports. Azaria & Robinson (2005) find that trade openness has a positive impact on total tax revenues.

Bikas & Andruskaite (2013) found a positive relationship between imports and VAT revenues, but on the other hand, they found a negative relationship between exports and VAT revenues. Aizenman & Jinjarak's (2008) results reveal the existence of a positive relationship between trade openness and the C-efficiency ratio. Wawire (2011) claims that the positive relationship between international trade and VAT revenues implies that VAT revenues can be increased through the expansion of international trade.

Bikas & Rashkauskas (2011) find that as unemployment increases, VAT revenues decrease substantially. As individuals purchase goods and services with their salary, unemployment decreases the purchasing power of individuals, leading to a reduction of consumption, and, ultimately, to a reduction in VAT revenues. A different perspective is given by Bikas & Andruskaite (2013), who suggest that unemployment has no direct effect on VAT revenues, but that it indirectly negatively affects VAT revenues through its direct negative effect on the available income of families and, consequently, on their consumption. Their results show a positive relationship between households' consumption and VAT revenues.

Inflation is positively related with VAT revenues and with the VAT rate, that is to say, higher inflation leads to higher VAT revenues and a higher VAT rate, meaning that VAT rates are adjusted in the face of inflation, in order that the government can achieve the necessary revenues to meet their projected expenditures (Pagán et al, 2001).

The increase in the share of VAT revenues as a fraction of GDP is accompanied by an increase in the complexity of the administration of VAT. Moreover, as complexity increases, corruption and the share of black economy also increases. In fact, both the share of the black economy and the level of corruption (measured by the Corruption Perception Index) are negatively related to VAT efficiency ratio (Sokolovska & Sokolovskyi, 2015).

The size of the black economy is usually associated with non-compliance. VAT may not be very effective in collecting revenues in countries with a large informal sector (Keen, 2007). Matthews & Lloyd-Williams (2000) and Matthews (2003) used the currency to GDP ratio as a proxy for the size of the black economy, and found that as the size of the black economy increases, VAT revenues tend to decrease. Emran & Stiglitz (2005) prove that reforming the tax system by replacing trade taxes such as

import and export tariffs with VAT can cause substantial reductions in welfare for countries with a large informal sector, which is very concerning, and jeopardizes the validity of VAT as being the best option for a consumption tax in those countries. Keen (2007) argues that developing countries, which are usually the ones with larger informal sectors, might be better off by using tariffs, rather than VAT.

Zídková (2014) suggests that the VAT gap, which is the difference between potential VAT revenues and the VAT revenues actually collected, is a good proxy for tax evasion, and he finds that final consumption as a fraction of GDP, the standard VAT rate, and the percentage of the black economy all contribute to the increase of the VAT gap. On the other hand, VAT revenues as a percentage of GDP, GDP per capita, intra-community trade, the number of VAT rates, and the share of consumption of households regarding restaurant and hotel services all contribute to the decrease of the VAT gap.

Tagkalakis (2014) shows that improving the tax administration's ability to fight tax evasion would increase efficiency. Engel et al (2001) find that an increase of 1 dollar with Internal Revenue Service expenditures would lead to an increase in VAT revenues of 31.2 dollars in Chile, and Agha & Haughton (1996) find that an increase of 1 dollar with administrative expenditures is expected to raise VAT revenues by 12% for a set of 17 OECD countries. It is thus possible to conclude that an increase in expenditures on enforcement would reduce tax evasion, and thus increase VAT revenues.

Political factors also affect VAT revenues. Aizenman & Jinjarak (2008) argue that current governments, as policy makers, can select a tax system design that might jeopardize efficiency during future governments' appointments. Their results reveal that political stability has a positive effect on the C-efficiency ratio. A higher probability for the current government to be reappointed will generate a more efficient tax system, as policy makers will maintain the investment aimed to increase tax capacity and to reduce tax evasion.

Although it is usually argued that VAT revenues lead to an increase in government spending, Pagán et al (2001) find that this is not true. In fact, their results demonstrate the opposite relationship, that is to say, increases in government spending lead to higher VAT revenues, which happens due to the economic stimulus caused by

government spending. Keen & Lockwood (2006) found no evidence that the adoption of VAT leads to increases in government size. Ufier (2014) finds that those countries adopting VAT experience lower levels of government spending.

Some demographic elements were also found to be important determinants of VAT revenues. Wawire (2011) finds that the size of the population has a positive impact on VAT revenues, and Aizenman & Jinjarak (2008) show that the percentage of urban population is associated with a higher C-efficiency ratio, which is expected, as it is more difficult to collect taxes in rural areas. A control of population is suggested, as this would have an impact on VAT revenues (Wawire, 2011).

Illiteracy also plays a role in determining tax revenues, but its sign is negative, meaning that countries with higher levels of illiteracy tend to collect less VAT revenues as a fraction of private consumption (Ebrill et al, 2001).

Some asymmetric shocks, such as the 1973 oil crisis, and participation in a war also have a considerable negative impact on VAT revenues and on the adoption of VAT (Čížek et al, 2012; Wawire, 2011).

One would question why different authors achieve different results when studying the relationship between the same variables. It is important to note that these results were achieved through studies for different countries, or groups of countries, developed for different time periods, and use different methodologies. Table I, Table II and Table III in the Appendixes present full details regarding the region, period and methodology used in each study as well as the main results obtained. Table I presents the results of empirical studies, Table II presents conceptual studies, and Table III presents the conclusions achieved for each independent variable allowing for a better comparison between similar and opposite conclusions regarding the same variable. Theoretical studies were excluded from the tables as their main ideas are presented in the Literature Review.

2.3 Studies

One of the arguments in favour of VAT is that countries with VAT are able to generate more revenues than those without VAT. However, the same argument has been used against VAT, as higher levels of revenue may not be necessarily desirable, as these can lead to inappropriate spending and "unwelcome" growth. In fact, from all the

OECD countries, the United States of America (USA) is the only one that did not adopt VAT, claiming that it does "too good of a job" in raising revenues (Ebrill et al, 2001; Keen, 2007; Keen & Lockwood, 2006).

Keen & Lockwood (2006) show the VAT is a "money machine", as countries with VAT are able to generate more revenues than those without VAT. However, not all studies are in accordance with this conclusion. Ebrill et al (2001) find no evidence that the presence of VAT leads to higher tax revenues.

Regarding the determinants of VAT adoption, Čížek et al (2012) find a negative relationship between GDP per capita and VAT introduction, which means that poor countries are more likely to adopt VAT than rich countries. He suggests this result is a consequence of the recent VAT spread pattern, as more recent adopters are located mainly in Africa. Agriculture share and rents from natural resources both have a significant negative impact on the probability of the adoption of VAT (Čížek et al, 2012; Keen & Lockwood, 2010; Ufier, 2014). Countries governed as federations tend to have a reduced probability of adopting VAT (Čížek et al, 2012; Ufier, 2014), which, according to Ufier (2014), is due to the fact that they have decentralized tax collection systems. Trade openness also has a negative impact on VAT adoption probability (Čížek et al, 2012; Keen & Lockwood, 2010). Čížek et al (2012) find that countries with low tax revenues have a higher probability of adopting VAT, which reflects their beliefs in VAT being a powerful revenue generator.

On the other hand, participating in an IMF programme designed for recovery from a financial crisis is positively associated with VAT adoption, which means that those countries that participated in the IMF programme for crisis resolution appear to be more willing to adopt VAT, which reflects the importance of the IMF in the spread of VAT (Čížek et al, 2012; Keen & Lockwood, 2010; Ufier, 2014). Furthermore, if a country in a region adopts VAT, then the probability of countries in the same region adopting VAT increases as well (Čížek et al, 2012; Keen & Lockwood, 2010).

Countries with a large population, as well as countries with a large share of elder population, are more likely to adopt VAT. This comes from the need for higher revenues which are required to finance social programmes (Čížek et al, 2012; Ufier, 2014). Countries larger in size are also more likely to adopt VAT. For large sized

countries, it is harder to collect tax from imports, given the higher number of possible entry locations, and VAT can help increase efficiency in doing so (Ufier, 2014).

Finally, Francophone countries adopted VAT earlier, when compared to other countries. On the contrary, small islands and former members of the Warsaw Pact are less likely to adopt VAT (Ufier, 2014).

Interesting results are also obtained by studies that look at the consequences of VAT adoption. Desai & Hines (2005) show that the presence of VAT has a negative impact on openness and on exports. Furthermore, higher reliance on VAT (higher ratio of VAT revenues to total tax revenues), leads to smaller levels of trade openness and smaller levels of exports. All these relationships become stronger for low-income countries. Desai & Hines (2005) suggest some possible factors to justify these results. Firstly, VAT falls more heavily on traded sectors of the economy, and in this way it is natural that VAT affects international trade. Furthermore, the use of VAT to replace other types of tax that can impact on trade can be a cause. Additionally, governments are not always efficient in providing exports deductions.

The reaction of inflation to the presence of VAT was also tested. According to Le (2003), countries that adopted VAT did not experience higher inflation. He believes that by generating more revenues, VAT may help governments to adjust monetary policy in such a way that prices decrease, instead of increasing. In this sense, VAT may actually be deflationary, instead of inflationary. However, the timing of the introduction of VAT has to be right. Introducing VAT during a time when inflation is increasing may lead to the perception that VAT is inflationary, which makes VAT harder to accept by people. Ufier (2014) shows that those countries adopting VAT experience lower inflation. On the other hand, investment tends to be higher for countries that adopt VAT, when compared to those that did not (Ufier, 2014).

Attention has also been given to the impact of VAT on consumption. VAT being an indirect tax, it is a useful tool to control the demand for private goods and services and, in this way, control resources. An increase in the VAT rate will also lead to an increase in prices, thus reducing demand. By increasing prices, VAT also helps stimulate savings (Alm & El-Ganainy, 2013; Lindholm, 1970).

Alm & El-Ganainy (2013) find a negative relationship between the effective VAT rate and private consumption. Gábriel & Reiff (2006) study the impact of the increase in the middle VAT rate from 12% to 15% in January 2004 in Hungary, and the decrease in the upper VAT rate from 25% to 20% in January 2006. The results show that prices increased more than what they should have done with the VAT increase. These results show that not only did retailers pass the full VAT increase to final consumers, but that they also seized the opportunity to raise prices and increase their profit margin. Additionally, the price of products for which the VAT remained at the same level also increased, especially products considered to be close substitutes of those where the VAT rate increase was applied, and products that incorporate both VAT subject and non-VAT subject products. On the other hand, the decrease of the upper VAT rate led to a decrease in prices, but the VAT relief was not fully transferred to final consumers, that is to say, the decrease in prices was smaller than that which it should have been if prices had incorporated the VAT decrease to its full extent. Once again, retailers took advantage of a VAT change to increase their profit margins.

Blundell (2009) and Crossley et al (2009) study how the 2008 temporary VAT cut in the United Kingdom (UK) from 17.5% to 15% during 13 months affected consumer demand, and how much of the VAT reduction would be passed on to final consumers. Blundell (2009) estimates that around 75% of the VAT cut would be transferred to final consumers in the form of lower prices. As prices are reduced in the face of a VAT cut, consumers are expected to maintain their level of expenditures, thus increasing demand in quantity. To maintain the expenditure level, the increase in demand will be proportional to the decrease in prices. On the other hand, Crossley et al (2009) estimate that a 2.5% decrease in the VAT rate would lead to a 1.2% decrease in prices, which would result in an increase in purchases of the same magnitude. Consumers who are not financially constrained would take advantage of the lower prices to buy goods and services that are not considered to be necessity goods, more specifically, durable goods. For financially-constrained consumers, lower prices would encourage them to buy a greater quantity of goods and services in proportion to the decrease in prices.

Tax evasion has also received a lot of attention. Several studies regarding VAT tax evasion have been conducted, namely, about how some elements of VAT design

affect compliance and evasion. As the average VAT rate increases, compliance becomes lower. The introduction of an additional VAT rate is expected to decrease compliance. On the other hand, as the number of years since VAT introduction increases, compliance also increases. Each additional year of experience is estimated to increase compliance by 1% (Agha & Haughton, 1996).

3 Methodology and data

In this dissertation, the objective is to answer the question "What are the main determinants of VAT revenues in Portugal?" We intend to estimate the variables that have a potential impact on the collection of VAT revenues. We have collected data on economic and tax variables from several sources ("Banco de Portugal", "Direção-Geral do Orçamento", "Instituto Nacional de Estatística", and the European Commission (2015)). Monthly data was collected for the period starting in January 1998, up until May 2015, with a total of 209 months.

3.1 Some Econometric Considerations

Econometrically speaking, we collected data on several time series. As we are working with time series, it is important to have some notes in mind before we introduce our variables. When carrying out an econometric analysis using time series, one needs to be careful about any trend, cycle, or seasonal component present in the time series that prevents the time series from being stationary. This subsection only addresses the theoretical background of our econometric model. Subsection 3.2 will detail how we have dealt with these issues practically, with regards to our study and sample.

As we are working with monthly data, we expect to find a strong seasonal component in our time series. Seasonality exists when there is the presence of regular and predictable movements in the time series during the time period. More specifically, there is seasonality when it is possible to predict when the series will increase or decrease based on its passed behaviour, as it always has that same behaviour at that time of the year. Seasonality "hides" any trends that may be present in a time series, thus making it impossible to visualize whether there are upward or downturn movements in data over time. In other words, as we are working with economic data, seasonality hides the real pattern of economic activity. Performing regressions where one or more time

series have a strong seasonal component will not allow us to understand the real relationship between variables, as seasonality interferes by hiding the time series' long term behavior. Thus, the first step is to seasonally adjust all the time series to ensure that seasonality will not interfere with the econometric analysis. In our case, we adjusted seasonality by applying a moving average filter. Later, in Subsection 3.2, we present further details on how seasonality was adjusted.

After adjusting for seasonality, we are left with the real pattern of the time series during time, without the fluctuations that repeat every year. When working with economic data, it is common that after removing seasonality we are left with a trend. However, when performing regression analysis between two or more time series with a trend, it is expected that they would show a positive or a negative relationship, even if they are independent from each other. This is known as a spurious regression problem, that is to say, two uncorrelated variables may be given as positively or negatively correlated by a regression model. In order to avoid spurious regressions, it is necessary to ensure that all the time series in the model are stationary.

A stationary time series is one where the mean, the variance, and the autocorrelation of the variable time series are constant over time, that is to say, a process $X_1, X_2, \dots, X_T$ is stationary if:

$$E(X_t) = \mu < \infty, \qquad \forall t \tag{1}$$

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

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

Applying the Ordinary Least Squares method when using non-stationary time series will lead to regression outputs with high R-squares and highly statistically significant variables, however the estimators will be inconsistent, and the standard values of any statistical test such as a *t*-test or an *F*-test will not be correct.

One can analyze the stationarity of a time series by the visual inspection of the time series plot, and by checking the autocorrelation function given by the correlogram of the time series, or by running a unit root test. The presence of a unit root in a time series means that the autoregressive polynomial has a root that is equal to the unit, meaning that the time series is non-stationary. More specifically, considering a time series X_t that follows a generic autoregressive process of order p:

$$X_t = \emptyset_0 + \emptyset_1 X_{t-1} + \cdots + \emptyset_p X_{t-p} + \varepsilon_t \tag{4}$$

where p is the number of lags of X_t. Then X_t has a unit root if x = 1 is a solution to the equation of the autoregressive polynomial:

$$\emptyset(X) = 1 - \emptyset_1 X - \cdots - \emptyset_p X^p = 0 \tag{5}$$

The Augmented Dickey-Fuller (ADF) test can be used to test for the presence of a unit root and to verify if a time series is stationary, or non-stationary. Furthermore, the ADF test allows us to understand how to transform the time series in order to make it stationary. In the test, we can include only an intercept, or an intercept and a trend. The decision on what to include in the test is based on the economic reasoning behind the time series. As most economic indicators tend to continually grow over time, an upward trend is expected. Visual inspection of the time series plot can confirm the existence of a trend. The presence of an upward or downward trend implies the inclusion of a trend in the test. If there is no trend, then only the intercept should be included. If we include an intercept and a trend, then the equation estimated by the test is:

$$X_t = \beta_0 + \beta_1 t + \pi X_{t-1} + \delta_1 X_{t-1} + \cdots + \delta_{p-1} X_{t-p+1} + \varepsilon_t \tag{6}$$

If we only include an intercept, then the estimated equation will be:

$$X_t = \beta_0 + \pi X_{t-1} + \delta_1 X_{t-1} + \cdots + \delta_{p-1} X_{t-p+1} + \varepsilon_t \tag{7}$$

where $\pi = \emptyset_1 + \cdots + \emptyset_p - 1$ and $\delta_1, \dots, \delta_1$ are parameters that do not depend on $\emptyset_1 + \cdots + \emptyset_p$.

Mathematically, the test is the following:

$$\begin{cases} H_0: \pi = 0 \ <=> \ X_t \sim I(1) \\ H_1: \pi < 0 \ <=> \ X_t \sim I(0) \end{cases} \tag{8}$$

The test statistics is: $t_{\hat{\pi}} = \frac{\hat{\pi}}{\hat{\sigma}(\hat{\pi})}$, being $\hat{\sigma}$ the standard error.

The Augmented Dickey-Fuller test can result in three different conclusions, depending on the type of test applied. The time series can be stationary, difference-stationary, or trend-stationary.

Test including only the intercept: The non-rejection of the null hypothesis indicates the presence of a unit root. This means that the time series is difference-stationary, that is to say, the analyzed time series is not stationary, and in order to make it stationary one should take the first difference of the time series. Considering X_t as a difference-stationary process, the right transformation to apply is the following:

$$\Delta X_t = X_t - X_{t-1} \tag{9}$$

The rejection of the null hypothesis indicates that there are no unit roots, and therefore the time series is already stationary and no transformations are needed.

The test includes intercept and trend: If the test includes a trend, not rejecting the null hypothesis means there is a unit root, and that the time series is difference-stationary. Once again, stationarity can be achieved by taking the first-difference, as in equation 9. Rejecting the null hypothesis indicates the absence of a unit root. If it does not have unit roots, then the time series is trend-stationary, and we should de-trend it, that is to say, remove the trend, in order to make it stationary. The de-trended time series will be the series of the residuals of a regression between the trend-stationary time series and the time variable t.

If the necessary transformations are not correctly applied to each of the time series when developing a regression model, there is a high probability that the model will reveal the presence of autocorrelation, that is to say, the error terms will probably be correlated. This violates a necessary assumption of the Gauss-Markov Theorem that the disturbance terms must be uncorrelated. Mathematically, no autocorrelation means:

$$\text{cov}(\varepsilon_t, \varepsilon_{t-s} | X) = 0 \quad , \quad s = 1, 2, \ldots, T - 1. \tag{10}$$

Autocorrelation, or serial correlation, is a typical problem when using time series, and this happens because the order in which data is presented is relevant. Autocorrelation means that the errors in a given moment are positively or negatively correlated with the errors in other moments, whether in the past or in the future. Because the error terms are correlated, a necessary assumption of the Ordinary Least Squares (OLS) method is violated, and the Gauss Markov Theorem stating that the OLS is the best unbiased estimator in a linear regression with uncorrelated errors does not hold. In the face of serial correlation, the OLS estimator will provide estimators with large variance, meaning that the OLS estimator is not efficient. Moreover, the test statistics of the *t* and *F*-tests will not be valid. Thus, it is necessary to correct all the time series in the regression model to ensure that there is no autocorrelation when performing a regression analysis.

The most well-known statistical tool to test for autocorrelation is the Durbin-Watson test. The Durbin-Watson tests if the error terms are independent from each other. Formally, the Durbin-Watson tests the following hypothesis:

$$H_0: \rho = 0$$
$$H_1: \rho > 0 \quad (11)$$

The Durbin-Watson test uses the following test statistic:

$$d = \frac{\sum_{i=2}^{n}(e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2} \quad (12)$$

where $e_i = y_i - \hat{y}_i$ which is the difference between the actual observed value and the value predicted by the model and corresponds to the residuals. After calculating the test statistics, one needs to compare the test statistic with the Upper and Lower bounds, d_U and d_L, given by the Durbin-Watson table for the respective values of k and n, where k is the number of explanatory variables and n is the number of observations in the sample. The conclusion about serial correlation is made through the following rule:

- If $d < d_L$ we reject the null hypothesis and conclude there is autocorrelation;
- If $d > d_U$ we do not reject the null hypothesis and conclude there is no autocorrelation;
- If $d_L < d < d_U$ we cannot conclude about the presence of autocorrelation.

As the test statistic follows an F-distribution, one can also conclude about autocorrelation by analyzing the p-value given by the test. For a 5% confidence level, if the p-value is smaller than 0.05, we reject the null hypothesis and there is autocorrelation. If the p-value is higher than 0.05, we do not reject the null hypothesis, and there is no autocorrelation.

As we are working with time series, more important than ensuring no autocorrelation is ensuring that the residuals of the regression are white-noise, or, in other words, ensuring that the process has zero-mean, constant variance, and that the correlation between residuals is always zero over time. Ensuring that the residuals follow a white-noise process guarantees that the estimated parameters of the model are efficient. Mathematically, the error terms follow a white-noise process if:

$$E(\varepsilon_t) = 0, \quad \forall t \quad (13)$$

$$Var(\varepsilon_t) = \sigma^2, \quad \forall t \quad (14)$$

$$Cov(\varepsilon_t, \varepsilon_{t-s}) = 0, \quad \forall s \neq 0 \quad (15)$$

One can test if the residuals follow a white-noise process by running the *Box-Ljung "portmanteau" test*, also known as *Q test*. We will be testing the following:

$$\begin{cases} H_0: corr(\hat{\varepsilon}_t, \hat{\varepsilon}_{t-k}) = 0 \\ H_1: corr(\hat{\varepsilon}_t, \hat{\varepsilon}_{t-k}) \neq 0 \end{cases}, k = 1,2,\dots \tag{16}$$

Under the null hypothesis, the test statistic is:

$$Q = n(n+2) \sum_{k=1}^{m} \frac{\hat{r}_k^2}{n-k} \sim \chi_m^2 \tag{17}$$

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

$$\hat{r}_k = \frac{\sum_{t=k+1}^{n} \hat{u}_t \hat{u}_{t-k}}{\sum_{t=1}^{n} \hat{u}_t^2} \tag{18}$$

As the *Q* converges to a chi-square distribution of order m, at a 5% confidence level, we reject the null hypothesis if the p-value is smaller than 0.05, and conclude that the residuals are not white-noise, and we do not reject the null hypothesis if the p-value is higher than 0.05 and conclude the residuals are white-noise.

3.2 Dependent Variable

Since we intend to estimate the determinants of VAT revenues, it is straightforward to think of the VAT revenues in millions of Euros as the main candidate for the dependent variable.

VAT revenues (in millions of euros): are the total monthly revenues collected from the tax on the value added of goods and services in Portugal. It is one of the most important sources of revenues. In 2012, the total VAT revenues accounted for 8.4% of GDP.

In Figure 1, we show the monthly VAT revenues in millions of Euros from January 1998 through May 2015. It is possible to observe that the variable has a strong seasonal component, meaning that we first need to seasonally adjust it. As a way to seasonally adjust the time series variable, we applied a simple moving average smoother. When applying 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, it appears that the movements in the monthly VAT revenues have a pattern that repeats every year. This way, we applied a simple moving average smoother using the last 12 terms. Our dependent variable will then be adjusted in the following way:

$$\hat{X}_t = \frac{1}{12}\sum_{i=0}^{12} X_{t-i} = \frac{X_t + X_{t-1} + \cdots + X_{t-12}}{12} \tag{19}$$

The seasonally adjusted time series plot is shown in Figure 2. Now it is clear that monthly VAT revenues have been increasing over time. This behaviour was impossible to observe when using the time series with the seasonal component. However, the trend means that our variable is not stationary and therefore using this variable to perform regression analysis would originate a spurious regression problem. After running the Dickey-Fuller test on the seasonally adjusted variable, we conclude that the variable is difference-stationary, and therefore we took the first-difference, in order to make it stationary. After taking the first-difference of the seasonally adjusted variable we obtain the time series presented in Figure 3.

Now we finally have a stationary variable and the Gauss-Markov Theorem can be applied when using this variable in the regression model. In this way, our dependent variable is the *first-difference of the seasonally adjusted monthly VAT revenues* (in millions of euros).

Figure 4 presents the histogram of this variable, where one can see that it is normally distributed.

One may ask why we did not use other options as dependent variables, such as the logarithm of the VAT revenues. The reason is because most of our explanatory variables contain a large number of observations with negative values. This makes it impossible to take the logarithm of these variables, as most observations would be lost. Because we are not able to apply logarithms to our explanatory variables, we decided not to take the logarithm of the dependent variable as a manner of consistency.

3.3 Explanatory Variables

As the objective is to estimate the determinants of VAT revenues, it is important to select the candidate variables to test. The selection of explanatory variables was based on the previous literature and on the possibility of finding monthly data on those variables. The selected variables were then grouped into seven groups, according to the expected results and from there, seven hypotheses were created. The description of the selected variables is the following:

GDP growth is the growth rate of the Gross Domestic Product, and it was used as a measure of economic growth. Given the unavailability of monthly data on GDP, the *index of economic activity*[1] from *Banco de Portugal* was used as a proxy for GDP.

Monthly Inflation is given by the *Consumer Price Index*[2], 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*.

Consumption is the general level of expenditures made by private entities. As no data on monthly consumption was available, the *index of private consumption*[3] from *Banco de Portugal* was used as a proxy for private consumption.

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*.

Unemployment 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.*

Exports are the share of all internally produced goods and services that are sold to another country. In Portugal, exports are exempt from VAT. Data on this variable was collected from *Banco de Portugal*.

Imports are the share of goods and services produced in another country, but finally consumed in national territory. Unlike exports, imports are subject to VAT. We collected data on this variable from *Banco de Portugal*.

Public deficit (in cash) is a measure of how much government expenditures exceed government revenues. This information is available in the monthly reports from *Direção Geral do Orçamento*.

Standard, Intermediate and Reduced VAT rates are the three different VAT rates applied in Portugal. Different rates are applied to different product categories of goods and services, as defined in the VAT code. Data on the level of the VAT rates over the years can be found from the European Commission (2015).

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1. Índice Coincidente de Actividade Económica
2. Índice de Preços no Consumidor
3. Índice Coincidente do Consumo Privado

As with the dependent variables, all the explanatory variables had to be previously adjusted for seasonality, with the exception of the three types of VAT rates. The three VAT rates did not need to be adjusted, as they do not present any seasonal pattern. After seasonally adjusting all the variables with seasonal component we applied the ADF test, and it was possible to conclude that all of the time series are difference-stationary, including those regarding the VAT rates. In this way, we took the first-difference of all the variables and we obtained stationary explanatory variables and thus our set of explanatory variables includes all the variables presented above, after correcting them for seasonality and stationarity.

3.4 Hypotheses

Hypotheses I: Economic growth is positively associated with VAT revenues.

Hypotheses II: Private consumption is positively associated with VAT revenues.

Hypotheses III: Unemployment is negatively associated with VAT revenues.

Hypotheses IV: Exports are negatively associated with VAT revenues.

Hypotheses V: Imports are positively associated with VAT revenues.

Hypotheses VI: Public deficit may be positively or negatively associated with VAT revenues.

Hypotheses VII: The level of the VAT rates is positively associated with VAT revenues.

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

As VAT is a consumption tax, an increase in private consumption is expected to lead to an increase in VAT revenues. Moreover, 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 VAT 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 VAT revenues.

As exports are exempt from VAT, it is expected that an increase in exports leads to a decrease in VAT revenues.

As imports are not exempt from VAT, an increase in imports is expected to lead to an increase in VAT revenues.

The expected results from the *public deficit* variable are not straightforward. On the one hand, 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 VAT revenues. On the other hand, an increase in the public deficit may be the result of a decrease in government revenues, including those from VAT. In this sense, an increase in the public deficit may lead to a decrease in VAT revenues.

Because VAT consists of a system of tax rates applied to products and services, an increase in each of the three rates (standard, intermediate and reduced) is singularly expected to increase VAT revenues.

In the Appendixes, Table IV 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 V presents the descriptive statistics of both dependent and explanatory variables.

3.5 Regression Models

After applying the necessary corrections, the variables can now be used to perform econometric regressions. It is possible to observe from the correlation matrix in Table VI that there is some multicollinearity between some variables, that is to say, 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. Thus 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 regressions, 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 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. While the Cochrane-Orcutt method drops the first observation of the time series, the Prais-Winsten method uses all the observations and therefore it is considered to be more efficient. Applying this method 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 only on 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 generic regression model is the following:

$$VAT\ rev_t = \beta_0 + \beta_1 GDPg_t + \beta_2 Infl_t + \beta_3 Cons_t + \beta_4 CCI_t + \beta_5 Unemp_t + \beta_6 Exp_t + \beta_7 Imp_t + \beta_8 Def_t + \beta_9 VATst_t + \beta_{10} VATred_t + \beta_{11} VATint_t + \varepsilon_t \tag{20}$$

where $VAT\ rev_t$ is the *fist-difference of the seasonally adjusted monthly VAT revenues (in millions of euros)*; $GDPg_t$, $Infl_t$, $Cons_t$, CCI_t, $Unemp_t$, Exp_t, Imp_t and Def_t are the *fist-difference of the seasonally adjusted GDP growth, monthly inflation, consumption, Consumers' Confidence Index, Unemployment, Exports, Imports* and *Public deficit,* respectively*; $VATst_t$, $VATred_t$,* and *$VATint_t$* are the *fist-difference of the* VAT *Standard, Reduced and Intermediate rates*, respectively.

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

4 Results

4.1 The evolution of VAT revenues in Portugal

Portugal introduced VAT in 1986, in the same year that it became a member of the European Union. Ever since then, VAT revenues have been increasing over time, and today it is one of the most important sources of revenues for the Portuguese government. Figure 5 presents the annual evolution of VAT in millions of euros from 1998 to 2014. From 1998 until 2008 VAT revenues increased 90%, from around 7,000 million euros in 1998, to more than 13,400 million in 2008. This increase is mostly due to the increase of the standard VAT rate from 17% in 1998, to 21% in 2008. During this

period, the reduced rate and the intermediate rate have remained at the same level, 5% and 12%, respectively.

In 2008, before the awake of the subprime crisis, the Portuguese government decided to reduce the VAT rate from 21% to 20%, as a way to boost consumption by relieving the tax burden from individuals. As a result of this measure, VAT revenues decreased, and in 2010 the government readjusted the standard VAT rate back up to 21%. At the same time, the reduced rate was increased to 6%, and the intermediate rate was increased to 13%. However, the standard VAT rate was only at this level for six months, and in January 2011, in the face of a higher need for revenues, the government set the rate at 23%.

4.2 Analysis of the Results

In this section we will answer the question "What are the main determinants of VAT revenues in Portugal?" This question is answered by observing the econometric results obtained through our regression models. The results can be found in Table VII and in Table VIII.

Note that in regressions 6, 7 and 8 we lagged the dependent variable. The reason for this is that when performing these regressions with the dependent variable, *first-difference of the seasonally adjusted VAT revenue*s, without any lag, the regression passed the autocorrelation test, but failed the Portmanteau[4] test, meaning the residuals were not following a white-noise process. Lagging the dependent variable corrects this problem. The p-values of both Durbin-Watson and Portmanteau tests are shown in Table VII. Table VIII only includes the results of the Portmanteau test, as it is not possible to apply the Durbin-Watson test when using the Prais-Winsten and Cochrane-Orcutt method. However, the Prais-Winsten and Cochrane-Orcutt method by itself ensures no autocorrelation. It is possible to observe that for a 5% significance level, all regressions passed both the Durbin-Watson and Portmanteau tests, meaning that there is no autocorrelation, and that the residuals are white-noise, which are two important conditions of the Gauss-Markov Theorem when performing an econometric analysis with time series.

When using the OLS method, the relationship between GDP and VAT revenues appears to be highly significant in one of the regressions, but it is not significant in the

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4. Ljung *"portmanteau" test*: tests if the residuals follow a white-noise process.

second regression. When using the Prais-Winsten and Cochrane-Orcutt method, the GDP is highly significant in both regressions. We can understand the importance of applying two regression methods. If we have doubts about the significance of a variable when applying one of the methods, applying a second method can clarify the results. It is thus possible to conclude that GDP has a strong positive impact on VAT revenues. The same doubts appears when we analyze the relationship between inflation and VAT revenues. The OLS method gives us a positive impact of inflation in GDP, but the variable is only statistically significant when lagging the dependent variable. Observing the results using the Prais-Winsten and Cochrane-Orcutt method, inflation is now strongly significant in all regressions. As with GDP, inflation has a strong positive impact on the collection of VAT revenues. These two results validate our first hypothesis, which states that economic growth leads to an increase in VAT revenues.

Consumption is also a strongly significant explanatory variable in our model. Due to multicollinearity, we were only able to use it in one regression, but the results are clear with both the OLS and the Prais-Winsten and Cochrane-Orcutt methods. On the other hand, the consumers' confidence index is only significant at a 10% confidence level when applying the Prais-Winsten and Cochrane-Orcutt method. The consumers' confidence index is a measure of optimism regarding the economic and financial situation of the economy and individuals. During part of our time period in the analysis, more specifically after 2008, it is possible that consumers were less optimistic about their personal financial situation, as well as about the financial situation of the economy in general. This may explain why the consumers' confidence index presents a positive, but insignificant relationship with VAT revenues. Nevertheless, consumption is positively related with VAT revenues and its statistical significance is very strong. In this way, we can validate Hypotheses II and confirm that consumption leads to higher VAT revenues.

The results given by unemployment are as expected in our model. Unemployment has a negative relationship with VAT revenues, meaning that as the unemployment rate rises, VAT revenues tend to decrease. This is not surprising, as a high unemployment rate means that a high share of the active population is not earning a salary. Consequently, their income drops substantially, leading to a decrease in

consumption. This result implies the validation of Hypotheses III, and we can generally conclude that higher unemployment leads to lower VAT revenues.

We expected a negative impact of exports, and a positive impact of imports on VAT revenues. Our results show that the impact of exports and imports is not statistically significant. These results are quite unexpected, as exports are VAT exempt, and also as a share of VAT is collected from imports. The 2008 subprime crisis may have had an important role in explaining this result. Tax evasion and techniques of international tax fraud, such as carousel fraud, which tend to increase during recessions, may have caused the loss of a significant share of VAT revenues which could have been collected through international trade. Thus, we cannot confirm hypotheses IV and V.

An increase in the public deficit indicates that there was an increase in government expenses, or a decrease in government revenues, or both. Our results show that the public deficit has a positive and strongly significant impact on VAT revenues, meaning that as the deficit increases, so do the VAT revenues. This may indicate that in the face of the higher need for revenues, governments adjust their tax policy to cover the increase in the deficit. This confirms Hypotheses VI.

Finally, our last hypothesis states that all the VAT rates (reduced, intermediate and standard) have a positive impact on VAT revenues. Surprisingly, the results show that all three rates have a positive impact on VAT revenues, but that only the impact of the reduced and intermediate rates are statistically significant. The impact of the standard VAT rate is not statistically significant. Once again, the subprime crisis may explain these results. Many other factors affect the collection of VAT revenues during recession periods. During recessions, governments tend to cut expenses, including those with tax administration and thus a decrease in compliance and the deterioration of the collection efficiency from tax administrations are common consequences of recessions. This worsening in compliance and collection efficiency is expected to be higher with the goods and services under the standard VAT rate, which is the higher VAT rate. As the VAT rate decreases, the incentive to evade tax is expected to decrease, which can explain why the impact of the standard VAT rate is not significant, yet the impact of the reduced and intermediate VAT rates are significant. Furthermore, consumption tends to decrease during recessions. However, the reduced and intermediate rate is commonly applied on first necessity goods and services, and the consumption of these goods and

services is not affected so much by recession periods the same way as the consumption of other goods and services are, meaning that revenues from the reduced and intermediate VAT rate will not suffer as much as the ones from the standard VAT rate.

Given this result, we can only partially confirm Hypotheses VII that the reduced and intermediate VAT rates do have a positive and significant impact on the collection of VAT revenues.

5 Conclusions and Future Research

Since it was first introduced in France in 1954 as an alternative to other consumption taxes, such as the sales tax and the turnover tax, the fast speed of the adoption of VAT by several countries has called the attention of many researchers. In fact, the incredible ability of VAT to raise revenues has been the subject of study for many years now. Extensive literature exists on the determinants of VAT, whether focusing on a particular country, or in a set of countries, but there are little or no empirical studies focusing on the determinants of VAT in Portugal.

In this dissertation we hope to contribute to the set of studies on VAT determinants by studying the specific case of Portugal. To do so, we collected monthly data on several economic and tax variables for the period starting in January 1998 until May 2015. Using this data, we performed a time series analysis, running two sets of regressions, using the OLS and the Prais-Winsten and Cochrane-Orcutt methods. The results indicate that GDP, inflation, consumption, the public deficit, and reduced and intermediate VAT rates all have a positive impact on Portuguese VAT revenues, whereas unemployment has a negative impact on Portuguese VAT revenues.

Although this was the first step of the study of the determinants of VAT in Portugal, there is still a long way to go. First, we were limited by the reduced extent of our data, which are only available since 1998, forcing us to use monthly data in order to obtain a sample larger enough to perform econometric analysis. Future researchers are invited to repeat this study, but with a wider dataset, possibly using quarterly or yearly data. Furthermore, because we used monthly data, we had to leave some explanatory variables out of our model that could be important to explain VAT revenues, such as the percentage of elder population, and agriculture share of GDP. This last variable, the agriculture share, can have an especially strong negative impact on VAT revenues,

considering that Portugal is a country with a strong agricultural sector. Furthermore, during our study, we found some complications, especially regarding the strong seasonal components present in our time-series, which made it harder to achieve stationarity. Researchers are invited to perform the same study using different methods for seasonal adjustment, as well as different econometric methodologies. It is important to understand whether the results still hold when different methods are applied, or whether the results are highly sensitive to the methodology used. A final suggestion is to perform the same study, but this time study the period before the subprime crises and the period after the subprime crisis separately. This could eliminate some of the effects that the subprime crises could have had on our results. We were not able to do this, as this implies splitting our data, which would result in two datasets with small sample time series. This study can only be done when there is enough data to create two datasets of large samples time series.

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Appendixes

Table I - Literature Review Summary Table of Empirical Papers

Author (year)	Country/ Region	Period	Methodology	Dep. Variable	Ind. Variables	Main Conclusions
Agha & Haughton (1996)	17 OECD countries	1987	▪ Assess determinants of VAT compliance	▪ Compliance index (Actual VAT Revenues/ Potential VAT Revenues)	▪ Average VAT rate ▪ Number of VAT rates ▪ Population ▪ Years since VAT introduction ▪ Administrative costs/ VAT Revenues	▪ VAT compliance increases with higher administrative expenditures and with the number of years since VAT introduction ▪ VAT compliance decreases as the average VAT rate, the number of VAT rates and population increase
Aizenman & Jinjarak (2008)	44 countries	1970 – 1999	▪ Estimate how economic development, the composition of population and GDP, international trade, political stability and political participation fluidity affect efficiency in collecting VAT	▪ C-efficiency ratio ▪ Efficiency ratio	▪ GDP per capita ▪ Agriculture share ▪ Trade openness ▪ % urban population ▪ Durability of political regime ▪ Regulation of political participation	▪ Higher percentage of urban population, GDP per capita, trade openness, higher political regimes and higher fluidity of political participation have a significant positive impact in C-efficiency ratio ▪ Higher agriculture share leads to lower efficiency in collecting VAT
Alm & El-Ganainy (2013)	15 EU countries	1961 – 2005	▪ Estimate the impact of VAT in consumption through regression analysis	▪ Household final consumption expenditures per capita	▪ Effective VAT rate ▪ Total Consumption Tax Revenues – VAT Revenues ▪ Total Income Tax Revenues ▪ GDP per capita ▪ GDP per capita growth rate ▪ Lagged household final consumption expenditures ▪ % pop. ≥ 65 ▪ Interest Rate	▪ The VAT effective rate has negative impact on private consumption ▪ GDP per capita, GDP per capita growth rate and lagged private consumption have positive impact on private consumption ▪ The level of the interest rate has negative impact on private consumption
Artavanis (2015)	Greece	Jan 2010 – Dec 2013	▪ Test the impact of changes in the VAT rate in Sales ratio (reported sales/ reported inputs)	▪ ΔSR (percentage variation in sales ratio relative to homologous period of previous year)	▪ VAT rate change	▪ Reduction in VAT rate decreases tax evasion through increase in compliance ▪ To cover tax evasion retailers adjust their VAT ratio downwards
Azaria & Robinson (2013)	24 countries	1970 – 2000	▪ Assess if the presence of VAT leads to higher tax revenues	▪ Tax revenues/ GDP	▪ GDP per capita ▪ Trade Openness ▪ VAT presence (dummy) ▪ VAT presence*GDP per capita ▪ VAT presence*Trade Openness	▪ As GDP per capita increases, tax revenues decrease ▪ Tax revenues increase with trade openness and with VAT presence ▪ The benefits from the VAT presence on tax revenues are stronger for countries with higher GDP per capita and trade openness
Bikas & Andruskaite (2013)	27 EU Member States	2004 – 2011	▪ Asses how some macroeconomic factors affect VAT revenues	▪ VAT revenue	▪ GDP ▪ GDP per capita ▪ Consumption ▪ Households' consumption	▪ GDP, GDP per capita, households' consumption and imports affect positively VAT revenues ▪ Exports affect negatively Vat revenues ▪ Unemployment has no direct impact on VAT revenues

				▪ Government consumption ▪ Imports ▪ Exports ▪ Unemployment	but it has a negative indirect impact by decreasing the available income of families and, consequently, their consumption
Bikas & Rashkauskas (2011)	Lithuania	1995 – 2009	▪ Estimate the factors affecting VAT revenues in Lithuania	▪ VAT income indexed to inflation	▪ Consumption indexed to inflation ▪ Standard VAT rate ▪ Number of reduced rates ▪ Standard VAT rate – lowest reduced rate (except 0%) ▪ Level of turnover required to register as a VAT payer ▪ Unemployment	▪ The standard VAT rate and the number of reduced rates (with exception of the 0% rate) have positive impact on VAT revenues ▪ Unemployment decreases consumption by a large scale ultimately resulting in reduced VAT revenues
Bogetic & Hassan (1993)	34 countries	1988	▪ Estimate VAT revenue determinants ▪ Compare VAT revenue performance of countries with single VAT rate with countries with multiple VAT rate ▪ Assess the impact of a 1% VAT rate increase in VAT revenue/GDP	▪ VAT revenue/ GDP	▪ VAT rate ▪ VAT base (dummy) ▪ Rate dispersion (difference between highest rate and lowest rate)	▪ VAT rate and tax base are the main determinants of VAT revenue ▪ Rate dispersion has negative impact on VAT revenues ▪ Single rate countries generate more VAT revenues than multiple rate countries ▪ An increase of 1% in VAT rate leads
Čížek et al (2012)	92 countries	1970 – 2008	▪ Estimate the determinants of VAT introduction through regression analysis	▪ VAT introduction (dummy)	▪ GDP per capita ▪ Openness ▪ Agriculture share ▪ Population density ▪ Revenue/GDP ▪ Federal (dummy) ▪ IMF (dummy) ▪ War (dummy) ▪ 5 regional dummies (Western Hemisphere; Middle East and Central Asia; Europe; Asia and Pacific; Africa)	▪ GDP per capita, openness, agriculture share, revenue as a fraction of GDP, being a federal country and participating in a war have negative impact on VAT adoption ▪ Countries with higher population and that received assistance from the IMF are more likely to adopt VAT ▪ It is possible to detect some regional bursts in the spread of the VAT
Desai & Hines (2005)	168 countries	1950 – 2000	▪ Assess impact of VAT in international trade	▪ Trade Openness (exports + imports)/ GDP ▪ Exports/ GDP	▪ VAT presence (dummy) ▪ VAT presence*GDP per capita ▪ VAT revenues/ Tax revenues ▪ (VAT revenues/ Tax revenues)*GDP per capita	▪ Countries using VAT are 17.5% less open than those who do not ▪ The use of VAT is associated with 7% fewer exports as a fraction of GDP ▪ VAT presence has negative impact on trade openness and exports
Ebeke & Ehrhart (2011)	103 countries	1980 – 2008	▪ Assess the impact of VAT adoption in tax revenues stability through panel data analysis	▪ Standard Deviation of tax revenue/GDP ratio (Tax Revenue Instability)	▪ GDP per capita ▪ GDP per capita instability ▪ Trade Openness ▪ Level of natural resource rent ▪ Inflation ▪ Inflation instability ▪ Elections (dummy) ▪ Lagged percentage of geographical	▪ The presence of VAT decreases tax revenues instability. This effect is stronger for low and middle-income countries and for countries with low levels of trade openness ▪ Inflation contributes to higher tax revenue instability

				neighbours that adopted VAT ▪ Lagged tax revenue ratio ▪ VAT presence (dummy) ▪ VAT(dummy)*GDP per capita ▪ VAT(dummy)*lagged trade openness	
Ebrill et al (2001)	183 countries, 93 of which with VAT	1994 – 1997	▪ Study if countries with VAT have higher tax revenues than those without through regression analysis	▪ Tax Revenues/ GDP	▪ GDP per capita ▪ Trade Openness ▪ Agriculture share ▪ VAT presence (dummy) ▪ VAT presence*GDP per capita ▪ VAT presence* Trade openness ▪ VAT presence* Agriculture share	▪ Positive impact of GDP per capita on tax ratio and negative impact of agriculture share on tax ratio ▪ There is no evidence that countries with VAT have higher tax revenues than those without
Ebrill et al (2001)	99 countries	1994 – 1997	▪ Estimate the determinants of VAT revenues through regression analysis	▪ VAT revenues/ private consumption	▪ Standard VAT rate ▪ Trade Openness ▪ Age of VAT ▪ Illiteracy ▪ Threshold ▪ Higher – Lower VAT rate ▪ Retail (dummy) ▪ Goods and Services (dummy)	▪ As the standard VAT rate, trade openness, the number of years since VAT introduction, and the difference between the highest and lowest VAT rate increase, VAT revenues as a fraction of private consumption also increase ▪ Higher levels of illiteracy lead to lower VAT revenues to private consumption ratio
Engel et al (2001)	Chile	1981 – 1997	▪ Estimate how increase in enforcement spending impacts on VAT revenues	▪ VAT Revenues/ GDP	▪ VAT rate ▪ Enforcement Spending	▪ Increase expenditures on enforcement would lead to a decrease in tax evasion and, consequently, an increase in VAT revenues
Godin & Hindriks (2015)	Several countries with special attention to low income countries	1980 – 2010	▪ Creation of a tax efficiency indicator (potential tax/actual tax) ▪ Potential tax estimated through regression analysis	▪ Total tax ▪ PIT ▪ Goods and services tax ▪ Trade tax	▪ Nominal GDP ▪ GDP per capita ▪ Spatial dependence ▪ Government quality ▪ Agriculture value added ▪ Other sources of government revenue	▪ Spatial dependence has strong impact on tax revenues ▪ Spatial dependence, government efficiency and agriculture value added have strong impact on PIT ▪ Spatial dependence and agriculture value added have strong impact on goods and services tax ▪ Low and medium income countries have lower potential and actual tax comparing with developed countries
Kaczynska (2015)	Poland	2000 – 2013	▪ Estimate VAT determinants ▪ Estimate impact of increase in VAT rate from 22 to 23%	▪ VAT revenue	▪ GDP in current prices ▪ Inflation Rate (CPI) ▪ VAT Rate	▪ GDP is a major determinant of VAT in Poland ▪ After increase of VAT rate, VAT revenues and efficiency ratio decreased
Keen & Lockwood (2006)	30 OECD countries	1965 – 2004	▪ Asses if introduction of VAT leads to higher tax revenues as a fraction of GDP ▪ Assess if the introduction of VAT led to higher government size	▪ Tax revenues/ GDP	▪ VAT presence (dummy) ▪ GDP per capita ▪ Trade openness ▪ Agriculture share ▪ GDP per capita* VAT presence (dummy) ▪ Agriculture share*VAT presence (dummy) ▪ Openness*VAT presence (dummy)	▪ The tax ratio is higher for countries with a VAT system than for those without ▪ Increases in VAT revenue are, in part, offset by a reduction in revenues from other sources ▪ VAT is a "Money Machine"

					▪ Federal country (dummy) *VAT presence (dummy) ▪ Population ▪ % pop. $\geq$ 65 ▪ % pop. $\leq$ 14 ▪ IMF Program crisis (dummy)	
Keen & Lockwood (2010)	143 countries	1975 – 2000	▪ Estimate the causes of VAT adoption ▪ Assess the impact of VAT adoption ▪ Assess if countries that did not adopt VAT would benefit by doing so	▪ Probability of VAT adoption ▪ Revenues	▪ Income per capita ▪ (exports + imports)/GDP (Openness) ▪ Agriculture share ▪ Population ▪ % pop $\leq$ 14 ▪ % pop $\geq$ 65 ▪ Services/GDP ▪ IMF program crisis (dummy) ▪ IMF program poverty (dummy) ▪ Federal countries (dummy) ▪ % of countries in the same region	▪ Participation in IMF program for crisis resolution and adoption of VAT by neighbour countries increases probability of VAT adoption ▪ Openness, participation in IMF program for crisis resolution and % pop $\geq$ 65 has positive impact on revenues after VAT adoption ▪ Countries that adopted VAT have benefited from it as would those who did not
Legeida & Sologoub (2003)	Ukraine	Jan 1998 – Dec 2002	▪ Estimate effective tax rate and efficiency ratio ▪ Estimate reaction of VAT revenues to changes in tax base ▪ Estimate relationship between VAT revenue growth and Vat base growth ▪ Forecast monthly VAT revenues for 2003	▪ VAT revenues ▪ Ln VAT revenues	▪ VAT base ▪ Ln VAT base	▪ Low effective tax rate (8%) and low VAT effort performance (efficiency ratio of only 40%) ▪ Increase of 1m UAH in VAT base leads to an increase of 30000 UAH in VAT revenues ▪ Increase of 1% in VAT base leads to an increase of 0.64% in VAT revenue ▪ VAT revenues for 2003 will remain stable with no positive changes
Matthews (2003)	14 EU countries	1970 – 1998	▪ Estimate VAT rate that maximizes VAT revenues in the EU ▪ Asses VAT determinants	▪ VAT revenue/ GDP	▪ Standard VAT rate ▪ (Standard VAT rate)^2 ▪ ΔStandard VAT rate ▪ Currency/ GDP ▪ Number of VAT rates ▪ German Unification (dummy)	▪ The VAT rate that maximizes VAT revenues is between 18 and 19.3% ▪ The VAT rate has a positive relationship with VAT revenues however, increases in the VAT rate have a negative impact on VAT revenues ▪ The size of 'black economy' and German unification have negative impact on VAT revenues
Matthews & Lloyd-Williams (2000)	20 countries	1993	▪ Estimate revenue maximizing rate	▪ VAT revenues/ GDP current prices	▪ Standard VAT rate ▪ (Standard VAT rate)^2 ▪ Currency/ GDP ▪ Number of VAT rates	▪ Higher levels of VAT rate lead to higher levels of VAT revenues but only until a certain point called the revenue-maximizing rate after which increases to standard VAT rate have negative impact on VAT revenues ▪ The revenue-maximizing rate was estimated to be 20% ▪ The size of the 'black economy increases non-compliance leading to smaller levels of VAT revenues
Nellor (1987)	11 European countries	1955 – 1984	▪ Estimate impact of introducing VAT in tax ratio	▪ Tax Ratio (Tax revenues/ GDP)	▪ Introduction of VAT (dummy) ▪ Size of Agriculture Sector/ GDP ▪ Government Expenditures	▪ Introducing VAT leads to an increase of the tax ratio ▪ An increase in the diversity of sources of tax revenue leads to an increase in the tax ratio

					▪ Net of interests ▪ Public Debt	
Pagán et al (2001)	Mexico	1981 – 1997	▪ Analyse relationships between government spending, inflation, VAT rate and VAT revenues using a vector autoregressive (VAR) model	▪ Government Spending ▪ Inflation ▪ VAT Revenues ▪ VAT rate	▪ Government Spending ▪ Inflation ▪ VAT Revenues ▪ VAT rate	▪ The levels of government spending, inflation rate and VAT rate have positive impact on VAT revenues ▪ The results show that higher levels of government spending lead to higher VAT revenues while the contrary is not observable ▪ VAT rate is mostly determined by VAT revenues, inflation rate and government spending ▪ VAT revenues have positive impact on inflation
Sarmento & Alvarez (2015)	27 EU countries	1998 – 2012	▪ Assess impact of variations in standard and effective VAT rate on VAT revenues as a fraction of GDP	▪ Δ VAT Revenues/ GDP	▪ Δ Standard VAT rate ▪ Δ Effective VAT rate	▪ Both increases of the standard and effective VAT rate lead to increases in VAT revenues as a fraction of GDP
Sokolovska & Sokolovskyi (2015)	41 countries	2012	▪ Estimate VAT efficiency ratio ▪ Analyse how shadow sector and corruption impact on VAT efficiency ratio through regression analysis	▪ VAT efficiency ratio	▪ Shadow Sector/ GDP ▪ Corruption Perception Index	▪ In Portugal, the VAT efficiency ratio was estimated to be 54% in 2012 ▪ There is a negative relationship between the share of shadow sector and the level of corruption and the VAT efficiency ratio
Tagkalakis (2014)	Greece	1st Quarter 2000 – 3rd Quarter 2012	▪ Study how economic conditions affect efficiency in collecting VAT revenues, controlling for shifts in consumption and tax evasion	▪ C-efficiency ratio	▪ GDP growth rate ▪ Elections period (dummy) ▪ Excessive Deficit Procedure (dummy) ▪ Economic Adjustment Programme (dummy) ▪ Shift in consumption towards necessity goods ▪ Control of Tax Evasion	▪ GDP growth rate is positively related with VAT efficiency. As the growth rate increases so does efficiency. However, during economic recessions efficiency tends to be lower ▪ Higher ability to fight tax evasion from tax administration increases VAT efficiency
Ufier (2014)	192 countries	1967-2012	▪ Estimate the determinants of VAT adoption ▪ Assess macroeconomic impact of adopting VAT	▪ Adoption of VAT (dummy)	▪ Consumption ▪ Inflation ▪ Investment ▪ GDP per capita growth rate ▪ Trade openness ▪ Agriculture share ▪ IMF program (dummy) ▪ GDP ▪ GDP per capita ▪ Country size (km^2) ▪ Rents from natural resources/ GDP ▪ Number of neighbour countries with VAT ▪ % population ≤ 14 ▪ % population ≥ 65 ▪ Population growth ▪ Population	▪ Countries large in size and in population and with higher share of older people are more likely to adopt VAT ▪ Participating in a IMF program and being a member of Francophonie increases probability of VAT adoption ▪ Countries rules as federations, high share of rents from natural resources as a fraction of GDP, former member of Warsaw Pact and small islands adopt VAT at slower rates ▪ Adopting VAT leads to lower inflation and government spending and increases GDP and investment

					▪ Alliance of small islands ▪ Soviet Union (dummy) ▪ Warsaw Pact (dummy) ▪ British Common Wealth (dummy) ▪ Francophonie (dummy) ▪ Island (dummy) ▪ Landlocked (dummy) ▪ Federal country	
Wawire (2011)	Kenya	1963/64 – 2008/09	▪ Derivation of a demand function using a utility maximization model ▪ Estimation of VAT determinants through regression analysis ▪ Evaluation of VAT elasticity in response to changes in tax bases	▪ Sales tax/VAT ▪ Per capita sales tax/VAT	▪ GDP ▪ Volume of trade ▪ Volume of imports ▪ Population ▪ Oil crisis event (dummy) ▪ Sales tax introduction (dummy) ▪ SAPs introduction (dummy) ▪ VAT introduction (dummy) ▪ Other historical events (dummy)	▪ GDP, population, the creation of the Kenya Revenue Authority (1995) and the introduction of sales tax (1973) and sales tax on imports (1984/85) have strong impact on VAT ▪ VAT is strongly impacted by GDP and demographic, institutional and structural changes ▪ VAT is elastic and can be used to increase government revenues
Zídková (2014)	24 EU Member States	2002/ 2006	▪ Explain VAT gap through regression analysis	▪ VAT gap	▪ Final Consumption/GDP ▪ VAT revenues/GDP ▪ Standard VAT rate ▪ Shadow Economy/GDP ▪ GDP per capita ▪ Share Intra-Community trade ▪ Number of VAT rates ▪ Shae of household final consumption on restaurant and hotel services	▪ Final consumption as a fraction of GDP, the standard VAT rate and the share of shadow economy contribute to the increase of the VAT gap ▪ VAT revenues as a fraction of GDP, GDP per capita, the share of intra-community trade, the number of VAT rates and the share of household final consumption on restaurant and hotel services contribute to the decrease of the VAT gap

Table II - Literature Review Summary Table of Conceptual Papers

Author (year)	Methodology	Main Conclusions
Ballard et al (1987)	▪ Application of a general equilibrium model to study the consequences of introducing VAT with application to the USA	▪ Introducing the VAT would lead to efficiency and welfare gains ▪ There is a trade-off between efficiency and equity when introducing the VAT but equity is better achieved through the adjustment of PIT ▪ Replacing the Corporate Income Tax with VAT would lead to efficiency gains. The additional gains have a U-shape.
Emran & Stiglitz (2005)	▪ Create a model to assess the impact of VAT in welfare of countries with a large informal sector	▪ In countries with a large informal sector, decreasing import and export tariffs and increase VAT or broadening its base reduces welfare
Gábriel & Reiff (2006)	▪ Estimate impact of increase in the Hungarian middle VAT rate in January 2004 from 12 to 15% in prices ▪ Estimate impact of decrease in the Hungarian upper rate in January 2006 from 25 to 20% ▪ To conclude about the impact of changes in the VAT rate in prices they study the	▪ The increase of the middle VAT rate led to an increase in prices more than proportional to the one expected with a full transfer of the VAT burden to final consumers ▪ The decrease in the upper VAT rate was only one fourth of the expected with a full relief of the VAT burden to final consumers ▪ Retailers took advantage of both the increase and decrease of VAT rate to raise their profit

	evolution of prices from January 2002 until May 2006	margins
Jenkis &Kuo (2000)	▪ Create a model to estimate tax base and potential VAT revenues for developing countries ▪ Application of model to Nepal for the period of 1994 until 1995	▪ The compliance ratio (actual revenues/ potential revenues) is usually small for developing countries ▪ VAT revenues in developing countries can be increased by broadening the tax base and increasing compliance
Keen (2013)	▪ Decompose VAT revenues as percentage of GDP ▪ Estimate main driver of VAT revenues as percentage of GDP ▪ Decompose C-efficiency ratio ▪ Application to 15 EU countries in the year 2006	▪ VAT revenue as a fraction of GDP can be decomposed into three elements: standard VAT rate, C-efficiency ratio and consumption as a fraction of GDP ▪ C-efficiency ratio is the major driver of VAT revenues as percentage of GDP ▪ The C-efficiency ratio can be decomposed into "policy gap" and "compliance gap" ▪ Policy gaps are usually larger than compliance gaps in most EU countries
Mathis (2004)	▪ Estimate how much of the taxable base is taxed with the standard VAT rate, with reduced rates, super reduced rates and zero rates ▪ Estimate implicit tax rates and compare them with the standard VAT rates ▪ Application to the EU-15 countries in 2000	▪ There is an excessive share of the taxable base subject to non-standard rates which goes against the idea of the Sixth Directive

Table III - Literature Review Summary Table of Independent Variables

| Independent Variable	Studies	Main conclusion on this variable
Administrative costs/ VAT revenues	Agha & Haughton (1996)	Higher expenses from tax administration lead to higher compliance
Agriculture Share of GDP	Keen & Lockwood (2006) Aizenman & Jinjarak (2008) Keen & Lockwood (2010) Čížek et al (2012) Ufier (2014) Godin & Hindriks (2015)	Strong negative impact on tax ratio Negative impact on C-efficiency ratio Strong negative impact on the probability of adoption of VAT and on total revenues Negative impact on the adoption of VAT Statistically insignificant to explain VAT adoption Negative impact on total revenues and Goods and Services Tax
Agriculture Share of GDP (log)	Ebrill et al (2001)	Higher agriculture share leads to lower tax revenues to GDP ratio
Alliance of small islands	Ufier (2014)	Negative impact on VAT adoption
Average VAT Rate	Agha & Haughton (1996)	As the average VAT rate increases, compliance becomes lower
Bordering countries with VAT	Keen & Lockwood (2010) Ufier (2014)	The probability of adopting VAT increasing when frontier countries have adopted VAT Statistically insignificant to explain VAT adoption
C-efficiency ratio	Keen (2013)	Major driver of VAT revenues as a percentage of GDP
Consumption	Bikas & Andruskaite (2013)	Weak correlation with VAT revenues
Consumption Tax Revenues excluding VAT revenues	Alm & El-Ganainy (2013)	Statistically insignificant to explain private consumption
Control of tax evasion	Tagkalakis (2014)	Increase in ability to fight tax evasion leads higher C-efficiency ratio
Corruption Perception Index	Sokolovska & Sokolovskyi (2015)	Negative impact on the VAT efficiency ratio
Country size (Km^2)	Ufier (2014)	Positive impact on VAT adoption
Currency/ GDP	Matthews & Lloyd-Williams (2000) Matthews (2003)	The size of 'black economy' increases non-compliance which decreases VAT revenues The size of 'black economy' is associated with increases in non-compliance meaning smaller VAT revenues
Effective VAT Rate	Alm & El-Ganainy (2013)	Negative impact on private consumption
Δ Effective VAT rate	Sarmento & Alvarez (2015)	Positive impact on VAT revenues as a fraction of GDP

Elections (dummy)	Ebeke & Ehrhart (2011)	Statistically insignificant to explain tax revenue instability
	Tagkalakis (2014)	Statistically insignificant to explain C-efficiency ratio
Enforcement Spending	Engel et al (2001)	Increases in enforcement spending would lead to increases in VAT revenues through reduction of tax evasion
Excessive Deficit Procedure (dummy: 1 during the period Greece was in excessive deficit period; 0 otherwise)	Tagkalakis (2014)	Negative impact on C-efficiency ratio
Exports	Bikas & Andruskaite (2013)	Negative impact on VAT revenues
Federal country (dummy)	Keen & Lockwood (2010)	Not statistically significant to explain VAT adoption and total revenues
	Čížek et al (2012)	Negative impact on the adoption of VAT
	Ufier (2014)	Negative impact on VAT adoption
Final Consumption/ GDP	Zídková (2014)	Higher consumption as a fraction of GDP leads to higher VAT gap
GDP	Bikas & Andruskaite (2013)	Positive impact on VAT revenues
	Kaczynska (2015)	Strong positive impact on VAT revenues
GDP (log)	Wawire (2011)	Strong positive impact on VAT revenues
	Ufier (2014)	Statistically insignificant to explain VAT adoption
GDP growth rate	Tagkalakis (2014)	Strong positive impact on C-efficiency ratio
GDP per capita	Aizenman & Jinjarak (2008)	Positive impact on C-efficiency ratio
	Bikas & Andruskaite (2013)	Positive impact on private consumption
GDP per capita (log)	Ebrill et al (2001)	As GDP per capita increases, the ratio of tax revenues to GDP increases
	Keen & Lockwood (2006)	Negative impact on tax ratio
	Keen & Lockwood (2010)	Strong negative impact on the probability of adoption of VAT
	Ebeke & Ehrhart (2011)	Statistically insignificant to explain tax revenue instability
	Čížek et al (2012)	Positive impact on VAT revenues
	Alm & El-Ganainy (2013)	Positive impact on tax revenues
	Azaria & Robinson (2013)	Negative impact on the adoption of VAT
	Ufier (2014)	Statistically insignificant to explain VAT adoption
	Zídková (2014)	As GDP per capita increases, the VAT gap decreases
	Godin & Hindriks (2015)	Poor indicator to explain total tax revenues
GDP per capita growth rate	Alm & El-Ganainy (2013)	Positive impact on private consumption
	Ufier (2014)	Statistically insignificant to explain VAT adoption
Government Consumption	Bikas & Andruskaite (2013)	Weak correlation with VAT revenues
	Ufier (2014)	Statistically insignificant to explain VAT adoption
Government Efficiency	Godin & Hindriks (2015)	Positive impact on PIT and total tax revenues
Government Spending	Pagán et al (2001)	Positive impact on VAT revenues
	Pagán et al (2001)	Statistically insignificant to explain inflation
	Pagán et al (2001)	Positive impact on VAT rate
Households' Consumption	Bikas & Andruskaite (2013)	Positive impact on VAT revenues
Illiteracy	Ebrill et al (2001)	Negative impact on VAT revenues as a fraction of private consumption
Imports	Bikas & Andruskaite (2013)	Strong positive impact on VAT revenues
Imports (log)	Wawire (2011)	Strong positive impact on VAT revenues
Income Tax Revenues	Alm & El-Ganainy (2013)	Statistically insignificant to explain private consumption

Inflation	Pagán et al (2001)	Positive impact on VAT revenues
	Pagán et al (2001)	Positive impact on VAT rate
	Ebeke & Ehrhart (2011)	Higher inflation contributes to higher tax revenue instability
	Ufier (2014)	Statistically insignificant to explain VAT adoption
Interest Rate	Alm & El-Ganainy (2013)	Negative impact on private consumption
Lagged Households' Consumption	Alm & El-Ganainy (2013)	Positive impact on private consumption
Lagged tax revenue ratio	Ebeke & Ehrhart (2011)	Statistically insignificant to explain tax revenue instability
Number of reduced rates	Bikas & Rashkauskas (2011)	Not statistically significant to explain impact on VAT revenues
Number of VAT rates	Agha & Haughton (1996)	As the number of VAT rates increase, compliance decreases
	Matthews & Lloyd-Williams (2000)	Not statistically significant to explain impact on VAT revenues
	Matthews (2003)	Not statistically significant to explain impact on VAT revenues
	Zídková (2014)	As the number of VAT rates increases, the VAT gap decreases
Percentage of population older than 65 years old or with 65 years old	Keen & Lockwood (2006)	Strong positive impact on tax ratio
	Keen & Lockwood (2010)	Positive impact on total revenues
	Alm & El-Ganainy (2013)	Statistically insignificant to explain private consumption
	Ufier (2014)	Positive impact on VAT adoption
Percentage of urban population	Aizenman & Jinjarak (2008)	Positive impact on C-efficiency ratio
Population	Agha & Haughton (1996)	As population increases, compliance decreases
Population (log)	Keen & Lockwood (2006)	Statistically insignificant to explain impact on tax ratio
	Keen & Lockwood (2010)	Not statistically significant to explain VAT adoption and total revenues
	Wawire (2011)	An increase in population leads to an increase of VAT revenues
	Ufier (2014)	Positive impact on VAT adoption
Population density	Čížek et al (2012)	Positive impact on VAT adoption
Population growth	Ufier (2014)	Statistically insignificant to explain VAT adoption
Shadow Economy/ GDP	Zídková (2014)	Higher fraction of shadow economy leads to higher VAT gap
	Sokolovska & Sokolovskyi (2015)	Negative impact on the VAT efficiency ratio
Share of Household Final Consumption on Restaurant and Hotel Services	Zídková (2014)	Negative Impact on VAT gap
Share of Intra-Community Trade	Zídková (2014)	Higher share of intra-community trade leads to lower VAT gap
Standard VAT rate	Ebrill et al (2001)	Positive impact on VAT revenues as a fraction of private consumption
	Matthews & Lloyd-Williams (2000)	Positive impact in VAT revenues but only until a certain VAT rate level after which further increases lead to lower VAT revenues. The VAT revenue-maximizing rate is 20%.
	Matthews (2003)	Positive impact on VAT revenues. The EU VAT revenue-maximizing rate is between 18 and 19.3%.
	Bikas & Rashkauskas (2011)	The higher the standard VAT rate, the higher the VAT revenues
	Zídková (2014)	Higher standard VAT rate leads to higher VAT gap
Threshold Level (turnover at which businesses have to register as taxpayers)		
Total revenues/GDP	Čížek et al (2012)	Negative impact on the adoption of VAT

|		
Trade Openness ((exports + imports)/GDP)	Ebrill et al (2001)	Positive impact on VAT revenues as a fraction of private consumption
	Keen & Lockwood (2006)	Negative impact on tax ratio although statistically insignificant
	Aizenman & Jinjarak (2008)	Positive impact on C-efficiency ratio
	Keen & Lockwood (2010)	Positive impact on total revenues
	Čížek et al (2012)	Negative impact on the adoption of VAT
	Ufier (2014)	Statistically insignificant to explain VAT adoption
	Godin & Hindriks (2015)	Positive impact on Goods and Services and Trade Tax
Trade Openness (log)	Ebrill et al (2001)	Positive impact on tax revenues to GDP ratio
	Ebeke & Ehrhart (2011)	Statistically insignificant to explain tax revenue instability
	Wawire (2011)	Strong positive impact on VAT revenues
	Azaria & Robinson (2013)	Positive impact on tax revenues
Unemployment	Bikas & Rashkauskas (2011)	An increase of unemployment reduces consumption which in turn impacts negatively on VAT revenues
	Bikas & Andruskaite (2013)	Does not directly affect VAT revenues but indirectly through the available income of families and, consequently, their consumption
VAT adoption (dummy)	Keen & Lockwood (2010)	Strong positive impact on total revenues
	Ufier (2014)	Adopting VAT has a positive impact on GDP
	Ufier (2014)	Adopting VAT leads to lower inflation
	Ufier (2014)	Adopting VAT has positive impact on investment
	Ufier (2014)	Countries adopting VAT have smaller levels of government spending
	Nellor (1987)	VAT introduction leads to an increase in tax ratio
VAT base (dummy: 1 if base is goods and services; 0 otherwise)	Bogetic & Hassan (1993)	A VAT base of goods and services has positive impact on VAT revenues
	Ebrill et al (2001)	Results are not robust enough to take conclusions on the impact of the variable on VAT revenues as a fraction of private consumption
	Legeida & Sologoub (2003)	Increases in the VAT base will lead to increases in VAT revenues
VAT presence (dummy: 1 if country has VAT; 0 if not)	Ebrill et al (2001)	Opposite signs in different regressions. Impossible to conclude about that the presence of VAT is associated with higher VAT revenues
	Desai & Hines (2005)	Negative impact on trade openness and exports
	Keen & Lockwood (2006)	Countries with VAT have higher tax ratio than those who do not have VAT
	Ebeke & Ehrhart (2011)	The presence of VAT reduces tax revenue instability
	Azaria & Robinson (2013)	Positive impact on tax revenues
VAT presence (dummy)* Agriculture share	Ebrill et al (2001)	The additional revenues from the presence of VAT are smaller for countries with high agriculture share
VAT presence (dummy)* Federal country (dummy)	Keen & Lockwood (2006)	Statistically insignificant to explain impact on tax ratio
VAT presence (dummy)* GDP per capita	Ebrill et al (2001)	The negative effect of the VAT presence on tax revenues is smaller for high-income countries
	Desai & Hines (2005)	The negative impact on trade openness and exports is stronger for low-income countries
	Keen & Lockwood (2006)	The positive effect of the presence of VAT on tax ratios is smaller for high-income countries
	Ebeke & Ehrhart (2011)	The benefits from the presence of VAT as tax revenue stabilizer are stronger for low and middle-income countries
	Azaria & Robinson (2013)	The benefits from the VAT presence on tax revenues are stronger for countries with higher GDP per capita
VAT presence (dummy)* Lagged Trade Openness	Ebeke & Ehrhart (2011)	The benefits from the presence of VAT as tax revenue stabilizer are stronger for countries with low levels of trade openness

VAT presence (dummy)* Trade Openness	Ebrill et al (2001)	Statistically insignificant to explain tax revenues to GDP ratio
	Azaria & Robinson (2013)	The benefits from the VAT presence on tax revenues are stronger for countries with higher trade openness
VAT rate	Bogetic & Hassan (1993)	Increases in VAT rate will lead to increase in VAT revenues
	Engel et al (2001)	Higher VAT rate leads to higher VAT revenues
	Pagán et al (2001)	Positive and significant impact on VAT revenues
	Pagán et al (2001)	Not statistically significant to explain inflation
Δ VAT rate	Matthews (2003)	Increases in VAT rate have a negative impact on VAT revenues
	Artavanis (2015)	Reduction of VAT rate leads to increase in Sales Ratio and compliance which in turn decreases tax evasion
	Sarmento & Alvarez (2015)	Positive impact on VAT revenues as a fraction of GDP
VAT rate range (highest-lowest)	Bogetic & Hassan (1993)	Negative impact on VAT revenues
	Ebrill et al (2001)	Positive impact on VAT revenues as a fraction of private consumption
	Bikas & Rashkauskas (2011)	The higher the difference between the highest and the lowest rate, the higher the VAT revenues
VAT Revenues	Pagán et al (2001)	Positive impact on inflation
	Pagán et al (2001)	Positive impact on VAT rate
	Pagán et al (2001)	Higher VAT revenues do not lead to higher government spending
VAT Revenues/ GDP	Zídková (2014)	Higher fraction of VAT revenues leads to lower VAT gap
VAT revenues/ Tax revenues	Desai & Hines (2005)	Higher reliance on VAT as a source of revenues is associated with smaller trade openness and exports as a fraction of GDP
(VAT revenues/ Tax revenues)* GDP per capita	Desai & Hines (2005)	The negative relationship between reliance on VAT and trade openness and exports is stronger for low-income countries
Years since VAT introduction	Agha & Haughton (1996)	Positive impact on compliance
	Ebrill et al (2001)	Positive impact on VAT revenues as a fraction of private consumption
	Aizenman & Jinjarak (2008)	Negative impact on C-efficiency ratio although not statistically significant

Figure 1 - Monthly VAT Revenues (in millions of Euros)
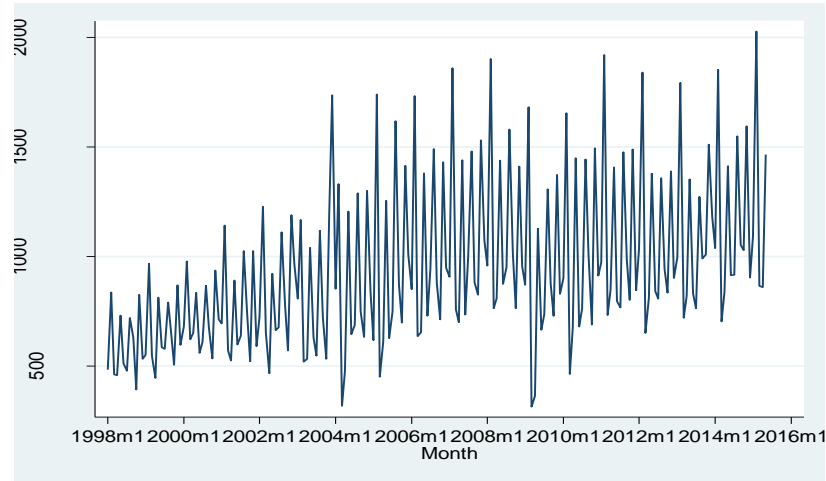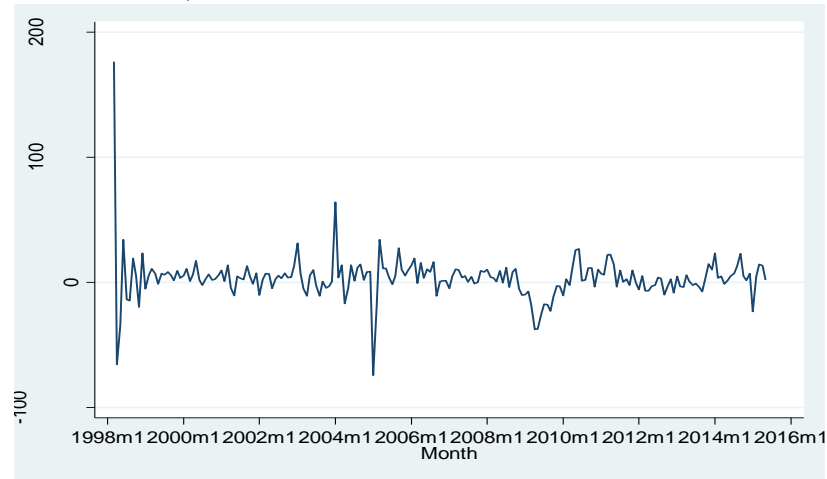

Source: Stata 13 Output

Figure 2 - Seasonally adjusted monthly VAT revenues (in millions of Euros)
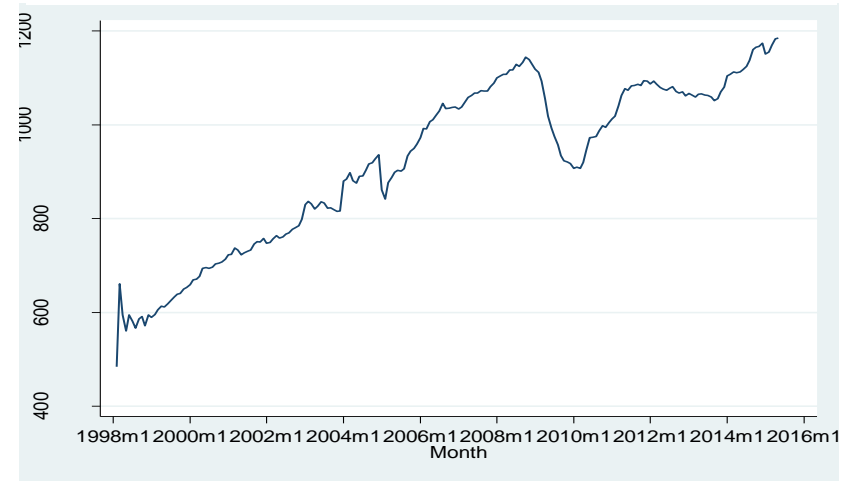
Source: Stata 13 Output

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

Source: Stata 13 Output

Figure 4 - Histogram of first difference of seasonally adjusted VAT Revenues (in millions of Euros)
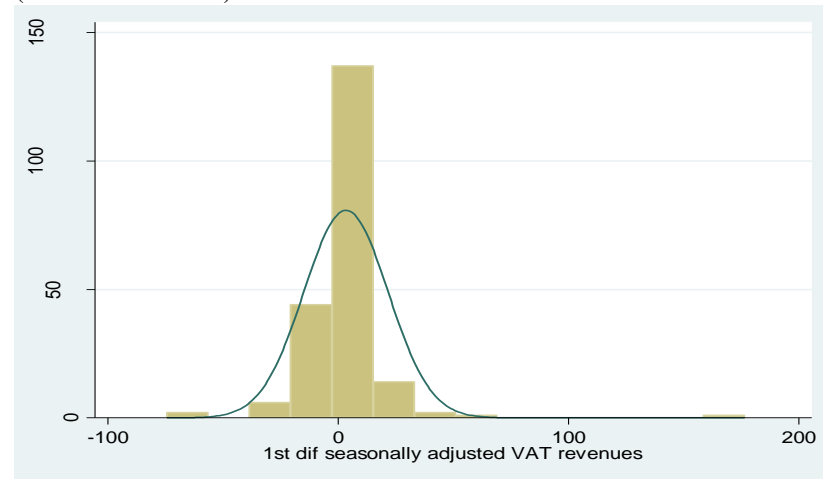
Source: Stata 13 Output

Figure 5 - Evolution of Portuguese VAT revenues (in millions of euros)
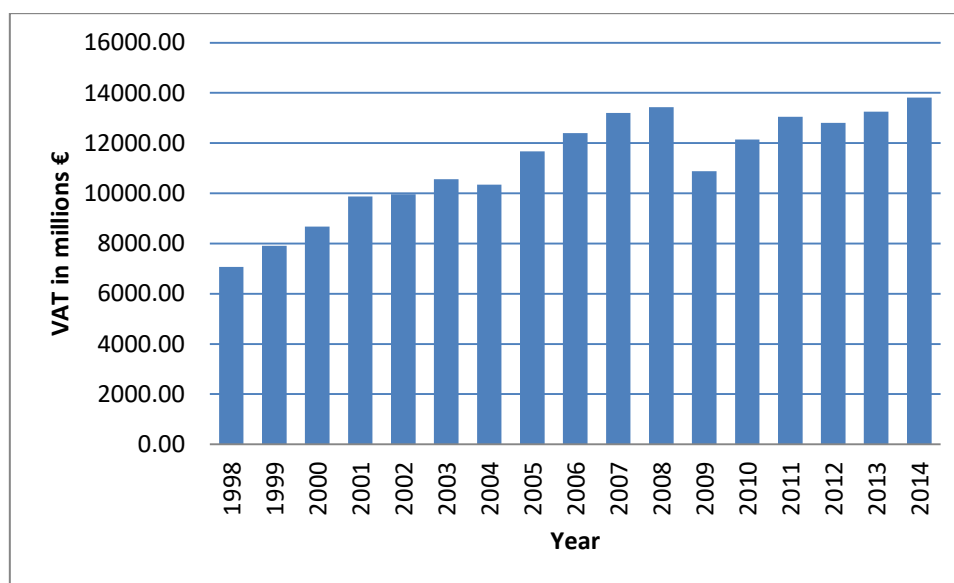
Source of Data: DGO

Table IV - Hypotheses and Explanatory Variables

Hypotheses Variables	Source	Expected sign	Reasons
Hypotheses 1: GDP growth Inflation	Banco de Portugal INE	+	Economic growth is associated with improvement of financial situation
Hypotheses 2: Consumption Consumers' Confidence Index	Banco de Portugal Banco de Portugal	+	VAT is a consumption tax
Hypotheses 3: Unemployment	INE	-	Unemployment decreases families income and their purchasing power
Hypotheses 4: Exports	Banco de Portugal	-	Exports are VAT exempt
Hypotheses 5: Imports	Banco de Portugal	+	Imports are subject to VAT
Hypotheses 6: Public deficit	DGO	+ / -	Increases government needs for revenues Is a result of lower revenues
Hypotheses 7: VAT Reduced Rate VAT Intermediate Rate VAT Standard Rate	European Commission (2015)	+	VAT is taxed through the application of rates

Table V - Table of Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
1st dif sa Monthly VAT Revenues	207	3.3884	18.3193	-74.3583	176.5744
1st dif sa GDP	207	-0.0219	0.1755	-0.3950	0.3794
1st dif sa Monthly Inflation (CPI)	207	0.1498	0.1040	-0.1303	0.3310
1st dif sa Consumption	207	-0.0094	0.2246	-0.5065	0.4853
1st dif sa Consumers' Confidence Index	207	-0.0632	0.8878	-2	2.5
1st dif sa Unemployment	206	0.0332	0.1085	-0.2167	0.2833
1st dif sa Monthly Exports	207	18.1718	32.5432	-94.9585	126.5850
1st dif sa Monthly Imports	207	13.4606	43.9260	-146.5190	147.0234
1st dif sa Monthly Public Deficit	207	-1.0169	72.2371	-353.3583	360.9350
1st dif VAT Reduce Rate	208	0.0048	0.0693	0	1
1st dif VAT Intermediate Rate	208	0.0048	0.0693	0	1
1st dif VAT Standard Rate	208	0.0288	0.2585	-1	2

Source: Stata 13 Output

Notes:
1st dif – first-difference
sa – seasonally adjusted

Table VI - Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) 1st dif sa GDP	1										
(2) 1st dif sa Monthly Inflation (CPI)	-0.4285	1									
(3) 1st dif sa Consumption	0.9231	-0.4961	1								
(4) 1st dif sa Consumers' Confidence Index	0.6383	-0.6045	0.7074	1							
(5) 1st dif sa Unemployment	-0.2206	0.196	-0.3481	-0.404	1						
(6) 1st dif sa Monthly Exports	0.2339	0.36	0.1952	0.0816	-0.2075	1					
(7) 1st dif sa Monthly Imports	0.3692	0.2417	0.37	0.1193	-0.442	0.7572	1				
(8) 1st dif sa Monthly Public Deficit	-0.0361	0.1508	-0.013	0.0371	-0.1139	0.1292	0.0041	1			
(9) 1st dif VAT Reduce Rate	0.1449	-0.0402	0.1352	0.0118	0.0646	0.0713	0.1556	-0.0328	1		
(10) 1st dif VAT Intermediate Rate	0.1449	-0.0402	0.1352	0.0118	0.0646	0.0713	0.1556	-0.0328	1	1	
(11) 1st dif VAT Standard Rate	0.0395	-0.004	0.0119	-0.0867	0.0665	0.0499	0.0685	-0.0287	0.2617	0.2617	1

Source: Stata 13 Output

Table VII - Regression models using Ordinary Least Squares method

	1st dif sa VAT revenues					Lagged 1st dif sa VAT revenues		
Hypotheses 1:								
1st dif sa GDP	24.6032***	13.2013						
	(7.4633)	(11.8194)						
1st dif sa Monthly Inflation (CPI)	28.4801	10.6204	33.4272*	6.2886	16.5672**	37.3102***	37.3102***	36.4106***
	(19.5829)	(27.1071)	(18.5314)	(26.0753)	(8.0726)	(8.5702)	(8.5702)	(8.6445)
Hypotheses 2:								
1st dif sa Consumption			20.7360***					
			(5.5661)					
1st dif sa Consumers' Confidence Index				1.3410				
				(1.7497)				
Hypotheses 3:								
1st dif sa Unemployment					-7.0175	-46.4323***	-46.4323***	-45.5353***
					(8.3022)	(17.1482)	(17.1482)	(17.1535)
Hypotheses 4:								
1st dif sa Exports	-0.0329		-0.0347					
	(0.0502)		(0.0491)					
Hypotheses 5:								
1st dif sa Imports		0.0591		0.0777	0.0488			
		(0.0594)		(0.0472)	(0.0305)			
Hypotheses 6:								
1st dif sa Public Deficit	0.0712***	0.0721***	0.0689***	0.0712***	0.0726***	-0.0551	-0.0551	-0.0554
	(0.0258)	(0.0263)	(0.0263)	(0.0274)	(0.0269)	(0.0387)	(0.0387)	(0.0387)
Hypotheses 7:								
1st dif VAT reduced rate						28.5146***		
						(1.7313)		
1st dif VAT intermediate rate							28.5146***	
							(1.7313)	
1st dif VAT standard rate								2.7245
								(2.8150)
Constant	0.3329	1.3649	-0.7233	1.5579	-0.2954	-0.8691	-0.8691	-0.7046
	(3.5046)	(4.0324)	(3.4182)	(4.1641)	(1.4607)	(2.1153)	(2.1153)	(2.1304)
Durbin Watson Test (Prob > F)	0.6514	0.3985	0.6601	0.4208	0.0811	0.7667	0.7667	0.8308
Portmanteau Test (Prob > χ^2)	0.9970	0.9670	0.9981	0.9662	0.1710	0.9397	0.9397	0.9611
Observations	207	207	207	207	206	206	206	206
R-squared	0.1228	0.1340	0.1253	0.1270	0.2216	0.1244	0.1244	0.1142

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Stata 13 Output

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

	1st dif sa VAT revenues					Lagged 1st dif sa VAT revenues		
Hypotheses 1:								
1st dif sa GDP	25.7157***	20.2720***						
	(5.5951)	(5.7494)						
1st dif sa Monthly Inflation (CPI)	40.3905***	31.5299***	43.6070***	25.4558**	17.4359*	37.4558***	37.4558***	36.4853***
	(9.9620)	(9.4518)	(10.4979)	(10.6510)	(10.1157)	(8.3336)	(8.3336)	(8.5446)
Hypotheses 2:								
1st dif sa Consumption			20.3777***					
			(4.5569)					
1st dif sa Consumers' Confidence Index				2.2340*				
				(1.2001)				
Hypotheses 3:								
1st dif sa Unemployment					-14.5074	-31.3810***	-31.3810***	-30.3757***
					(10.3168)	(7.9977)	(7.9977)	(8.2100)
Hypotheses 4:								
1st dif sa Exports	-0.0165		-0.0139					
	(0.0300)		(0.0300)					
Hypotheses 5:								
1st dif sa Imports		0.0273		0.0574***	0.0495**			
		(0.0220)		(0.0200)	(0.0242)			
Hypotheses 6:								
1st dif sa Public Deficit	0.0708***	0.0702***	0.0682***	0.0679***	0.0579***	-0.0126	-0.0126	-0.0138
	(0.0116)	(0.0115)	(0.0117)	(0.0120)	(0.0113)	(0.0131)	(0.0131)	(0.0133)
Hypotheses 7:								
1st dif VAT reduced rate						32.1092**		
						(13.0126)		
1st dif VAT intermediate rate							32.1092**	
							(13.0126)	
1st dif VAT standard rate								3.1652
								(3.5388)
Constant	-2.5500*	-1.9771	-3.4492**	-1.7614	0.1693	-2.1228	-2.1228	-1.9567
	(1.4730)	(1.4570)	(1.5548)	(1.6536)	(1.6948)	(1.4829)	(1.4829)	(1.5220)
Portmanteau Test (Prob > χ^2)	0.9971	0.9879	0.9973	0.9800	0.2332	0.9287	0.9287	0.9486
Observations	206	206	206	206	205	205	205	205
R-squared	0.2754	0.2836	0.2720	0.2532	0.1934	0.1433	0.1433	0.1178

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Stata 13 Output