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The Greek VAT Gap: The Influence of Individual Economic Sectors

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Abstract

Purpose: *The size of the Greek VAT Gap has been consistently high throughout the last two decades in comparison with the European Union's (EU) average. In order to better understand which specific productive sectors in the Greek economy play a more significant role in VAT revenue collection, VAT evasion and in measuring and limiting the Greek VAT Gap, an attempt to quantify and analyze the Gross Value Added/Gross Domestic Product (GVA/GDP) ratio of each productive sector was made.*
Design/Methodology/Approach: *Specifically, using the NACE Revision 2 standard used by Eurostat, the various Greek productive sectors were broken down into fifteen (15) categories and examined for a period of 21 years (between 1997 and 2018) using econometric models based on time series data. In addition, the VAT Revenue Ratio (VRR) was used as a proxy dependent variable in order to measure the Greek VAT Gap.*
Findings: *The analysis revealed that of the fifteen (15) economic sectors examined in this paper, four (4) were found to be statistically significant in regards with the Greek VAT gap. Specifically, the Catering and Accommodation services sector (I), the Public Administration sector (O) and the Agriculture sector (A), had a positive relationship, with the increase of their share in GDP being associated with an increase in the VAT gap. On the other hand, the Industrial sector's (B, D, E) share of GDP is associated with a reduction in the VAT gap.*
Practical Implications/Originality/Value: *The results of this paper can shed light into the complexity of identifying the economic activities that influence the Greek VAT Gap, as well as produce more sector-specific countermeasures for limiting VAT non-compliance and evasion.*

Keywords: *Value added tax (VAT), VAT gap, VAT revenue ratio (VRR), Gross Value Added / Gross Domestic Product (GVA/GDP), Economic sectors.*

JEL codes: *H26, H83, M41, M42.*
Paper type: *Research Paper*

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1. Introduction

The Greek VAT gap is influenced by several factors, the degree and direction of which may greatly vary. One such prevalent influential factor is the Gross Value Added (GVA); it reflects the new wealth that is created, measured without taxes and taking into account product subsidies as a percentage of the Greek economy's gross domestic product (GDP). Having already investigated the overall influence of the aggregate gross value added to the Greek VAT Gap in a previous paper (Papadakis *et al.*, 2021), it became obvious that a more in-depth investigation of each economic sector and their specific influence on the Greek VAT Gap was needed.

The notion of determining which productive sectors play a larger role in the increase (or decrease) of VAT Gaps is not new; recent international literature includes several productive sectors, such as the construction sector, agriculture sector, catering sector, manufacturing sector, retail sector, real estate sector, etc. However, an in-depth study focusing solely on the structure, particularities and evolution of each productive sector and their relationship with the Greek VAT Gap is still lacking.

For this purpose, a brief but thorough presentation of all productive sectors and their specific activities followed by their existence in international bibliography is given in this paper. It is followed by a description of the structure and evolution of the sectoral composition of the Greek economy for the entire period under investigation (1997-2018).

Afterwards, an econometric model using these productive sectors as the independent variables is constructed in order to determine which sector and to what degree influences the Greek VAT Gap. So as to be able to draw safe conclusions and produce comparative results with the previous paper (Papadakis et al., 2021), it was decided that focusing on the same time period from 1997 to 2018 (21 years in total) and using the same econometric methodology and tools to calculate the Greek VAT Gap; namely the VAT Revenue Ratio (VRR) was most appropriate.

Finally, the paper concludes with the econometric research's findings and the recommendations that stem from them towards battling VAT evasion and non-compliance in the Greek economy.

2. Literature Review

2.1 Sectoral Composition and its Relation to the Research of VAT Gaps

The sectoral composition of production or otherwise productive structure of an economy has been identified as a determining factor in terms of tax compliance both in recent literature (Allognon and Koumpias, 2020; CASE 2018) and in past studies. The main reason for this being that some sectors of the economy are easier to tax than others (Gupta, 2007). Also, according to Remeta, Perret, Jareš, and Brys (2015),

a better understanding of the sectoral distribution of the VAT gap contributes to having more effective audits and tax fraud policies. The question of why different types of businesses should be examined individually in economic models of tax compliance was posed by Cowell (2003), who argued that tax evasion is or should be different depending on the productive sector under consideration, attaching great importance to 'business categorization' as an exploratory tool, considering that it has not been given due importance both bibliographically and at the level of policy-making.

Similarly, Yusof, Ling, and Yap (2014) argued that most tax compliance studies focus on individual behavior instead of corporate tax behavior. Moreover, causes of tax evasion differ between individuals and businesses, with companies responding differently to changes aimed at curbing tax evasion than individuals, thus different tools are needed to reduce tax fraud in each case (Tedds, 2010).

A common point for many scholars regarding the factors that affect the tax compliance of companies, is that companies that rely on cash transactions are more correlated with tax evasion, as cash transactions are difficult to investigate, there is no evidence (Hondroyiannis and Papaoikonomou, 2017; 2018; Immordino and Russo, 2017; Artavanis, Morse, and Tsoutsoura, 2015; Madzharova, 2014; Yusof *et al.*, 2014; Kleven *et al.*, 2011; Morse, Karlinsky, and Bankman, 2009).

In conclusion, the sectoral composition of an economy plays a big role when investigating tax evasion and tax compliance and even more so when investigating the VAT Gap. On this subject, it is of great importance to accurately define and describe the activities included in each productive sector so as to clarify their relation to the VAT Gap. For the purposes of this paper this classification was based on the NACE Revision 2 international standard (in nomenclatures database RAMON) as used by the Eurostat statistics organization, as seen in the following subsections.

2.1.1 Agriculture, Forestry and Fishing

The Agriculture, Forestry and Fishing sectors are grouped and coded on the Eurostat database under item (A), based on the NACE Rev.2 standard and cumulative data are also provided for the three together. This economic sector refers to the exploitation of natural resources, plants and animals and includes (in summary) the breeding and reproduction of animals, plant crops, logging and timber harvesting and fishing.

In international literature, special emphasis has been given to whether or not agriculture and its share of an economy's GDP affects tax evasion and the VAT gap. Such studies include those of the CASE institute (2020), Piancastelli and Thirlwall (2020), Dalamagas, Palaios, and Tantos (2019), Motsatsi (2018), Cnossen (2018), Zidkova (2016), Godin and Hindriks (2015), Thackray και Ueda (2014), Crivelly and Gupta (2014), Betliy (2014), Ufier (2014), Botlhole, Asafu-Adjaye, and Carmignani (2012), Martinez-Vazquez and Bird (2011), Pessino and Fenochietto

(2010), Keen and Lockwood (2010), Aizenman και Jinjirak (2008), Bird, Martinez-Vazquez, and Torgler (2008), Gupta (2007), Bird *et al.* (2004) and Ebrill *et al.* (2001). The results from each of these studies varied greatly, mainly due to the fact that the agricultural sector is hard to tax and most of the studies concern cross-country data.

2.1.2 Mining and Quarrying, Electricity, Gas, Water Supply, Waste Management

The economic sector that includes "mines and quarries", "electricity supply, natural gas supply, etc.", and "water supply - sewage treatment, etc." is coded on the Eurostat database under items (B), (D) and (E), based on the NACE Rev.2 standard and cumulative data are provided for all three together. This productive sector includes the following elements:

- Mines, quarries and the mining industry in general, which includes the extraction of oil and gas, the extraction of ores, minerals, stones, rocks, etc. as well as other mining support activities.
- Units/plants that produce, transmit or distribute electricity, gas, steam, air conditioning and other related resources through permanent infrastructure (network) lines and pipelines.
- Water supply, wastewater treatment and waste management (collection, treatment and disposal) units that handle different waste such as solid or non-solid, industrial or household waste and other related activities.

Relevant recent bibliographic references include those of CASE (2020), Lakuma and Sserunjogi (2018), Motsatsi (2018), Abdixhiku, Krasniqi, Pugh, and Hashi (2017), Gupta (2007), Alm, Martinez-Vazquez, and Schneider (2003) and Eltony (2002). Conclusions between the various researchers vary.

2.1.3 Manufacturing

The manufacturing sector is coded on the Eurostat database under item (C), based on the NACE Rev.2 standard. In summary, this sector includes the transformation of raw materials into new products, except those that are specifically mentioned in other sections.

The manufacturing sector has been examined by both individual researchers and research institutes alike, such as CASE (2020), Piancastelli and Thirlwall (2020), Cevik, Gottschalk, Hutton, Jaramillo, Karnane, and Sow (2019), Motsatsi (2018), Langford and Ohlenburg (2016), Remeta *et al.* (2015), Botlhole *et al.* (2012), Hanlon, Mills, and Slemrod (2007), Gupta (2007), Teera and Hudson (2004), Eltony (2002), Piancastelli (2001) and Stotsky και Woldemariam (1997). The relevant conclusions are mixed.

2.1.4 Construction

The construction sector is coded on the Eurostat database under item (F), based on the NACE Rev.2 standard. It includes general or specialized construction activities,

as well as new works, repairs, additions and modifications or erection of prefabricated buildings or temporary structures.

The construction sector has been studied by the CASE institute (2020; 2018), the study by Transparency International Latvia, Transparency International Finland and BEROC (2017), Reckon (2009) and OECD (2006), while individual researchers include Lukáč και Simonidesová (2020), Combey (2020), Lakuma και Sserunjogi (2018), Luzgina (2017), Zidkova (2016), Hrdlička (2015), Remeta *et al.* (2015), Thackray και Ueda (2014), Yusof *et al.* (2014), Nor, Ahmad, and Saleh (2010). Although not all studies had the exact same findings, the overall results classified the construction sector as one of those with the highest VAT evasion percentage.

2.1.5 Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities

The sector involving 'wholesale and retail trade' and 'transport, accommodation and food service activities' are coded on the Eurostat database under items (G), (H) and (I), based on the NACE Rev.2 standard and cumulative data are provided for all three together. This sector includes activities such as:

- The wholesale and retail sale (without transformation) of any kind of goods as well as the provision of services that are ancillary to the sale of goods. Wholesale and retail trade are the final steps in the distribution of goods. This section also includes the repair of motor vehicles and motorcycles. Also included are brokers, agents, commission agents, assemblers as well as cooperatives involved in the marketing of agricultural products.
- Transport and storage services. Transport services concern passengers or goods in any way (by road, rail, air, water, etc.), as well as postal services and couriers.
- Accommodation services for the stay of visitors and travelers and the provision of meals and beverages for immediate consumption, excluding long-term accommodation in primary residences and food and beverages that are either not suitable for immediate consumption or are sold through wholesale or retail activities.

Relevant studies on this sector have been conducted by the CASE institute (2020; 2018), Fedotov and Nevzorova (2020), Motsatsi (2018), Lakuma και Sserunjogi (2018), Abdihiku *et al.* (2017), Kesar and Čuid (2017), Badariah, Habibullah, Baharom, and Saari (2016), Vladimirov (2015), Šlahor and Barteková (2015), Hrdlička (2015), Alari (2015), Thackray and Ueda (2014), Zidkova (2014), Milic (2014), Botlhole *et al.* (2012), Reckon (2009), Hanlon *et al.* (2007), Christie and Holzner (2006). Due to the fact that this particular sector encompasses a variety of different services and activities the conclusions of previous studies are mixed.

2.1.6. Information and communication services

The Information Technology (IT) and communications sectors are coded on the Eurostat database under item (J) based on the NACE Rev.2 standard. This sector, in summary, includes the following activities:

- Publishing activities of any kind such as printed or online books, magazines, catalogs, brochures or other material, software publishing (games, networks, databases, programming, applications or systems), production, distribution and screening of motion pictures, video and broadcasting programs and their accompanying activities, recordings or music releases as well as the granting of relevant licenses and rights.
- They also include telecommunications of all kinds such as wired, wireless, satellite and teleconferencing, computer programming, web design and multimedia software and other information services such as databases and web portals.

In international literature the IT sector has been investigated by the CASE institute (2020; 2018), Lakuma και Sserunjogi (2018) and Podlipnik (2012). Again, the findings vary depending on the methodology and data available to each researcher.

2.1.7 Financial and insurance activities

The financial and insurance services sectors are coded on the Eurostat database under item (K) based on the NACE Rev.2 standard. This productive sector includes activities related to all types of financial services, insurance and pension fund services, as well as the services of insurance agents, experts and appraisers. Most of the activities in this sector, such as financial, banking, investment and insurance services are exempt from VAT in Greece (and other EU countries) in accordance with the provisions of Directive 2006/112 / EC / 28-11- 2006.

Various scholars such as Rodriguez (2020), Angelov and Nenkova (2019), Hachem (2018), Huizinga (2002) and Levine, Loayza, and Beck (2000) have investigated this sector. For this sector results vary depending on the degree of the sector's involvement in the shadow economy, as well as depending on the kind of taxation being examined (e.g. income tax, direct tax).

2.1.8 Real estate activities

The real estate management sector is coded on the Eurostat database under point (L), based on the NACE Rev.2 standard. The activities of this sector revolve around the purchase and sale of real estate, the rental and management of privately owned or leased real estate, the time leasing of real estate, the services of concession of use of facilities, the real estate agencies as well as other related services.

The real estate sector has been studied by the CASE institute (2020, 2018), Alognon *et al.* (2020), Fedotov and Nevzorova (2020), Abdihiku *et al.* (2017), Yusof *et al.* (2014), OECD (2006). Results vary between studies due to different degrees of laws

and regulations as well as controlling and auditing the activities of the real estate sector.

2.1.9. Professional, scientific and technical activities; administrative and support service activities – Administrative and support services

The 'professional, technical and scientific services' and 'administrative and support activities' sectors are coded on the Eurostat database under items (M) and (N) respectively, according to the NACE Rev.2 standard. This sector includes activities such as legal, veterinary, accounting, management consulting, advertising, market research, polling, public relations and communications, business consulting, organization, quality certification, design, decorator, costume designer, architect, engineer, scientific research and development, chemist, biologist, mechanical engineer, electrician, designer, photographic activity, translation, interpreter and other related activities.

Administrative and support activities include travel agency services, rental and leasing of personal or household goods, rental and leasing of machinery, rental of videotapes, equipment and supplies, staffing, private security and research activities, cleaning, seminar arrangements and other related activities.

Previous literature on this sector includes Piancastelli and Thirlwall (2020), Cevik *et al.* (2019), Artavanis *et al.* (2015), Šlahor και Barteková (2015), Hrdlička (2015), Yusof *et al.* (2014), Thackray and Ueda (2014) and Chan and Mo (2000). The conclusions drawn from previous studies seem to converge on the sector being prone to VAT evasion and non-compliance.

2.1.10 Public administration, public defense, education, human health and social work activities

'Public administration, public defense and compulsory social security', 'health and social services' and 'education' are grouped and codified on the Eurostat database under items O, P and Q respectively (NACE Rev.2) and provide aggregate data and for the three together.

Public administration, defense and compulsory social security centers around activities of a governmental nature, carried out by the public administration, such as the interpretation of laws, legislative activities, taxation, national defense, public order and security, services immigration, foreign affairs and the management of government programs. The classification of said activities concerns their nature without those of a public nature falling a priori into this section. For example, while the administration of the educational system is included here, 'teaching' is included in the unit of education. Similarly, some of the activities described in this section may be carried out by non-governmental entities.

Education is both public and private, of any degree or form, whether oral or written, provided by radio, television, internet or mail, including all levels and educational

institutions, such as sports, cultural education, driving schools, seminars and tutoring.

Health and social services include a wide range of health and social care activities such as all kinds of medical and dental services, hospital services, physiotherapy services, diagnostic centers, alternative therapies, all kinds of social care or welfare activities, with or without accommodation.

The 'public administration, defense and compulsory social security' and 'health - social services' sectors are exempt from VAT in Greece.

In more recent years, this sector has been investigated by Cevik *et al.* (2019) and Artavanis *et al.* (2015). Older studies include those of Siskou, Kaitelidou, Economou, Kostagiolas and Liaropoulos (2009), Matsaganis, Mitrakos, and Tsakloglou (2008), Liaropoulos, Siskou, Kaitelidou, Theodorou and Katostaras (2008), Hanlon *et al.* (2007), Mossialos, Allin, and Davaki (2005) and Kornai (2000). Overall, the results vary depending on the degree of involvement with the shadow economy with the particular characteristics of each economy playing a large role in it.

2.1.11 Arts, entertainment and recreation; other service activities; activities of household as employers and extra-territorial organizations and bodies

The productive sectors involving 'arts - entertainment and recreation', 'other service activities', 'household activities as employers' and 'activities of external organizations and bodies' are coded on the Eurostat database under items R, S, T and U respectively (NACE Rev.2 standard) and cumulative data are provided for all four together.

'Arts - entertainment and recreation' includes activities such as the performing arts and activities by writers, composers, sculptors and their supporting activities, the use of theater halls, library, archives, museums and other cultural activities, museums, sites or other similar attractions, botanical and zoological activities and natural habitats, gambling and betting, sports and leisure activities, sports services, entertainment and leisure activities (playgrounds, amusement parks, amusement parks, water games, ski resorts) and other related activities.

'Other service activities' include activities such as repairing computers and personal or household goods, repairing communication equipment, repairing footwear, clothing and leather goods, repairing watches, jewelry, furniture and household furniture, hairdressing salons, dry cleaners.

In recent international literature this sector has been studied by the CASE institute (2020; 2018), Alognon *et al.* (2020), Lakuma και Sserunjogi (2018), Korver (2018). Most of the studies conclude that a high degree of non-compliance and VAT evasion is present in this sector.

2.2 Composition of the Productive Sectors in the Greek Economy, 1997–2018

This section focuses on the particular characteristics of the Greek economy and the composition of each productive sector. While Eurostat decomposes all basic economic activities into eleven (11) sectors, as shown in the previous segment, for the purposes of this paper, some sectors were expanded into their individual 'items' in order to better determine their impact on the Greek VAT Gap.

The result was the 'construction' of fifteen (15) sectors in total. Specifically, given the particularities of the Greek economy and since there are detailed data on the Eurostat database; two sector categories were broken down in sub-sectors for a total of 15 different (independent) economic sectors. This analysis was performed in the following cases:

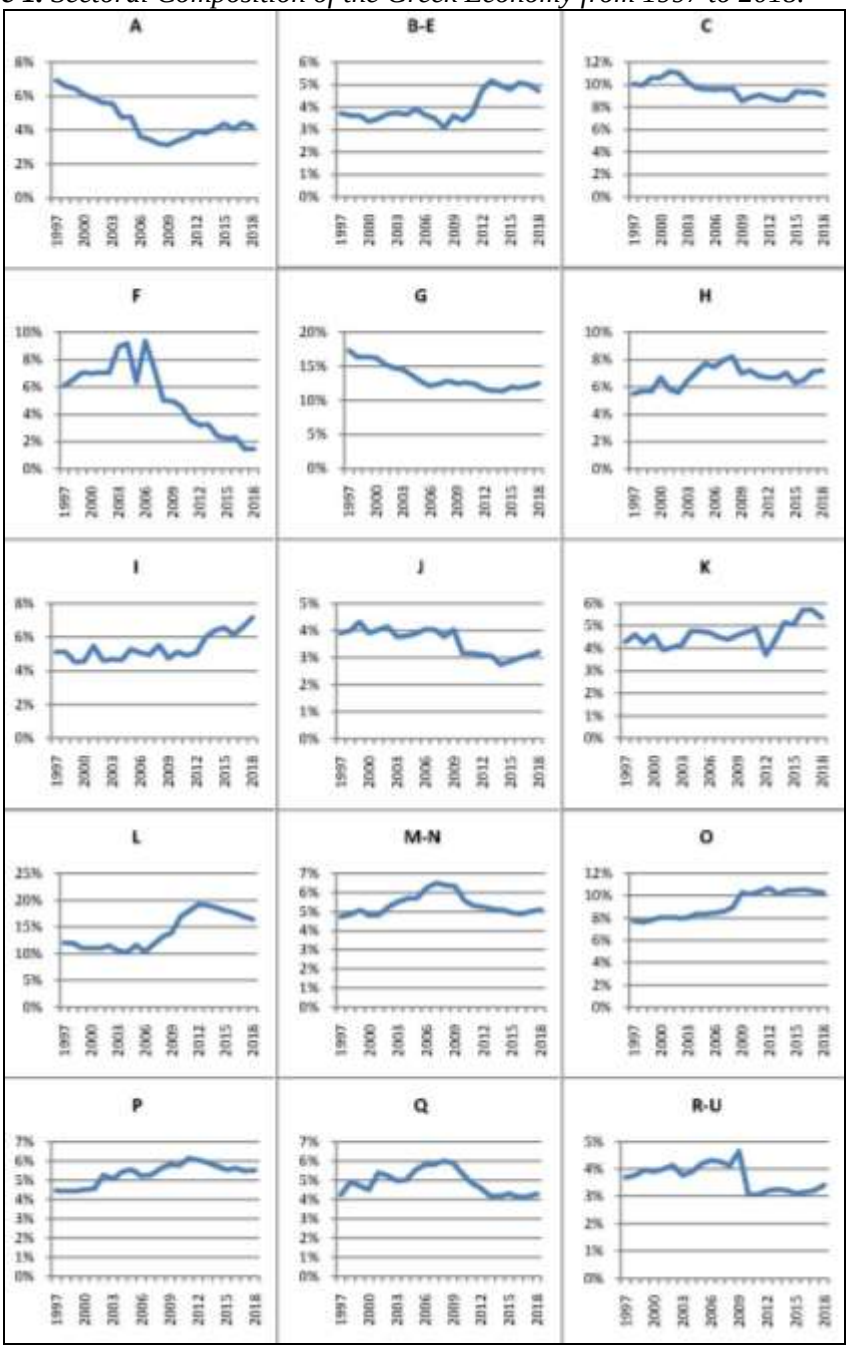
a. The 'Wholesale and retail trade, transport, accommodation and food service activities' sector (denoted as items G - I in the NACE classification), where each sub-sector was broken down into a separate sector. This sector was chosen due to the heterogeneity of the three sub-sectors and the distinct importance of each one in the Greek economy. For example, when considering the 'accommodation and food service activities' sector, about half of the total prudential audits that are carried out annually by the Greek tax authorities concern this sector. It is also noted that the non-compliance of the Catering - Accommodation industries remains high throughout the investigated period despite the ongoing inspections.
b. The 'Public administration, defense, education, human health and social work activities' sectors (denoted as items O – Q in the NACE classification), where each sub-sector was broken down into a separate sector. We were led to this choice again due to the heterogeneity of the three individual sectors and the fact that each of them is differentiated by contrasting characteristics.

It is also important to take into account the changes between the shares of each productive sector during the 1997-2018 period. In the beginning of the 90's the Greek economy is more focused on the Agriculture, Manufacturing, Wholesale & Retail trade and Information and Communication services sectors, while from the 00's to the beginning of the 2008 financial crisis the most well-developed sectors include Manufacturing, Construction, Transport services, Administrative and support services and Public administration, Public defense and Social Insurance services.

After the end of the crisis the Greek economy turned more towards the Mining, Electricity & Gas, Manufacturing, Financial services, Real estate services and Public administration sectors. A more detailed representation of the sectoral composition of the Greek productive activity can be seen in the following figure (Figure 1) for the

entire period between 1997 till 2018. Table 1 shows the percentage of total economic activity in Greece's gross domestic product.

Figure 1. *Sectoral Composition of the Greek Economy from 1997 to 2018.*



Source: *Own study.*

Table 1. *Sectoral Composition of the Greek Productive Activity*

A.A.	SECTORS	NACE Rev. 2 CATEGORIZATION	PERCENTAGE OF SECTOR IN GDP (1997-2018 AVERAGE)
1	Agriculture, forestry and fishing	A	**4,62%**
2	Mining and Quarrying, Electricity, Gas, Water Supply, Waste Management	B,D,E	**4,01%**
3	Manufacturing	C	**9,61%**
4	Construction	F	**5,29%**
5a	Wholesale and retail trade	G	**13,43%**
5b	Transport services	H	**6,75%**
5c	Accommodation and food service activities	I	**5,37%**
6	Information and communication services	J	**3,59%**
7	Financial and insurance activities	K	**4,64%**
8	Real estate activities	L	**14,16%**
9	Professional, scientific and technical activities; administrative and support service activities – Administrative and support services	M,N	**5,38%**
10a	Public administration, public defense and compulsory social security	O	**9,18%**
10b	Health and social services	P	**5,34%**
10c	Education	Q	**4,92%**
11	Arts, entertainment and recreation; other service activities; activities of household as employers and extra-territorial organizations and bodies	R,S,T,U	**3,70%**

Source: *Authors' calculations, primary data from Eurostat.*

From the Table presented above, it appears that the 'Real Estate' and 'Wholesale and Retail Trade' sectors are the ones that have the highest averages with percentages of 14.6% and 13.43% of the Greek economy's production respectively. From these evidence the weight and importance of these specific sectors in the Greek economy is demonstrated. Furthermore, the share of the 'Manufacturing' and 'Public administration, public defense and compulsory social security' sectors is large

throughout the twenty two (22) years period with an average of 9.61% and 9.18% respectively.

On the other hand, the two sectors that appear to hold the least influence throughout the 22-year period under investigation are the 'Arts, entertainment and recreation; other service activities; activities of household as employers and extra-territorial organizations and bodies' and 'Information and communication services' sectors, whose averages are 3.7% and 3.59% respectively.

3. Econometric Investigation of the Relationship Between the Greek VAT Gap and the Productive Sectors of the Greek Economy

First, we specify the followed econometric model, the variables that are examined and the basic statistical data of the explanatory variables of the model. Next, we run the preliminary statistical tests on the existence or not of stationarity and multicollinearity. Then, tests for autocorrelation, heteroskedasticity and normal distribution of residues follow and the evaluation of the model and the results of the regression are presented. Finally, the final results are determined and in particular what are the important explanatory variables, the direction of their influence and their effect on the dependent variable.

3.1 Specification of the Model

For the purpose of this research, an econometric model was used in which the relation between the various sectors of the Greek Economy with the VAT gap is examined. In particular, as far as the sectors are concerned in their role as explanatory variables, the share of the added value of each one in the total added value of the economy is taken into account.

The main tool used to determine the relationship between these variables and the VAT Gap was the VAT Revenue Ratio (VRR), which is the dependent variable of the specified Model and its values have already been calculated (Papadakis *et al.*, 2021). The period under investigation is from 1997 to 2018, covering a period of twenty-two (22) years, while least squares techniques as well as appropriate econometric and statistical tests were used to confirm our results.

The sectors of the Greek Economy are categorized according to the NACE Rev. 2 standard, that is followed by Eurostat, from which the relevant data were derived (Eurostat). In the followed standard, eleven (11) branches are monitored. After the analysis of specific sectors into their individual items, as mentioned in section 1.2, it was decided that fifteen explanatory variables will be examined. They are presented in Table 2 below.

Table 2. *Explanatory Variables for the Sector Model*

Variable – Greek Economy Industry	**Symbolism in the Model**	**Data source and completeness**
Agriculture, forestry and fishing	**A**	Eurostat database – Full Data
Mining and quarrying, Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities	**BE**	Eurostat database – Full Data
Manufacturing	**C**	Eurostat database – Full Data
Construction	**F**	Eurostat database – Full Data
Wholesale and retail trade; repair of motor vehicles and motorcycles	**G**	Eurostat database – Full Data
Transporting and storage	**H**	Eurostat database – Full Data
Accommodation and food service activities	**I**	Eurostat database – Full Data
Information and communication	**J**	Eurostat database – Full Data
Financial and insurance activities	**K**	Eurostat database – Full Data
Real estate activities	**L**	Eurostat database – Full Data
Professional, scientific and technical activities Administrative and support service activities	**MN**	Eurostat database – Full Data
Public administration and defense; compulsory social security	**O**	Eurostat database – Full Data
Education	**P**	Eurostat database – Full Data
Human health and social work activities	**Q**	Eurostat database – Full Data
Arts, entertainment and recreation Other services activities Activities of households as employers; undifferentiated goods - and services - producing activities of households for own use Activities of extraterritorial organisations and bodies	**RU**	Eurostat database – Full Data

Source: *Authors' calculations*

A first algebraic approach of a model takes the form of a Multiple Linear Regression (MLR), given by Equation 1, where Y_t is the dependent variable (the VRR), X_t are the explanatory variables (the 15 economic sectors presented in Table 2), b_0 is the constant term and b_i is the coefficient of each independent variable.

$Y_t = b_0 + \sum_{i=1}^{k} b_i * X_t$	Equation 1

The model of Equation 1 will be acceptable provided that the Gauss-Markov assumptions are met. The available data cover a time period of 22 years (a relatively small sample) and so a Generalized Least Squares (GLS) regression will have no advantage over an Ordinary Least Squares (OLS) regression as a method of estimation (Baltagi, 2008). Table 3 below presents the summary statistics of the explanatory variables of the model. The data-set is complete for all 22 years.

Table 3. *Summary Statistics of the Variables, use of observations from 1997 to 2018*

Variable	**Mean**	**Median**	**Minimum**	**Maximum**	**Std. Deviation**	**Coefficient of Variation (CV)**
VRR	0,43177	0,43616	0,36509	0,52133	0,042019	0,097319
A	0,046231	0,043013	0,031370	0,069220	0,011845	0,25620
BE	0,040126	0,037074	0,030858	0,051759	0,0066518	0,16577
C	0,096089	0,095563	0,085439	0,11166	0,0076106	0,079204
F	0,052928	0,055583	0,014572	0,093686	0,025183	0,47579
G	0,13430	0,12573	0,11389	0,17377	0,018528	0,13796
H	0,067510	0,067581	0,055078	0,082402	0,0076248	0,11294
I	0,053731	0,051072	0,045159	0,071619	0,0076602	0,14257
J	0,035858	0,037836	0,027484	0,043097	0,0049176	0,13714
K	0,046437	0,046065	0,037153	0,057143	0,0052089	0,11217
L	0,14165	0,12661	0,10280	0,19248	0,033323	0,23525
MN	0,053757	0,051896	0,047415	0,064994	0,0055226	0,10273
O	0,091787	0,087680	0,076121	0,10695	0,011626	0,12666
P	0,053422	0,055095	0,044481	0,061434	0,0053879	0,10086
Q	0,049164	0,048867	0,041341	0,060055	0,0063529	0,12922
RU	0,037017	0,037685	0,030604	0,046462	0,0048363	0,13065
Variable	**Skewness**	**Kurtosis - 3**	**5% Percentage**	**95% Percentage**	**IQ Range**	**Missing Obs.**
VRR	0,10381	-0,73356	0,36607	0,51614	0,073117	0
A	0,55992	-0,99115	0,031430	0,068718	0,020570	0
BE	0,64102	-1,1759	0,031261	0,051626	0,011681	0
C	0,53217	-0,58279	0,085528	0,11145	0,010765	0
F	-0,022971	-1,1944	0,014572	0,093414	0,040669	0
G	0,83302	-0,71378	0,11396	0,17230	0,028792	0
H	-0,0059503	-0,68816	0,055227	0,081969	0,010017	0

I	0,88410	-0,37266	0,045254	0,070783	0,013048	0
J	-0,30523	-1,4730	0,027639	0,042834	0,0093124	0
K	0,44582	-0,19465	0,037468	0,057117	0,0062420	0
L	0,30614	-1,6185	0,10297	0,19214	0,067042	0
MN	0,86828	-0,51015	0,047520	0,064820	0,0076564	0
O	0,054308	-1,7772	0,076341	0,10676	0,023232	0
P	-0,54226	-0,86913	0,044494	0,061312	0,0079819	0
Q	0,30199	-1,2509	0,041385	0,059897	0,011452	0
RU	0,11714	-1,2306	0,030624	0,045970	0,0091763	0

Source: *Authors's calculations.*

3.1.1 Data Availability

Raw data regarding all fifteen of the independent variables were obtained from Eurostat's General Government Surveys (data accessed on August 04, 2020), collected on an annual basis from 1997 to 2018.

The quantification of the VRR for all 22 years is based on Keen's methodology (Keen, 2013) and was computed according to the calculations of the author's previous paper (Papadakis et al., 2021) with raw data collected from the TAXUD reports and Main National Accounts Tax Aggregates (denoted as gov_10a_taxag) from the Eurostat database. The standard VAT rates were taken from the European Commission's 'VAT rates applied in the Member States of the European Union' (European Commission, 2020).

3.2 Preliminary Statistics Tests

Before the results of the model are presented, several diagnostic tests were conducted. Table 4 shows a test for stationarity. The output of the unit root test in Table 4 indicates that the explanatory variables are not stationary and that could result in spurious regression.

Table 4. *Stationarity Test for the model of Equation 1*

Group unit root test: Summary				
Series: A, B_E, C, F, G, H, I, J, K, L, M_N, O, P, Q, R_U, VRR				
Sample: 1997 - 2018				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0 to 2				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	*Statistic*	*Prob.***	*Cross-*	*Obs*

			sections	
Null: Unit root (assumes common unit root process)				
*Levin, Lin & Chu t**	*0.16163*	*0.5642*	*16*	*332*
Null: Unit root (assumes individual unit root process)				
ADF - Fisher chi-square	*17.4632*	*0.9827*	*16*	*332*
PP - Fisher chi-square	*25.8777*	*0.7690*	*16*	*336*
Source: Writer's calculations				
*** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.*				

Source: *Own study.*

To solve this problem the differences of the logarithms of the variables were examined. This operation transformed every variable (dependent and independent) in the model of Equation 1 into a logarithmic difference of said variable, as seen in Equation 2. Henceforth, all symbols regarding the model's variables are denoted with an 'LD_' prefix that indicates the Logarithmic Difference of said variable.

$$\mathrm{dlog(var)} = \log\left(\frac{\mathrm{var}_t}{\mathrm{var}_{t-1}}\right) = \log(\mathrm{var}_t) - \log(\mathrm{var}_{t-1}) \qquad \text{Equation 2}$$

Thus, by applying Equation 2 to Equation 1, the MLR model can be rewritten, using the symbols used above, where Yt is the dependent variable (VRR) and Xi,t is each of the explanatory variables (i) at the unit of time (t). The constant term is denoted as b_0 and the coefficient of each explanatory variable as b_i. This is a model of change in VRR as a function of change in the explanatory variables (Equation 3).

$$\log\left(\frac{Y_t}{Y_{t-1}}\right) = b_0 + \sum_{i=1}^{k} b_i * \log\left(\frac{X_{i,t}}{X_{i,t-1}}\right) \qquad \text{Equation 3}$$

A stationarity test is conducted again for the transformed (logarithmic) model of Equation 3. The following output (Table 5) shows that the stationarity problem has been addressed. Another advantage of the logarithmic transformation is the evening-out of the units of measure involved. The explanatory variables and the dependent variable (VRR) are now expressed as dimensionless numbers, equivalent to percentage changes.

Table 5. *Stationarity test for the transformed logarithmic model of Equation 3.*

Group unit root test: Summary				
Series: LD_A, LD_BE, LD_C, LD_F, LD_G, LD_H, LD_I, LD_J, LD_K, LD_L, LD_MN, LD_O, LD_P, LD_Q, LD_RU, LD_VRR				
Sample: 1997 - 2018				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0 to 3				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-8.46214	0.0000	16	314
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.14227	0.0000	16	314
ADF - Fisher chi-square	114.909	0.0000	16	314
PP - Fisher chi-square	132.975	0.0000	16	320
Source: Writer's calculations				
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

The model of Equation 3 can be easily converted to give a VRR 'prediction formula', as illustrated in Equation 4.

$$Y_t = Y_{t-1} * e^{b_0} * \prod_{i=1}^{k} \left(\frac{X_t}{X_{t-1}} \right)^{b_i} \qquad \text{Equation 4}$$

Despite the fact that the stationarity problem was solved with the logarithmic transformation of the model, the correlation matrix (Table 6) shows that there exists multicollinearity between the explanatory variables.

Table 6. *Correlation Matrix*

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) ld_VRR	1.000															
(2) ld_A	-0.117	1.000														

(3) ld_BE	-0.306	0.342	1.000													
(4) ld_C	0.631	0.204	-0.374	1.000												
(5) ld_F	0.143	-0.570	0.011	-0.171	1.000											
(6) ld_G	0.200	0.296	-0.497	0.355	-0.308	1.000										
(7) ld_H	0.036	-0.061	-0.418	-0.148	-0.160	0.092	1.000									
(8) ld_I	0.004	0.214	-0.202	0.205	-0.331	0.038	0.189	1.000								
(9) ld_J	-0.018	-0.280	0.318	-0.062	0.133	-0.200	-0.437	-0.348	1.000							
(10) ld_K	-0.065	-0.201	-0.274	-0.258	0.032	0.048	0.330	-0.089	-0.196	1.000						
(11) ld_L	-0.110	0.355	0.103	0.052	-0.563	0.090	-0.018	0.157	-0.442	-0.136	1.000					
(12) ld_MN	0.096	-0.520	-0.015	-0.233	0.350	-0.281	0.011	-0.378	0.602	-0.122	-0.558	1.000				
(13) ld_O	-0.535	-0.099	0.213	-0.406	-0.030	-0.056	-0.284	-0.484	0.144	-0.045	0.086	-0.021	1.000			
(14) ld_P	-0.011	-0.119	0.155	-0.172	-0.201	-0.132	-0.104	-0.403	0.159	0.100	0.368	0.072	0.261	1.000		
(15) ld_Q	0.089	-0.277	-0.243	0.144	-0.003	-0.311	-0.179	0.303	0.375	-0.224	-0.135	0.334	-0.072	-0.076	1.000	
(16) ld_RU	-0.199	-0.273	0.359	-0.308	0.011	-0.318	-0.224	-0.232	0.851	-0.108	-0.438	0.593	0.295	0.186	0.345	1.000

Source: *Own study.*

Further tests for multicollinearity were taken using the Variance Inflation Factor (VIF) as seen in Table 7 below, so as to distinguish and remove the explanatory variables that may create problems. A VIF value that exceeds 10 would indicate a problematic amount of collinearity (Gareth *et al.*, 2014). The results show high multicollinearity for two specific sectors, i.e., the 'Mining and quarrying, Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities' sector and the 'Information and communication services' sector (denoted as variables LD_BE and LD_J). This result is consistent with previous international literature and both sectors are often found as not statistically important (CASE (2020), Abdixhiku, Krasniqi, Pugh, and Hashi (2017)), therefore excluding them from the model does not cause significant problems for the purposes of this paper.

Table 7. *Multicollinearity test-Variance Inflation Factors (VIF) – 15 Variables.*

Minimum possible value = 1.0	
Values > 10.0 may indicate a collinearity problem	
ld_A	10,991
ld_BE	25,237

ld_C	4,991
ld_F	9,811
ld_G	9,472
ld_H	4,080
ld_I	8,592
ld_J	14,528
ld_K	3,344
ld_L	8,181
ld_MN	7,023
ld_O	6,092
ld_P	2,253
ld_Q	9,137
ld_RU	11,145

Source: *Authors' calculations.*

In order to deal with the multicollinearity problem that has arisen, variables ld_BE and ld_J, are removed. The VIF test is repeated in Table 8 without the two variables.

Table 8. *Multicollinearity test-Variance Inflation Factors (VIF) – 13 Variables.*

Minimum possible value = 1.0	
Values > 10.0 may indicate a collinearity problem	
ld_A	4,349
ld_C	3,652
ld_F	8,308
ld_G	1,743
ld_H	2,002
ld_I	5,593
ld_K	2,669
ld_L	6,435
ld_MN	6,317
ld_O	3,940
ld_P	2,126
ld_Q	2,359

ld_RU	4,339

Source: *Authors' calculations.*

From the results shown on Table 8 there no longer seems to be a problem of multilinearity and therefore the estimation of the model can proceed with the method of Ordinary Least Squares (OLS) using thirteen (13) explanatory variables.

3.3 Model Estimation

The regression results are given below in Table 9, forming a first estimate of the model, referred to as Model K1. The statistically significant variables are marked with one or more asterisks (*) the higher the significance they hold.

Table 9. *Model K1 – OLS estimation results, Use of observations 1998-2018 (T = 21)*

Dependent variable: ld_VRR					
HAC standard errors, bandwidth 2 (Bartlett kernel)					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**p- value**	
const	0,0193731	0,0118721	1,632	0,1467	
ld_A	−0,0856133	0,180595	−0,4741	0,6499	
ld_C	0,729898	0,226431	3,223	0,0146	**
ld_F	0,0563630	0,0851667	0,6618	0,5293	
ld_G	0,210217	0,241106	0,8719	0,4122	
ld_H	0,0600292	0,102458	0,5859	0,5763	
ld_I	−0,133225	0,193220	−0,6895	0,5127	
ld_K	−0,00961371	0,0828942	−0,1160	0,9109	
ld_L	0,0390414	0,150360	0,2597	0,8026	
ld_MN	0,0147903	0,420081	0,03521	0,9729	
ld_O	−0,728556	0,460044	−1,584	0,1573	
ld_P	0,185660	0,213982	0,8676	0,4143	
ld_Q	0,0478531	0,132353	0,3616	0,7284	
ld_RU	0,0238781	0,0800621	0,2982	0,7742	
Mean dependent var		0,001771	**S. D. dependent var**	0,061144	
Sum squared residuals		0,026926	**S. E. of regression**	0,062021	
R-squared		0,639888	**Adjusted R-squared**	-0,028890	
F(13, 7)		52,38532	**Prob(F-statistic)**	0,000011	

Log likelihood	40,12373	**Akaike criterion**	−52,24746
Schwarz criterion	−37,62414	**Hannan-Quinn crit.**	−49,07382
Correlation Coefficient (ρ)	−0,312101	**Durbin-Watson stat.**	2,527413

Source: *Authors' calculations.*

The results from the first estimation of the model indicate that the Industry sector (denoted as LD_ C) is statistically important. Before eliminating the less important variables and re-running the estimation, autocorrelation and heteroskedasticity tests are performed to confirm that the requirements for the use of OLS are met. The results of the tests are shown in Table 10 below.

Table 10. *Autocorrelation and Heteroskedasticity tests on the K1 model.*

Breusch-Pagan Test for Heteroskedasticity
Null Hypothesis: No Heteroskedasticity
Control statistics: LM = 5,56621
with p-value = P (chi-square (13)> 5.56621) = 0.960528
Residuals Normality Test
Null Hypothesis: errors are distributed normally
Control statistics: chi-sq. (2) = 1.8733
with p-value = 0.391938
LM control for autocorrelation up to order 5
Null Hypothesis: No Autocorrelation
Control statistics: LMF = 0,412172
With p-value = P(F(5, 2) > 0,412172) = 0,816525

Source: *Authors' calculations.*

Since the test results presented in Table 10 imply neither autocorrelation nor heteroskedasticity between normally distributed residuals we can continue using the OLS estimation method. Moreover, taking into account that the sample size is small, the OLS estimation method is preferred over the GLS method (Rao and Griliches, 1969). After a sequential deletion of variables using bilateral p-value 0.10, where in each step the less significant variable is left out until the remaining are all significant is performed (Table 11), the following model, denoted as K2, is obtained (Table 12). The statistically significant variables are marked with one or more asterisks (*) the higher the significance they hold.

Table 11. *Sequential deletion using bilateral alpha = 0.10*

Ignore ld_MN (p-value 0.973)
Ignore ld_K (p-value 0,886)

Ignore ld_L (p-value 0,785)
Ignore ld_RU (p-value 0,827)
Ignore ld_Q (p-value 0,685)
Ignore ld_H (p-value 0,719)
Ignore ld_F (p-value 0,565)
Ignore ld_P (p-value 0,578)
Ignore ld_G (p-value 0,628)
Test in Model K1:
Null hypothesis: the regression parameters are zero for the variables ld_F, ld_G, ld_H, ld_K, ld_L, ld_MN, ld_P, ld_Q, ld_RU
Control statistics: Reliable F (9, 7) = 0.802811, p-value 0.629256
The omission of variables improved 3 out of 3 information criteria.
Source: Writer's calculations

Source: *Authors' calculations.*

Table 12. *Model K2 – OLS estimation results, Use of observations 1998-2018 (T = 21)*

Dependent variable: ld_VRR					
HAC standard errors, bandwidth 2 (Bartlett kernel)					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**p-value**	
const	0,0156006	0,00883299	1766	0,0964	*
ld_A	−0,147707	0,0822061	−1,797	0,0913	*
ld_C	0,723623	0,112541	6430	<0,0001	***
ld_I	−0,187389	0,0853671	−2,195	0,0433	**
ld_O	−0,792650	0,216509	−3,661	0,0021	***
Mean dependent var		0,001771	**S. D. dependent var**	0,061144	
Sum squared residuals		0,028371	**S. E. of regression**	0,042109	
R-squared		0,620565	**Adjusted R-squared**	0,525707	
F(13, 7)		19,32487	**Prob(F-statistic)**	5,71e-06	
Log likelihood		39,57491	**Akaike criterion**	−69,14983	
Schwarz criterion		−63,92722	**Hannan-Quinn crit.**	−68,01639	
Corr. Coefficient (ρ)		−0,296834	**Durbin-Watson stat.**	2,436865	

Source: *Authors' calculations.*

Now, the estimation's results give five (including the constant term) statistically important variables. It can be seen that the statistical importance of the Industry sector (LD_C) still holds and is improved and that three more variables (LD_A, LD_I and LD_O) also present significant statistical importance in the model, as

indicated above. The tests for autocorrelation and heteroskedasticity are repeated to make sure that the residuals are still normally distributed (Tables 13 and 14).

Table 13. *Autocorrelation and Heteroskedasticity tests on the K2 model.*

White Heteroskedasticity Test
Null Hypothesis: No Heteroskedasticity
Control Statistic: LM = 11,1524
With p-value = P(chi-square (14) > 11,1524) = 0,674025
Breusch-Pagan Heteroskedasticity Test
Null Hypothesis: No Heteroskedasticity
Control Statistic: LM = 0,977796
With p-value = P(chi-square (4) > 0,977796) = 0,913144
Residuals Normality Test
Null Hypothesis: errors are distributed normally
Control Statistics: Chi-Square (2) = 0,818274
With p-value = 0,664223
LM Autocorrelation Test up to order 11
Null Hypothesis: No autocorrelation
Control Statistic: LMF = 1,34554
With p-value = P(F(11, 5) > 1,34554) = 0,392733

Source: *Authors' calculations.*

Table 14. *Variance Inflation Factors (VIF) Test and Belsley-Kuh-Welsch collinearity diagnostics on K2 Model.*

Minimum possible value = 1.0						
Values > 10.0 may indicate a collinearity problem						
ld_A	1.084					
ld_C	1.238					
ld_I	1.357					
ld_O	1.507					
VIF (j) = 1 / (1 - R (j) ^ 2), where R (j) is the multiple correlation coefficient between the variable j and all other independent variables						
Belsley-Kuh-Welsch collinearity diagnostics						
Variance Ratios						
lambda	**cond**	**const**	**ld_A**	**ld_C**	**ld_I**	**ld_O**
2.214	1.000	0.014	0.072	0.037	0.058	0.055
1.316	1.297	0.221	0.014	0.177	0.011	0.039

0.762	1.705	0.125	0.408	0.339	0.023	0.021
0.503	2.098	0.021	0.489	0.447	0.098	0.201
0.205	3.289	0.620	0.017	0.001	0.810	0.683
lambda = eigenvalues of inverse covariance matrix (smallest is 0,204683)						
cond= condition index						
Note: the variance ratio columns add up to 1.0						
According to BKW, cond >= 30 indicates "strong" near linear dependence, and cond between 10 and 30 "moderately strong". Parameter estimates whose variance is mostly associated with problematic cond values may themselves be considered problematic.						
Count of condition indices >= 30: 0						
Count of condition indices >= 10: 0						
No evidence of excessive collinearity						

Source: *Authors' calculations.*

From the above tests it can be seen that there is no problem of multicollinearity, heteroskedasticity or autocorrelation and that the errors are normally distributed.

Furthermore, separate attempts were made to add each discarded variable that was not considered significant back into the model. The findings showed that there is no improvement in criteria, no other variables came back as significant and in conclusion the results derived from model K2 did not change.

3.4 Model Results

From the results of K2 Model it is found that the change of VRR is positively correlated with the change of the relative size of the Manufacturing sector (C) and negatively with the change of the relative size of the Agriculture (A), Accommodation & Food Services (I) and Public Administration, Public Defense & Social Security (O) sectors. The fitted equation of Model K2 is the following:

^ld_VRR = 0,0156 + 0,724*ld_C - 0,793*ld_O - 0,187*ld_I - 0,148*ld_A (0,0088) (0,112) (0,216) (0,085) (0,082) T = 21, R-Squared = 0,621 (Std. Errors are between brackets)	Equation 5

The final formulation of this model can serve two purposes. Firstly, it can explain which variables stand out and have a significant impact on VRR, as well as the magnitude and direction of their impact. Secondly, it can also serve as a forecasting

tool that can be used to formulate policy proposals. For example, we see that a 1% increase in the manufacturing sector (C) to GDP will lead to an increase (ceteris paribus) in VRR of 0.724%. The corresponding forecasts for the percentage impact on VRR due to an equal variable change (1%), as well as their relationship to the Greek VAT Gap, are summarized in Table 15 below. It must be noted that the VAT Revenue Ratio (VRR) changes reversely to the VAT Gap (Papadakis et al., 2021, Keen, 2013) and therefore all positive changes of the VRR are negative changes for the VAT Gap and vice versa.

Table 15. *Summary of predicted VRR changes in the K2 model.*

Variable	**Relationship with the VAT Gap**	**Change of variable (%)**	**Resulting change of VRR (c.p.) (%)**
Manufacturing (C)	Negative	1	0.724
Public Administration, Public Defense, Social Security (O)	Positive	-1	0.793
Accomodation and Food Services (I)	Positive	-1	0.187
Agriculture (A)	Positive	-1	0.148
Source: Writer's calculations.			

Source: *Authors' calculations.*

4. Conclusions, Recommendations and Future Research

Of the fifteen (15) economic sectors examined in this paper, four (4) were found to be statistically significant in regards to the Greek VAT gap. Specifically, three (3) had a positive relationship, with the increase of their share in GDP being associated with an increase in the VAT gap while one had a negative relationship with the increase of its share in GDP being associated with a decrease in the VAT gap. Specifically, the Catering and Accommodation services sector's (I), the Public Administration sector's (O) and the Agriculture sector's (A) increase leads to an increase in the Greek VAT Gap, while on the contrary the increase of the Industrial sector's (B, D, E) share of GDP is associated with a reduction in the Greek VAT gap.

It must be noted that in international literature there exist several cases where the sectors of Agriculture and Industry in their generalized forms, i.e. 'Agriculture including Forestry and Fisheries' and the Industrial sector in the sense of industrialization, were examined in relation to different indicators of tax evasion besides the VAT gap, such as total tax revenue to GDP. The vast majority of said studies have revealed the difficulty of taxing the Agriculture sector, whereas the activities of the Industrial sector are more receptive to the collection of taxes. The findings of this paper's econometric analysis agree with the above-mentioned

generic conclusions, while the more specific conclusions are cited below case-by-case.

Regarding the Industrial sector there is agreement with scholars such as Cevik et al. (2019), Motsatsi (2018) and Langford and Ohlenburg (2016) as well as older studies such as Piancastelli (2001), noting that the latter two investigated the relationship between the industry and total tax revenue. In several studies the impact of the industrial sector on either the VAT gap or tax revenue has not been statistically significant (CASE 2020, Piancastelli and Thirlwall 2020, Gupta 2007, Teera and Hudson 2004, Eltony 2002, Stotsky and Woldemariam 1997). There have also been studies that have examined the industry sector in relation to tax revenue in general, attributing to it significant tax losses such as Lukáč and Simonidesová (2020) for Slovakia, Hanlon (2007) for some US states where VAT is not applied and Botlhole (2012) for sub-Saharan Africa.

In this paper, the relationship between the Industrial sector and the Greek VAT gap, as portrayed by the econometric results, depends on various factors. One of them is that industries are organized units, which follow national and international accounting practices that are easily identifiable and can potentially generate significant taxable revenue. They also have a better knowledge of their tax obligations in relation to companies that deal in the agricultural sector.

Regarding the identified difficulty of taxing Agricultural activities, there is an agreement with Dalamagas *et al.* (2019), Godin and Hindriks (2015), Thackray and Ueda (2014), Crivelly and Gupta (2014), Botlhole *et al.* (2012), Martinez-Vazquez and Bird (2011), Pessino and Fenochietto (2010), Keen and Lockwood (2010), Aizenman and Jinjirak (2008), Bird *et al.* (2008), Gupta (2007), Bird *et al.* (2004), Ebrill *et al.* (2001). Only some of the researchers (CASE 2020; Piancastelli and Thirlwall 2020; Motsatsi 2018; Ufier 2014) found the relationship to not be statistically significant, while even more rare was the existence of a negative and statistically significant relationship between agriculture and tax revenues such as in Agbeyegbe, Stotsky, and WoldeMariam (2014), who specifically focused on sub-Saharan Africa, where most of the agricultural production is exported to and not produced internally.

The difficulty of taxing the Agricultural sector in the Greek economy is due to the fact that the sector is dominated by many small farmers, who make a living from agricultural activities, often having non-existent accounting services and little knowledge of their VAT obligations. Another major factor that contributes to this phenomenon is the large number VAT exemptions, reduced VAT rates ans subsidies on food, goods and services related to the Greek agricultural sector.

The second sector with a positive (increasing) effect on the VAT gap is that of Catering and Accommodation services. Although it is grouped in the same category as Wholesale and Retail, Transport and Warehousing (G, H, I) according to the

NACE classification used by Eurostat in Greece, this particular sector is of a distinct size, thus an individual examination of the three items mentioned above was deemed necessary. This suggestion for an in-depth individual examination of the sector was also strengthened by the conduct of a very large number of audits by the Greek Tax Administration in the companies providing Catering and Accommodation services as they constitute a large part of the preventive audits (30% - 45%) on an annual basis, while VAT non-compliance in said activities is at high levels throughout the entire time period under investigation (see section 1.1.5.).

The econometric analysis confirmed this assumption; that the activities of catering and accommodation services increase the VAT gap when their share in GDP increases, mainly due to increased VAT non-compliance. This finding is in agreement with the relevant international literature and articles, as many scholars attribute high tax evasion or even connection with the shadow economy to the Catering and Accommodation sector (Fedotov and Nevzorova, 2020; Abdihiku *et al.*, 2017; Kesar and Čuić, 2017; Badariah *et al.*, 2016; Hrdlička, 2015; Vladimirov, 2015; Milić, 2014; Hjalager, 2008).

Only a few studies did not find a statistically significant relationship between this sector and the VAT gap, such as Reckon (2009) and Zidkova (2014). Even more rarely (Christie and Holzner, 2006) the existence of a negative relationship between tourism (Catering and Accommodation can be considered as a proxy variable) and tax compliance has been suggested, attributing the relationship to the fact that tourism-related tax evasion is not included in national accounts.

Finally, the last sector with a positive (increasing) effect on the VAT gap is that of Public Administration, Public Defense and Social Insurance. This outcome is mainly attributed to the fact that all government expenditure is exempt from VAT in Greece, hence a distortion in the VAT tax system is produced. This finding is consistent with previous research from the same author (Papadakis *et al.*, 2021).

Based on an analysis of these conclusions, the following actions are recommended in order to improve VAT revenues and VAT compliance and to help overcome VAT evasion and decrease the VAT Gap.

- An adaptation of this model can be extended to all European countries so as to draw more extensive and safer conclusions about the links between an economy's sectoral distribution and its VAT Gap.

- The findings regarding the agricultural sector can be mainly attributed to the existence of special schemes, exemptions and reduced VAT rates on its products. Thus, it is recommended that policy makers need to reevaluate this issue and modify said rates so as to reduce distortions in the VAT system, having previously taken into account other types of taxation in this sector. This recommendation is directly related to the corresponding ones of the

previous research (Papadakis *et al.,* 2021) regarding the determinants of the Greek VAT gap. In fact, the results yielded from the current research strengthen them. Similar suggestions have been made by other scholars such as Betliy (2014) and Thackray and Ueda (2014). In addition, another recommended action is developing a large-scale information campaign targeting small and medium enterprises (SMEs) as well as individual producers, focusing on legal advice and raising awareness of VAT obligations, followed by training workshops. Also, specialized units within the Greek Tax Administration's ranks could be developed in order to minimize conflict, promote trust and optimize VAT collection.

- The sector of public administration, public defense and social insurance is also similarly tied to the results of the author's previous work (Papadakis *et al.,* 2021). Here the issue revolves around the lack of binding legal framework instead of evasion or non-compliance, hence affecting the part of the VAT Gap known as the 'Policy Gap'. In this case, the most recommended action for reducing the Geek VAT Gap is the rationalization of public spending.

- Recommendations about the Food Service Activities (Catering) and Accommodation sector's services – industries that rely heavily on cash transactions instead of plastic money and are more prone to evasion – focus on preemptive auditing and fines. An important factor here is the probability of tax examination on VAT compliance. By maintaining the volume and quality of preemptive audits, it is possible to greatly inhibit the Greek VAT Gap (Papadakis *et al.,* 2021).

- On the other hand, findings on the industry sector and its relation to the Greek VAT Gap can provide useful data for adopting best practices on accounting and tax policies. Policy makers can help SMEs from different sectors by increasing their accounting skills through best practice techniques, improving their comprehension on VAT laws and regulations and building adequate accounting systems through short taxation courses and training workshops.

- Additionally, another action that can lessen the Greek VAT Gap is the use of the 'One Stop Shop (OSS) electronic portal of the Greek Tax Administration (AADE) for businesses that operate through e-commerce. This application allows businesses to safely comply with their VAT obligations on e-commerce sales within the EU.

In summary, this paper argued that the sectoral distribution of the Greek economy plays a key role in influencing the Greek VAT Gap, which was proven to be true since four major economic sectors were found to be statistically important. Future research should aim to replicate results in a larger scale and incorporate other forces

that are known to influence VAT Gaps, such as carousel fraud and the involvement of the shadow economy. Another interesting topic for future work could be the degree of influence of the OSS application on Greek e-commerce and VAT compliance.

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