Impact of Institutional Environment Quality on Tax Evasion: A Comparative Investigation of Old Versus New EU Members

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Abstract

This paper aims at comparatively investigating the impact of institutional environment quality (IEQ) on tax evasion in old (pre-2004) and new (post-2004) European Union (EU) member states. IEQ is measured by the World Bank's *Worldwide Governance Indicators*, which include voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. The size of shadow economy is used as a proxy for tax evasion. Using a linear mixed model to analyse the data, the results indicate a higher level of tax evasion in new member states compared to the old ones and reveal that tax evasion is decreasing in the old, albeit at a lower rate compared to the new EU members. Overall, there is evidence that the impact of IEQ on tax evasion is different between the two groups. While regulatory quality, voice and accountability, control of corruption, political stability and government effectiveness are significant determinants of tax evasion levels in older EU members, government effectiveness is the only significant factor in the new EU member states.

Keywords: Tax evasion, Worldwide Governance Indicators, Institutional environment quality, EU, Linear mixed model

1 Introduction

The tax evasion phenomenon has been investigated in several studies at the national, corporate and individual levels, aiming at understanding its determinants and economic implications. The examination of tax evasion at the national level, the focus of this study, has historically focused on economic factors with fewer studies paying attention to non-economic factors. This is regardless of the assertion that "tax compliance seems to depend upon numerous factors beyond the standard economic ones" (Alm & Torgler, 2006, p. 225).

A number of studies have highlighted the importance of non-economic variables in tax evasion studies. For example, Riahi-Belkaoui (2004, p. 141) calls for "the need for a contingency theory of tax compliance that calls on not only economic determinants of tax compliance but also institutional and moral determinants." Building on Riahi-Belkaoui's (2004) study, Richardson (2006, p. 150) examined the determinants of tax evasion in 45 countries and concluded that "non-economic determinants have the strongest impact on tax evasion" compared to economic variables. Furthermore, Richardson (2008) found evidence that adding non-economic variables to tax evasion models increase their explanatory power.

Accordingly, this study investigates the impact of governance indicators, as a set of non-economic, institutional environment quality (IEQ) measures, on tax evasion in an attempt to understand the role of IEQ in explaining tax evasion levels. This is achieved by examining the relationship between the World Bank's *Worldwide Governance Indicators* (WGIs) and tax evasion at country-level. These indicators include voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. Using a linear mixed model, this study comparatively examines tax evasion levels in old (pre-2004) and new (post-2004) EU member states (hereafter referred to as EU_1 and EU_2, respectively) over the period 2004-2014. During this period, the EU witnessed its biggest enlargement wave, with the accession of 10 countries in 2004, for the union to reach 27 countries, encompassing several East European countries. In other words, '*old EU member states*' includes those countries that established or joined the EU before 2004, whereas '*new EU member states*' refers to those countries that joined the EU in 2004 or later. It is contested here that tax evasion levels are likely to be different between EU_1 and EU_2 and that the difference could be

explained by the variation in IEQ. This could potentially inform policy makers when setting unified regulations and directives across the union.

Tax evasion in the EU was estimated at €860 billion annually (Murphy, 2011). The case of Greece is perhaps the worst in the EU, as tax evasion is estimated to be equal to one-third of its total tax revenues; a figure that is almost equal to its budget deficit (Beck, Lin, & Ma, 2014). However, globally, it is claimed that the "actual [level of] evasion is unknown and impossible to determine" (Tsakumis, Curatola, & Porcano, 2007, p. 140). The Panama papers leak, widely reported in April 2016, highlighted the involvement of not only business people but also politicians and world leaders in using offshore financial centres as tax havens.[1] This leak resulted in a number of investigations worldwide and led to the resignation of the Prime Minister of Iceland, a highly vocal opponent of tax evasion.

The rationale for investigating the tax evasion phenomenon in the EU context is related to its economic strength, composition, and the recent threats to its unity. Considered as one bloc, the EU is the second largest economy in the world with a GDP of €16.5 trillion in 2016 (International Monetary Fund, 2017). The unity of the EU has been under threat, especially after the 2008 financial crisis, as its economic consequences had reflected negatively on the member states at different levels with a number of southern European countries suffering the most, such as Greece, Italy and Spain.

Although countries must meet a number of conditions (Copenhagen Criteria)[2] before joining the union, it can be argued that they are not completely similar, albeit with less differences among the member states compared to other studies that examined tax evasion in countries with no common backgrounds. The investigation in such a comparative context should fine-tune our understanding of how IEQ influences TE. Highlighting the differences between the two groups could provide policymakers with guidance on how to minimise the impact of these differences through the operationalisation of specific institutional environment factors.

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[1] The Panama Papers were published in April 2016 by The International Consortium of Investigative Journalists (ICIJ, 2016).

[2] "*The criteria require that a state has the institutions to preserve democratic governance and human rights, has a functioning market economy, and accepts the obligations and intent of the EU.*" (Source: European Commission website www.ec.europa.eu)

In addition, differences in standards of living across the union have led to an immigration movement from eastern to western countries; a factor that played a significant role during the political debates leading to the 2017 UK referendum that resulted in a simple majority vote to leave the EU (known as Brexit). A few years earlier, economic pressures emanating from the government-debt crisis in Greece had put the country under pressure to leave the EU (or Grexit). As the standards of living, social welfare, and government-debt are linked to tax evasion, studying the phenomenon in the EU, comparing its levels in old versus new members, appears to be a suitable context to examine the impact of IEQ on tax evasion. Based on the above discussion, the study attempts to answer the following three research questions:

- Is there a difference in the level of tax evasion between old (pre-2004) and new (post-2004) EU member states?
- What is impact of institutional environment quality on the level of tax evasion in the EU?
- How did tax evasion behaviour in the EU change over the period 2004-2014?

After controlling for social and economic differences among the EU member states, the results indicate a higher level of tax evasion in EU_2 compared to EU_1 member states. However, tax evasion was declining over time at a slower pace in EU_1 member states. With regard to IEQ, the results reveal that five of the six WGIs in EU_1 (regulatory quality, voice and accountability, control of corruption, political stability and government effectiveness) have an impact on tax evasion. This is compared to only one indicator, government effectiveness, in EU_2.

The study contributes to the literature on tax evasion in a number of ways. It responds to the calls made by different scholars on the role of non-economic variables on tax evasion. An understanding of the relationship between IEQ and tax evasion could prove effective in controlling tax evasion in the long term. Torgler and Schneider (2009) investigated the IEQ's impact on shadow economies on a sample of 55 countries during the period between 1990 and 1999. They concluded that IEQ is "relevant in explaining the size of shadow economy" (2009, p. 236). This study adopts a similar approach but focusing exclusively on EU member states and utilises a more informative statistical analysis, as discussed in section 4.3. In addition, this is the first study, to the best of our knowledge, that examines tax evasion in the EU in a comparative context in an attempt to highlight the impact of IEQ difference on tax evasion levels.

The remainder of this paper is organised as follows. The next section provides a review of the literature on tax evasion. This is followed by hypotheses development in the third section. The fourth section presents the research design and methodology employed in the study, followed by a presentation of the results in the fifth section. Finally, the paper is concluded with a discussion of the findings, including guidance for policy makers, the limitations, and future research.

2 Tax evasion: a background

Several attempts have been made to define tax evasion. For example, Korndörfer, Krumpal, and Schmukle (2014, p. 19) define tax evasion as "an illegal act that violates the law and deviates from social norms that prescribe that taxes should be paid." It can also be seen as "the wilful attempt to defeat or circumvent the tax law in order to illegally reduce one's tax liability" (Gottschalk, 2010, p. 453).

To understand the phenomenon of tax evasion, a number of studies have been conducted. The earlier studies tended to be general, theoretical, experimental-based or setting the agenda for further research (for example, Allingham & Sandmo, 1972; Jackson & Milliron, 1986; Fischer, Wartick, & Mark, 1992; Andreoni, Erard, & Feinstein, 1998; Sandmo, 2005; Long & Swingen, 1991). In one of the earliest studies, Allingham and Sandmo (1972) provide a theoretical model of individuals' decisions to evade income tax, under which the choice to evade tax is based on the outcome of a comparison between the detection risk and the gains achieved from evading the tax.

More recently, the literature investigated the tax evasion phenomenon from different perspectives including its determinants (Riahi-Belkaoui, 2004; Richardson, 2006; Chau & Leung, 2009; Pickhardt & Prinz, 2014; Khlif & Achek, 2015), and the impact of culture (Tsakumis et al., 2007; Richardson, 2008; Réthi, 2012; Putnam, Abdelfattah, Bagchi, & Braun, 2016). The political perspective was investigated in a few studies (Feld & Tyran, 2002; Katz & Owen, 2013), as well as the behavioural perspective (Groenland & Van Veldhoven, 1983; Spicer & Hero, 1985; Wenzel, 2005; Torgler & Valev, 2010; Pickhardt & Prinz, 2014; Kaplanoglou & Rapanos, 2015; Casal, Kogler, Mittone, & Kirchler, 2016; Litina & Palivos, 2016), with a number adopting the *Slippery Slope Framework*, a tax compliance model that links tax payments to the level of trust in governments and the power of tax authorities (Kirchler, Hoelzl, & Wahl, 2008; Wahl, Kastlunger, & Kirchler, 2010; Kastlunger, Lozza, Kirchler, & Schabmann,

2013). The framework implies a positive correlation between voluntary compliance and the level of trust in governments, whereas the power of tax authorities is positively correlated with enforced compliance.

A few studies have addressed the measurement of tax evasion (e.g., Alm, 2012; Korndörfer et al., 2014). Alm (2012) provides a detailed discussion of the various approaches to measure tax evasion and classifies them to traditional (such as audits of samples of tax returns and the size of shadow economies) and modern measures (such as conducting controlled field experiments and consumption-based measures). One interesting non-traditional approach is proposed by Henderson et al. (2012), which involves the use of satellites to measure luminosity from space as an estimate of real economic activity. Comparing this 'real' activity to official economic levels, tax evasion can be estimated as the difference. Alm's (2012) discussion leads to the conclusion that there is no one superior method for measuring tax evasion, as every approach has its limitations.

This study utilises the size of the shadow economy as a proxy for tax evasion, as explained later in section 4.1. A shadow economy "includes all market-based legal production of goods and services that are deliberately concealed from public authorities" (Schneider, 2005, p. 4). The concealment could be for various reasons such as evading tax and/or avoiding other legal requirements related to labour minimum wages and working hours. The shadow economy size is frequently used in tax evasion studies (Alm, 2012). According to Alm (2012, p. 58), a shadow economy can be seen as the "gap between predicted level of economic activity and the official national accounts level …, which can then [be] used as a proxy for the amount of tax evasion."

A body of the literature has examined the determinants of tax evasion (for example, Chau & Leung, 2009; Fischer et al., 1992; Khlif & Achek, 2015; Riahi-Belkaoui, 2004; Richardson, 2006, 2008; Tsakumis et al., 2007; Zoana, 2011). As noted earlier, much of the literature focused on economic factors and scholars called for more consideration of non-economic variables. Fischer's et al. (1992) tax compliance model identified a number of economic and non-economic factors that affect the level of tax evasion. Economic factors include income level, income source, and occupation, whereas non-economic ones include demographic variables, attitudes and perceptions towards the fairness of the tax system, and tax system complexity and structure. Chau and Leung (2009) added culture as a non-economic variable to Fischer's model.

A number of studies have highlighted the importance of non-economic variables in tax evasion studies. Investigating the impact of tax morale on tax evasion in 30 countries, Riahi-Belkaoui (2004) found a positive link between tax compliance non-economic factors such as economic freedom, competition laws and low crime rates. Accordingly, he concluded that "a powerful deterrent to tax evasion is the creation of a tax morale or climate where citizens are guaranteed economic rights, and safe lives" (2004, p. 141) and called for "the need for a contingency theory of tax compliance that calls on not only economic determinants of tax compliance but also institutional and moral determinants" (2004, p. 141).

Building on Riahi-Belkaoui's (2004) study, Richardson (2006, p. 150) examined the determinants of tax evasion in 45 countries and concluded that "non-economic determinants have the strongest impact on tax evasion" compared to economic variables. Particularly, he found the complexity of the tax system and education to be among the most important determinants of tax evasion. In another study, Richardson (2008) examined the relationship between culture and tax evasion in 47 countries building on Tsakumis' et al. (2007) model. Adding the rule of law, trust in government and religiosity as determinants of tax evasion to the model increased the explanatory power of Tsakumis' et al. (2007) model. Accordingly, Richardson (2008) highlighted the importance of including non-economic variables in tax evasion studies, as they may lead to better understanding of the phenomenon and probably providing better insights for policy makers.

With the aim of extending the literature on the role of non-economic variables, this study investigates the impact of the World Bank's *Worldwide Governance Indicators*, as a set of non-economic, institutional environment quality measures, on tax evasion in the EU. To achieve this objective, the study tests a number of hypotheses related to tax evasion in old versus new EU members states and the link between each of the six WGIs and tax evasion, as developed in the following section.

3 Hypotheses Development

3.1. Tax evasion in old versus *new EU member states*

The EU witnessed its biggest enlargement wave in 2004 with the accession of 10 countries, followed by Bulgaria and Romania in 2007, for the union to reach 27

countries. It currently has 28 countries, with the accession of Croatia in July 2013.[3] Most of the new (post-2004) EU member states, with the exception of Cyprus and Malta, are in eastern and central Europe, including three countries that were part of the Soviet Union. To join the EU, a country must meet specific political, economic and administrative conditions, known as the Copenhagen criteria (EU, 2017). The accession of the new countries implies meeting the criteria; however, dissimilarities may still exist among the member states, including levels of tax compliance.

There is little evidence in the literature on the level of tax evasion in eastern European countries, and it suggests low tax compliance in a number of the new EU member states. For example, Alon and Hageman (2013) investigated the impact of corruption on firm tax compliance in 22 former Soviet economies and found evidence of high corruption levels and low tax compliance. It is not expected that the accession of these countries to the EU will result in an imminent change in the 'level of corruption' or any of the other WGIs. However, the old EU member states have been subject to many directives and regulations, covering economic, social and political aspects, for decades, and it is normal to expect a relatively high degree of harmonisation among these countries compared to the new EU member states. There is evidence from the literature of high tax compliance in some of the old EU member states (Alm & Torgler, 2006). Nevertheless, no previous studies have directly compared the level of tax evasion in the sets of member states comprising the EU. Thus, the first hypothesis is:

H1: There is a significant difference in the level of tax evasion between old (EU_1) and new (EU_2) member states.

3.2. Institutional Quality Environment and Tax Evasion

The link between public governance and economic development has ignited the interests of policymakers and scholars to look for a suitable measure of governance quality at country-level (Thomas, 2010). A number of indicators have been suggested, but the World Bank-backed Worldwide Governance Indicators developed by Kaufmann et al. (2011) is "[one] of the most well-known and comprehensive studies of

[3] Accordingly, Croatia is not included in this study due to the lack of enough data after joining the EU.

the institutional environment of countries" (Daniel, Cieslewicz, & Pourjalali, 2012, p. 373).

Public governance could be defined as "the traditions and institutions by which authority in a country is exercised (Kaufmann et al., 2011, p. 222). Kaufmann et al. (2011, p. 223) propose the six governance indicators shown in Table 1. The six measures have been calculated for 215 countries since 1996 as part of a long-term project commissioned by the World Bank.[4] The reliability and validity of these indicators have been tested by academics and policy makers (Daniel et al., 2012). The links between tax evasion and each of the six indicators are presented in the rest of this section.

INSERT TABLE 1 HERE

3.2.1. Voice and accountability (VA)

A number of studies investigated the impact of the voting process on tax compliance (for example, Alm, McClelland, & Schulze, 1999; Feld & Tyran, 2002; Wahl et al., 2010), and reported consistent results suggesting that engagement in the voting process is positively associated with tax compliance in society. In addition, Walker, Gardner, Herr and Ostrom (2000) found that participation and voting can increase cooperation and the efficiency of operations. Accordingly, the second hypothesis is:

H2: The higher the level of voice and accountability (VA), the lower the level of tax evasion.

3.2.2. Political stability

Evidence from prior research suggests a positive link between tax morale and established democratic traditions (e.g., Alm & Torgler, 2006). Riahi-Belkaoui (2004, p. 141) advocates that a good "deterrent to tax evasion is the creation of a tax morale." Accordingly, this evidence suggests that political stability should lead to high tax morale and in turn to lower tax evasion. Political uncertainties faced by taxpayers can be classified into two types; not knowing which political party will be in control, and not knowing whether they would be caught for evading taxes by a new government

[4] The data needed to calculate these measures have been extracted from 31 data sources including households, non-governmental organisations (NGOs), the public sector, and commercial firms (Kaufmann, Kraay, & Mastruzzi, 2011).

(Katz & Owen, 2013). Based on their perceptions of these political uncertainties, taxpayers may attempt to protect their wealth by hiding their real incomes and accordingly evading tax.

Investigating the relationship between democracy and crime, Cuesta (2013) provides a review of a number of theories. The civilisation theory, for instance, predicts lower crime rates as democratic systems become more established, i.e., having higher political stability (LaFree & Tseloni, 2006). As a crime, tax evasion is expected to decline as political stability increases. Thus, the third hypothesis is:

H3: The higher the level of political stability (PS), the lower the level of tax evasion.

3.2.3. Government effectiveness

According to Allingham and Sandmo's (1972) theoretical model, concealment of income depends on the taxpayer' evaluation of the expected utility of the income. It also depends on the efficient allocation of resources by the government. This reflects the government effectiveness, which, in turn, affects taxpayers' satisfaction. It can be argued that government effectiveness contributes to forming taxpayers' perception regarding the expected utility of their tax payments. Torgler and Schneider (2009, p. 229) advocate that "better institutions provide stronger incentives to behave legally and increase the costs of illegal activities as a consequence of greater institutional accountability." Accordingly, if taxpayers perceive governments to be efficient rather than wasteful, it is likely they will comply with tax laws. Hence, the fourth hypothesis is:

H4: The higher the level of government effectiveness (GE), the lower the level of tax evasion.

3.2.4. Regulatory quality

Regulations that permit and promote the private sector help in creating a suitable environment to foster a respectful relationship between the government and taxpayers. This will reduce the hostile and antagonistic interactions that can positively affect tax compliance levels (Hofmann, Gangl, Kirchler, & Stark, 2014). The simplification of tax systems leads to higher tax compliance (Awasthi & Bayraktar, 2014; Richardson, 2006). In other words, high regulatory quality should lead to more tax compliance. Thus, the fifth hypothesis is:

H5: The higher the level of regulatory quality (RQ), the lower the level of tax evasion.

3.2.5. Rule of law

It is argued that the level of tax evasion is subject to a number of factors including trust in authority and the deterrence power of the tax authority (Wahl et al., 2010). Kirchler et al. (2008) differentiate between two types of societies, antagonistic and synergistic climates. In antagonistic climates, a culture of 'cops and robbers' prevails, whereas synergistic climates are characterised as having a 'service and client' culture. Taxpayers are likely to voluntarily comply under the latter. Kirchler et al. (2008, p. 212) advocate that "tax compliance can be achieved through increasing levels of power and trust." Perceiving the government as legitimate persuades individuals within a society to be committed to follow its rules (Tyler, 2006). Hence, the sixth hypothesis is:

H6: The higher the level of rule of law (RL), the lower the level of tax evasion.

3.2.6. Control of corruption

According to Friedman et al. (2000, p. 460), "greater corruption, and a weaker legal environment are all associated with a larger unofficial economy." In addition, Alon and Hageman's (2013) study of 5,000 firms operating in 22 former Soviet countries found evidence of lower tax compliance under a high level of corruption. It can be argued that corruption can incentivise individuals and businesses to evade paying taxes as well as to facilitate it through public officials. Thus, the seventh hypothesis is:

H7: The higher the level of control of corruption (CoC), the lower the level of tax evasion.

4 Research design

4.1. Data description

As a proxy of tax evasion, the size of the shadow economy was obtained for each of the 27 countries for the period between 2004 and 2014 from Schneider et al. (2015). The size of the shadow economy can be estimated at the micro or the macro levels (Schneider & Buehn, 2012). Measured at the microeconomics level, it is based on surveys or questionnaires or other indirect means such as the demand for currency. At the macroeconomics level, the measurement is based on a number of factors including the level of employment, the tax burden and the degree of regulation. This study is based on the MIMIC model (Multiple Indicators Multiple Causes): a macroeconomic

measure of the shadow economy. The MIMIC model considers different indicators that directly affect the development of shadow economies' sizes over time. Schneider et al. (2012, p. 9) claim that "there can be no exact measure of the size of the shadow economy" as estimates can suffer a 15% error margin, but stress the superiority of the MIMIC as a measure of the shadow economy.

The six WGIs explained in Table 1, are published by the World Bank as measures of IEQ, ranging between (-2.5) to (+2.5) (World Bank, 2016). As a sign of their reliability, in addition to being published by the World Bank, the WGIs are perceived as a reliable measure of IEQ, as they are frequently used by governments in countries such as the US when allocating grants worth millions of dollars to foreign countries (Thomas, 2010).

4.2. Control variables

Due to the nature of this study, being a cross-country study, a number of variables are included to control for the social and economic differences between the countries. A number of studies found a negative relationship between the education level and tax evasion (Richardson, 2006; Wallschutzky, 1984; Witte & Woodbury, 1985). Taxpayers' positive perception of taxation increases with the level of education, hence leading to higher tax compliance (Jackson & Milliron, 1986). Accordingly, to control for differences in the level of education and knowledge among the 27 EU member states, the Human Development Index (HDI), developed by the United Nations Development Programme, is included in the model.[5] To control for economic differences, two control variables are included in the model: unemployment rates (UNEM) and agriculture (AGR) as a percentage of the GDP.[6] The higher the unemployment rate, the higher the expected level of tax evasion (Torgler & Schneider, 2009). As a source of income, agriculture has been found to be a factor linked to higher levels of tax evasion compared to other sources of income (Wallschutzky, 1984).

[5] Available on the UNDP's website: http://hdr.undp.org/en/content/human-development-index-hdi

[6] Available on the World Bank's website: https://data.worldbank.org/indicator/

4.3. Linear mixed model (LMM)

Although widely utilised, Ordinary Least-Squares models (OLS) have been criticised for being unfit for panel data analysis for violating basic assumptions, such as the independence of observations assumption (Hox, 2010). In cross-country studies, observations may not be independent, as the data, for the same country, could be duplicated leading to within-cluster (country) correlation. Furthermore, disregarding the data clustered structure could lead to biased estimates of standard errors and potentially higher Type I error (Hox, 2010; Shek & Ma, 2011). Accordingly, linear mixed models (LMM) have been suggested as a suitable solution for modelling panel data, as LMM facilitates tracking variables (such as the size of tax evasion) over time for differences cases (countries) without disregarding the effect of other time-invariant variables (Laird & Ware, 1982).

A number of studies have indicated the superiority of LMM to OLS models, as the former produces error terms to control for the correlations resulting from the nature of the data clusters (countries), as described above (Field, 2013; Kreft, 1996; Morris, 1995; Mundfrom & Schultz, 2002; Raudenbush & Bryk, 2002; Tabachnick & Fidell, 2007). Furthermore, LMM could be seen as a generalisation of OLS, as it deals better with continuous variables leading to enhanced randomised effect designs, leading to more accurate estimates of error terms and lower Type I errors (Newman, Newman, & Salzman, 2010; Shek & Ma, 2011).

To measure the impact of institutional quality on tax evasion and whether there are any differences between the levels of tax evasion between EU_1 and EU_2, the following general form of the mixed effects model is proposed:

$$TE_{ij} = \underbrace{(\beta_{oo} + \beta_1 t_{ij} + \beta_2 t_{ij}^2 + \beta_3 t_{ij}^3)}_{\text{fixed effect}} + \underbrace{(b_{0i} + b_{1i} t_{ij})}_{\text{random effect}} + \beta_4 PS + \beta_5 GE + \beta_6 RQ + \beta_7 RL + \beta_8 CC + \beta_9 VA + \beta_{10} EU + \beta_{11} CTRLi + \epsilon_{ij}$$

Where: TE_i is the tax evasion for country i at time j, β_{oo} is the mean tax evasion, and b_{0i} is the country deviation from this mean, $(b_{0i} \sim N(0, \sigma_0^2)$. Similarly, β_1 is the mean growth/decline rate in TE and b_{1i} is the country deviation from this mean $(b_{1i} \sim N(0, \sigma_1^2)$. ϵ_{ij} are independent random errors for each country i and time j, $\epsilon_{ij} \sim N(0, \sigma_\epsilon^2)$. VA (voice and accountability), PS (political stability), GE government effectiveness),

RQ (regulatory quality), RL (rule of law), CoC (control of corruption), and EU (indicator variable: 0 = old (EU_1) and 1 = new (EU_2) member states) are the covariates, which were included in the model to evaluate their effect on TE. $\beta_{11}CTRLi$ represents the control variables included in the model.

The model also included the higher-order polynomial trends (i.e., quadratic) (β_2), and cubic slope (β_3) to test a nonlinear growth trajectory across time and improve model goodness of fit.

4.4. Robustness of the model

Linear and curvilinear models with higher order polynomials (quadratic and cubic terms) have been incorporated into the model to track all details of changes in tax evasion over time. These models test whether the rate of change of tax evasion accelerated or decelerated across time using several variance covariance structures of the error term. LMM allows treating the intercept and linear slope as fixed or random across countries. Under the random coefficients modelling framework, the proposed model was progressively built with explanatory variables accommodating for different variance covariance structures.

As the true error structure is usually unknown, a comparison criterion is necessary to compare between models with different variance covariance structure (Jennrich & Schluchter, 1986). A backward stepwise procedure was adopted to select which variables and their interactions should remain in the final model. Starting from a full model incorporating all fixed (with interaction between covariates) and random effects, decisions as to which variables to retain in the final model and the best variance covariance structure were based on comparisons of the differences in the Akaike Information Criterion (AIC) given by $(- 2 \log likelihood + 2k)$, as assessed by a chi-square test $(p < 0.05)$ (Akaike, 1974). AIC measures the relative fit of competing models with different covariance patterns, where k is the number of covariance parameters. This method sought to identify the 'best' subset of predictors while simultaneously removing those variables that are redundant (Hegyi & Garamszegi, 2011). The final model fit, using Restricted Maximum Likelihood (REML) estimation, was assessed using standard model diagnostic tools.

5 Empirical results

5.1. Descriptive statistics

Tables 2 and 3 present descriptive statistics for the variables included in this study for the 27 EU member states as one bloc and broken down to old (EU_1) and new (EU_2) sub-groups. As illustrated in Table 2, the overall average of tax evasion for both groups (EU_1 and EU_2) is 19.5 (SD=6.98). The TE average for EU_2 is higher than EU_1 with 25.27 versus 15.10. Country-based analysis (Table 3) reveals that TE averages range between 8.7 (SD =1.19) for Austria (from EU_1) to 32.0 (SD =0.64) for Bulgaria (from EU_2). Almost all EU_2 countries' TE averages are higher than 23 except for the Czech Republic (16.9, SD =1.21) and Slovakia (16.4, SD =1.10). However, EU_1 countries' TE averages range between 8.7 for Austria (SD =1.19) to 22.3 (SD =1.42) and 25.2 (SD =1.57) for Italy and Greece, respectively. Table 2 presents a summary of the six WGIs and control variables. The results reveal that all EU_1 countries have higher averages for all WGIs compared to EU_2 countries. Further analysis reveals consistent patterns of change in the means of all six WGIs over the analysis period between EU_1 and EU_2.

INSERT TABLE 2 HERE

INSERT TABLE 3 HERE

Table 3 indicates that Greece has the highest mean of tax evasion in EU_1 and that Italy, Portugal and Spain are above the entire EU overall average of 19.5. Indeed, these countries have been experiencing some sort of financial and economic issues in recent years. Except for the Czech Republic and Slovakia, all EU_2 countries are above the overall TE average of 19.5. This suggests that tax evasion is a more fundamental problem in EU_2 compared to EU_1.

Table 4 reports the Pearson pairwise correlation coefficients between the variables. The results reveal that all WGIs are negatively and significantly correlated with TE. Thus, this implies that the higher the WGIs the lower the level of tax evasion. The results also reveal that WGIs are also highly and significantly correlated with each other, which implies that they support one another. In other words, IEQ emerges as a combination of these attributes. In technical terms, such high correlations among variables may cause multicollinearity in the regression analysis, but this issue is addressed by monitoring VIF values and using stepwise regression analysis (see Appendix A, and

Tables 6 & 7). According to the VIF values, multicollinearity is not an issue for the analyses.

INSERT TABLE 4 HERE

5.2. Main Findings

Table 5 presents the results of examining TE levels in the EU, as one bloc (Full Model), and broken down into groups, old (EU_1) and new (EU_2) member states. The objective is to determine whether there is a significant difference in the level of tax evasion between the two groups. Three control variables (AGR, UNEM and HDI) have been added to the models. The Full Model indicates that HDI is significant (-21.06, P<0.01) and negatively related to TE, and UNEM is significant (0.087, P<0.001). HDI is significant (-27.28, P<0.01) in the EU_2 Model but not in the EU_1 Model. This suggests that the level of education and knowledge in EU_2, the new member states, is a contributing factor to tax evasion. UNEM is significant in both EU_1 (0.103, P<0.001) and EU_2 (0.061, P<0.001), with a higher coefficient in EU_1 compared to EU_2. This suggests a higher impact of unemployment on the level of TE in the old compared to the new member states.

The rest of this section provides a detailed discussion of the results, as presented in Table 5, addressing the three research questions of the study.

INSERT TABLE 5 HERE

5.2.1. Tax Evasion in EU_1 Versus EU_2

The results in Table 5 indicate that the intercept in EU_1 countries (26.49%, p<0.01) is lower than its equivalent in EU_2 (49.31%, p<0.001). This indicates that the average of tax evasion in EU_2 is higher than EU_1 since the start of the analysis period in 2004. The Full Model indicates that EU as an indicator variable is highly significant at (p<0.001); implying a significant difference between EU_1 and EU_2. Thus, the empirical results give support to H_1. These results are not directly comparable to previous research, as this is the first study that compares TE levels in old versus new EU member states. However, it is consistent with Alon and Hageman's (2013) findings of high corruption level and low tax compliance in former Soviet economies. It is also consistent with Alm and Torgler's (2006) evidence of high tax compliance in a number of western European countries.

5.2.2. Institutional environment quality impact on tax evasion

With regard to the link between IEQ and TE, four WGIs are significant in the Full Model (CoC, GE, RQ and VA). CoC (-0.46) and RQ (-0.54) were significant at ($p<0.1$) and negatively related to TE (see Table 5). This indicates that regulatory quality and control of corruption are negatively related to TE, which is consistent with prior studies (Awasthi & Bayraktar, 2014; Hofmann et al., 2014). The other two WGIs, VA and GE, are significantly related to TE ($p<0.05$); both are positively related to TE (VA 0.88; GE 0.59). This, rather unexpected, positive association is probably due to the presence of a suppressor variable. Further tests were conducted that provide evidence that VA and GE are negatively associated with TE (see Appendix A, Table 6). Thus, the results lend support to H_2, H_4, H_5, and H_7 and fail to lend support for the other hypotheses (H_3, and H_6).

These findings are consistent with previous research regarding the positive link between participating in the voting process on tax issues (reflecting high VA) and tax compliance (e.g., Alm et al., 1999; Feld & Tyran, 2002). The findings are also consistent with Allingham and Sandmo's (1972) prediction that better institutions and the efficient allocation of resources by the government (reflecting its effectiveness, GE) provide stronger incentives for taxpayers to be tax compliant. Additionally, the results confirm Torgler and Schneider's (2009) findings of a negative association between control of corruption, as well as regulatory quality, and TE. In addition, the findings lend support to evidence reported in previous research on the link between the complexity of the tax system and the level of tax compliance (e.g., Awasthi & Bayraktar, 2014; Richardson, 2006).

With regard to old member states, the EU_1 Model shows that GE and VA are positively associated with TE (GE 1.09, $p<0.001$; VA 0.89, $p<0.1$); both are subject to the suppressor effect (see Appendix A, Table 7). CoC (-0.463, $p<0.1$), RQ (-0.97, $p<0.01$), and PS (-0.44, $p<0.1$) are negatively related to TE in EU_1. In the EU_2 Model, only GE is significant and negatively related to TE (-0.555, $p<0.1$). These results indicate that there are different significant WGIs in EU_1 compared to EU_2, accordingly providing evidence of differences in institutional environment quality between the two groups of member states contributing to the observed difference in the level of tax evasion, as discussed in section 5.2.1.

5.2.3. Tax Evasion: Time Analysis

To trace tax evasion behaviour over time, three time variables (linear, quadratic, and cubic) were added to the model, as explained in section 4.3. The linear and quadratic time variables, in Table 5, are highly significant in the Full Model ($p<0.001$). This indicates that TE behaviour is not linear (constant) over time. The negative effect of linear growth ($\beta= -15.17$) suggests that TE decreased at the beginning of analysis period (since 2004) at an average of 15.17% each year in the EU. The positive effect of the quadratic term of time ($\beta= 2.13$) indicates a deceleration in the TE declining rate in the EU.

In addition, the random intercept and slope terms of the Full Model are significant, with a standard deviation of 4.75 and 0.087, respectively. This indicates that the initial level of TE and the deceleration rate of TE are different at country-level, which is likely due to the varying IEQ of each country.

The results in Table 5 also reveal that the initial tax evasion levels in EU_1 member states are significantly different (random intercept, 4.84) as well as the deceleration rate in TE over time (random slope, 0.11). Similar observations can be made for EU_2 regarding the random intercept (4.39) and random slope (0.079). Similar to the Full Model, the initial level and the declining rate of TE in EU_1 and EU_2 member states are different at country-level. However, the standard deviation for EU_1 slopes is higher than the standard deviation of EU_2 slopes (0.11 versus 0.079, respectively), which means that the variation in deceleration rate in EU_1 is higher than EU_2. This is probably due to the within-group differences in TE levels in EU_1, i.e., countries with an average TE of more than 19.5 such as Greece, Italy, Spain, and Portugal (mainly southern European), and countries with an average TE below 19.5 such as Germany and France (northern European).

The time coefficients, in Table 5, are significant for both EU_1 and EU_2 (-12.96, $p<0.001$ and -0.228, $p<0.001$, respectively). However, the quadratic term of time is significant for EU_1 (2.41, $p<0.001$) but not for EU_2. This implies that the TE deceleration behaviour in EU_2 is linear, while it is quadratic in EU_1; meaning that the deceleration rate in EU_2 is faster than its equivalent in EU_1. This difference in tax evasion behaviour over time between EU_1 and EU_2, and even within each group, as discussed above, is a noteworthy observation that should be considered by policymakers.

6 Implications and Conclusion

This study aims at investigating the impact of institutional environment quality (IEQ) on tax evasion in the EU during the period 2004-2014. A comparative analysis is undertaken between old, pre-2004 (EU_1) and new, post-2004 (EU_2) member states. The three main research questions of the study focused on the difference in tax evasion levels between EU_1 and EU_2, the impact of IEQ of tax evasion in the EU, and tax evasion behaviour over the analysis period. This section summarises the main findings and highlights a number of implications for policymakers and researchers. It also presents the study limitations and opportunities for further research.

The results reveal that there is a difference in tax evasion levels between the old and new member states. Compared to old members, new members have significantly higher levels of tax evasion. Furthermore, there is evidence of a difference in the tax evasion behaviour during the period under investigation, as the declining rate of tax evasion in the new member states is faster than its equivalent in the old ones. Another finding of this study is the revelation that the accession of the new members to the EU has resulted in an improvement in their institutional environment quality in a number of these countries. However, institutional environment quality levels are found to be higher in the old compared to the new member states. This seems to have an impact on tax evasion levels, as more indicators of institutional environment quality are found to be significant in the old member states. Five indicators are found to be significant in the old member states compared to only one in the new ones.

The findings of this study have a number of implications for policymakers and researchers. First, the evidence of a significant difference between tax evasion levels in the old and new member states is an issue that should be paid more attention to by EU officials. This study examines the impact of the institutional environment quality, but other factors reported in the literature exist. A holistic approach should be adopted to consider the evidence reported in this study as well as reported in previous research to tackle tax evasion more effectively, particularly in the new member states.

Second, the revelation that only one WGI, government effectiveness, is significant with regard to tax evasion in the new member states is a reason for concern. Although there has been an improvement in the level of institutional environment quality in some of the new member states since 2004, this improvement did not reflect positively on the

level of tax evasion in the group, as it did in the older member states. EU officials need to enhance the five other areas mainly in the new member states in order to have more consistency across the union.

Third, efforts to enhance institutional environment quality should not focus on the new member states only. The evidence shows differences within the old member states as a group. For example, Greece, Italy, Spain, and Portugal have above average levels of tax evasion. Fourth, another difference between old and new members that is noteworthy of EU officials' attention is related the education and knowledge level, which is revealed as a significant contributing factor to tax evasion in the new member states, but not the old ones.

Finally, one implication for researchers is the utilisation of a linear mixed model (LMM) to examine the determinants of tax evasion in cross-country studies. Using LMM to model panel data allows tracking tax evasion over time for different countries (treated as random effects in the model) while considering the impact of other time-invariant variables in the model.

To summarise, this is the first study that comparatively investigates the impact of IEQ on tax evasion levels in old and new EU member states taking the changing level of tax evasion over time into consideration. The study makes a number of contributions to the literature on tax evasion. First, it provides evidence on the impact of non-economic variables, IEQ measured by the World Bank's WGIs, on tax evasion. Evidence from prior research suggests that non-economic variables seem to have a strong impact on tax evasion and calls have been made for more consideration of such variables. Second, the adoption of a linear mixed model to examine how IEQ affects tax evasion is another contribution that distinguishes this study from prior work, as described above.

Third, not only does the current study extend the literature on the impact of non-economic variables on tax evasion, but it also examines the impact in a unique context comparing old and new EU member states. Studying the phenomenon of tax evasion in the EU is unique due to the composition of the union. Meeting the Copenhagen Criteria does not warrant complete similarity in economic and social conditions but leads to fewer differences among the countries. This is a crucial factor when comparing the context adopted in the current study to previous cross-country studies that examined tax evasion in countries with no common backgrounds. Accordingly, the investigation

in such comparative context should fine-tune our understanding of how IEQ influences TE and provide policymakers with evidence on the need to operationalise specific IEQ factors for more effective control of tax evasion.

The results of this study are subject to a number of limitations. First, the results should be interpreted subject to the World Bank's WGIs limitations signalled by Thomas (2010) regarding the indicators' large standard errors and their 'construct validity', i.e., whether the indicators really measure and reflect the level of governance at country-level. However, these indicators are considered "[one] of the most well-known and comprehensive studies of the institutional environment of countries" (Daniel et al., 2012, p. 373). Second, the use of shadow economies is a proxy for measuring the size of tax evasion. However, as Alm (2012) advocates, each approach for estimating tax evasion has its own limitation. The study attempted to minimise the impact of this limitation by using the MIMIC model, as described in section 4.1.

Opportunities for future research may include replicating this study in other jurisdictions or utilising other measures of institutional environment quality. In addition, a number of studies have examined the impact of culture on tax evasion but did not address the mechanism through which this influence occurs. Could institutional environment quality be this mechanism? Could enhancing specific aspects of the institutional environment be a factor in minimising the impact of culture on tax evasion? Perhaps this could be investigated in future research.

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Table 1. Definitions of Worldwide Governance Indicators (GIs) and Control Variables

	Measure	**Definition**
World Governance Indicators	Voice & accountability (VA)	"Capturing perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media"
	Political stability (PS)	"Capturing perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism."
	Government effectiveness (GE)	"Capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies."
	Regulatory quality (RQ)	"Capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development."
	Rule of law (RL)	"Capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."
	Control of corruption (CoC)	"Capturing perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests."
Control Variables	Agriculture (AGR)	The value added of agriculture as a percentage of GDP
	Unemployment (UNEM)	Unemployment as a percentage of total labor force
	Human Development index (HDI)	A composite index measuring average achievement in three basic dimensions of human development, healthy life, Education and a decent standard of living. Used as a proxy for education.

Table 2. Descriptive Statistics of Tax Evasion, Worldwide Governance Indicators Variables and Control Variables

Variable	N	Mean			Median			SD			Min	Max
		All	EU_1	EU_2	All	EU_1	EU_2	All	EU_1	EU_2		
TE	291	19.50*	15.10	25.27	19.10	14.20	26.00	6.98	4.93	4.69	7.50	32.70
HDI	297	0.86	0.88	0.82	0.86	0.89	0.82	0.04	0.03	0.03	0.75	0.93
UNEM	297	8.82	8.49	9.23	7.73	7.65	7.89	4.21	4.58	3.68	2.75	27.47
AGR	297	2.60	1.70	3.72	2.27	1.62	3.50	1.72	0.90	1.84	0.27	13.98
CoC	297	1.05	1.53	0.44	1.00	1.66	0.33	0.81	0.71	0.43	-0.30	2.55
GE	297	1.16	1.50	0.75	1.14	1.59	0.83	0.61	0.51	0.44	-0.36	2.36
PS	297	0.76	0.81	0.69	0.79	0.91	0.72	0.41	0.46	0.33	-0.47	1.59
RQ	297	1.24	1.43	1.00	1.21	1.55	1.03	0.40	0.38	0.28	0.16	1.92
RL	297	1.15	1.49	0.72	1.13	1.69	0.79	0.60	0.48	0.44	-0.18	2.12
VA	297	1.15	1.36	0.89	1.11	1.39	0.96	0.33	0.25	0.23	0.29	1.83

*** Average Tax evasion in the EU**

Table 3. Descriptive Statistics of Tax Evasion by Country

Country	N	Mean	SD	Min.	Max.
PANEL A (EU_1)					
Austria	11	8.7	1.19	7.5	11
Belgium	11	17.9	1.49	16.1	20.7
Denmark	11	14.5	1.38	12.8	17.1
Finland	11	14.4	1.41	12.9	17.2
France	11	11.7	1.33	9.9	14.3
Germany	11	14.3	0.97	13.0	16.1
Greece	11	25.2	1.57	23.3	28.1
Ireland	11	13.1	1.05	11.8	15.2
Italy	11	22.3	1.42	20.8	25.2
Luxembourg	11	8.8	0.78	8.0	10
Netherlands	11	10.3	1.11	9.1	12.5
Portugal	11	19.6	0.98	18.7	21.7
Spain	11	19.6	1.13	18.4	21.9
Sweden	11	15.4	1.41	13.6	18.1
United Kingdom	11	10.7	0.86	9.6	12.3
PANEL B (EU_2)					
Bulgaria	8	32.0	0.64	31.0	32.7
Cyprus	11	26.5	1.07	25.2	28.3
Czech Republic	11	16.9	1.21	15.3	19.1
Estonia	11	29.0	1.10	27.1	30.8
Hungary	11	23.3	1.01	21.6	24.7
Latvia	11	27.2	1.67	24.7	30.0
Lithuania	11	29.5	1.35	27.1	31.7
Malta	11	25.9	0.87	24.3	27.2
Poland	11	25.5	1.29	23.5	27.4
Romania	8	29.3	0.70	28.1	30.2
Slovakia	11	16.4	1.10	14.6	18.2
Slovenia	11	24.6	1.10	23.1	26.5

Table 4. Correlation Matrix between Variables

Variable	1	2	3	4	5	6	7	8	9
1. Tax Evasion (**TE**)									
2. Control of Corruption (**CC**)	-0.74								
3. Government Effectiveness (**GE**)	-0.73	0.94							
4. Political Stability (**PS**)	-0.44	0.56	0.59						
5. Regulatory Quality (**RQ**)	-0.70	0.89	0.89	0.57					
6. Rule of Law (**RL**)	-0.76	0.95	0.95	0.61	0.90				
7. Voice and Accountability (**VA**)	-0.75	0.93	0.93	0.62	0.88	0.93			
8.Human Development Index (**HDI**)	-0.77	0.76	0.76	0.38	0.71	0.80	0.77		
9. Unemployment (**UNEM**)	0.25	-0.39	-0.32	-0.45	-0.42	-0.36	-0.38	-0.21	
10. Agriculture (**AGR**)	0.73	-0.69	-0.74	-0.46	-0.67	-0.77	-0.76	-0.79	0.23

All pairwise correlations are significant at the level of $\alpha = 0.001$

Table 5. Linear-Mixed Model Results

Independent Variables			
Fixed Effects	**Full Model**	**EU1 – Model Old Countries**	**EU2 – Model New Countries**
Intercept	32.07 (6.08) ****	26.49 (8.26) ***	49.31 (6.08) ****
Time (Year)	-15.17 (1.79) ****	-12.96 (1.86) ****	-0.228 (0.044) ****
Time – Quadratic	2.13 (0.53) ****	2.41 (0.54) ****	NS
HDI	-21.06(6.82) ***	NS	-27.28(8.42) ***
UNEM	0.087 (0.014) ****	0.103 (0.019) ****	0.061 (0.016) ****
CoC	-0.46 (0.24) *	-0.463 (0.275) *	NS
GE	0.59 (0.24) **	1.09 (0.302) ****	-0.555 (0.311) *
RQ	-0.54 (0.288) *	-0.97 (0.329) ***	NS
VA	0.88 (0.413) **	0.89 (0.509) *	NS
PS	NS	-0.44 (0.244) *	NS
EU	9.88 (1.52) ****	NA	NA
Random Components Standard deviation			
Intercept	4.75****	4.84****	4.39****
Slope	0.087****	0.11****	0.079****
Residuals	0.397	0.379	0.327
AIC	414.63	220.72	166.86

* p<0.1, ** p<0.05, ***p<0.01, ****p<0.001, NA: Not applicable; NS: Not-significant and excluded from the model. Values in parentheses are Standard errors of the estimates. Full Model: all EU member states; Model-EU_1: countries joined the EU before 2004; Model-EU_2: countries joined the EU after 2004.

Appendix (A)

As referred in section 5.2.2, VA and GE are found to be positively associated with TE (as indicated in Table 5). This could be explained by the existence of a suppressor variable. This problem occurs when the sign of the correlation coefficient between the dependent variable and a predictor (TE and GE, for example) does not match the sign of the coefficient in the regression model as the case in this study. Despite the negative sign of the correlation between TE and GE in Table 4, the signs of the observed coefficient for VA and GE in the Full Model (see Table 5) are positive. There is a strong evidence of suppression effect with the results of the multiple regression indicating that VA and GE are effectively reducing TE levels. This issue has been investigated further for the models that contain VA and GE effects to make sure that the signs of VA and GE coefficients and the correlations (see Table 4) are the same. A further examination was conducted to test the effect of all WGIs (see Table 5) and then the individual effect of each WGI using simple linear regression (Tables 6 and 7). This provides evidence that VA and GE are negatively associated with TE.

Table 6. Full Model and Individual Regression Models of Significant GI Factors for both Groups (EU_1 and EU_2)

	Full Model (Both EU_1 & EU_2)	VIF	Simple linear regression- Model 1 GE	Simple linear regression- Model 2 VA
Intercept	32.07 (6.08) ****			
Time (Year)	-15.17 (1.79) ****	2.83		
Time – Quadratic	2.13 (0.53) ****	1.17		
HDI	-21.06(6.82) ***	2.72		
UNEM	0.087 (0.014) **	1.31		
CoC	-0.46 (0.24) *	1.22		
GE	**0.59 (0.24) ****	1.25	-8.95 (0.464) ****	
RQ	-0.54 (0.288) *	1.31		
VA	**0.88 (0.413) ****	1.33		-17.18 (0.791) ****
EU	9.88 (1.52) ****	1.05		

* p<0.1, ** p<0.05, ***p<0.01, ****p<0.001, NA: Not applicable; NS: Not-significant

Table 7. EU_1 Model and Individual Regression Models of Significant GI Factors

	Full Model (Both EU_1 & EU_2)	VIF	Simple linear regression- Model 1 GE	Simple linear regression- Model 2 VA
Intercept	26.49 (8.26) **			
Time (Year)	-12.96 (1.86) ****	2.09		
Time – Quadratic	2.41 (0.54) ****	1.33		
HDI	-14.34 (9.25) ***	2.03		
UNEM	0.103 (0.019) ****	1.42		
CoC	-0.463 (0.275) *	1.27		
GE	**1.09 (0.302) ******	**1.45**	-6.82 (0.52)****	
RQ	-0.97 (0.329) ***	1.42		
VA	**0.89 (0.509) ***	**1.50**		-14.59 (1.09)****
PS	-0.44 (0.244) *	1.2		

* p<0.1, ** p<0.05, ***p<0.01, ****p<0.001, NA: Not applicable; NS: Not-significant