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Factors of Tax Evasion: The Case of the Czech Republic[1]

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Abstract

The main goal of this paper is to estimate factors of tax evasion in the Czech Republic. Among other things, tax evasion reduces state revenues which fact leads to a decrease in the quantity and quality of publicly provided goods and services. Therefore it is necessary to ensure that taxpayers comply with their tax obligations. Firstly, we use the monetary method (cash/deposit ratio) to estimate the size of tax evasion in absolute and relative terms. According to our estimates, the extent of tax evasion in the Czech Republic was almost 3.6 percent of GDP in 2021. Secondly, we use multivariate time series cointegration analysis models to analyse the economic, tax, and institutional determinants of tax evasion in the Czech Republic. The factors negatively associated with tax evasion include tax overpayments, VAT revenue, and implementation of tax measures introduced in 2020. The positive impact has GDP, PIT revenue, CIT revenue, inflation, monetary freedom, Gross National Savings, trade freedom, PIT rate, unemployment, and average wage.

Keywords: *tax evasion, income taxes, value-added tax, cointegration analysis, Czech Republic*

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Introduction

Tax evasion represents a significant challenge in both tax theory and practice. Although the tax system of the Czech Republic underwent a revolutionary transformation in the early 1990s, its nature has not been principally changed and most of its taxes were not modified at all. In the tax theory, it is important to examine the question of tax incidence and tax efficiency, i.e. how to collect as much taxes as possible at the lowest cost for a given tax burden on the taxpayer. These costs are divided into direct and indirect administrative costs. Direct costs are the costs of tax administration in a given country. Indirect costs are incurred by the taxpayer (for example in the case of VAT) to collect the tax in the correct amount and on time. Indirect administrative costs represent the financial burden on each taxpayer. Another tax cost is the excessive tax burden, which is not so obvious and intuitive for the taxpayer.

However, it is not only monetary expenditure but also expenditure related to the fulfilment of tax obligations, which can be expressed in terms of time or the number and frequency of tax payments. Paying Taxes (2020) tracks this data internationally, and in 2020 the Czech Republic ranked 53rd out of 189 countries assessed. From an international perspective, the Czech tax system appears relatively competitive. It should be emphasised that the publication focuses on the corporate income tax, labour taxation, and excise duty (represented in the Czech Republic by VAT). However, if we compare the results with the EU and EFTA countries, the indicator estimates the time to comply with tax obligations. The Czech Republic scores significantly worse, at 230 hours, compared to the average of 160.5 hours in these countries.

From the publication 'Information on the Activities of the Financial Administration of the Czech Republic for 2021' (Finanční správa, 2021), for individual taxes, it is possible to determine the so-called cost indicator (total expenditure/total revenue x 100). In 2021, this indicator was the lowest for personal income tax on employment. That is, of course, because employers collect this tax on behalf of their employees. When converted into EUR, for corporate income tax and value-added tax the indicator was EUR 0.04 and EUR 0.051, respectively. Road tax and real estate tax appear according to this indicator relatively costly at EUR 0.37 and EUR 0.45, respectively; the reason is the low revenue from these taxes. The highest cost indicator is for personal income tax from tax returns, with a cost of EUR 0.7 in 2021. However, this is only a direct administrative cost; the publication logically does not consider the indirect costs to taxpayers as it does not have this data. The overall cost indicator of the Czech Republic stood in 2021 at EUR 4.20.

The tax system's complexity and the extent of associated indirect administrative costs affect both the given country's economic competitiveness and the

willingness of its taxpayers to pay taxes. Secondarily, it also affects the scope of tax evasion in a given country. This issue is naturally more complex because the Czech Republic is an economically developed country, a member of the EU, and has more than 100 treaties on avoiding double taxation in income and property taxes. Therefore, our paper will focus on the three most important taxes: personal income tax, corporate income tax, and value-added tax. We will abstract from social security taxes in this article, as they do not fill such an area for tax evasion by their very nature. Next, we will conduct a quantitative analysis of tax evasion. We first estimate tax evasion in the Czech Republic and then assess the impact of economic, tax, and institutional factors on its size. To this purpose, we use advanced multivariate time series cointegration analysis to address the problem of multicollinearity of multiple explanatory variables.

1. Factors Determining Tax Evasion

We now turn to the factors that according to the relevant literature may determine tax evasion for the three taxes mentioned above. Previously, authors focused more on microeconomic factors such as the utility function. The taxpayer's utility function, in the sense of whether it pays to evade taxes illegally, has been theoretically addressed by Allingham and Sandmo (1972). They assumed that taxpayers are homogeneous, rational, selfish, and utility-maximising. The taxpayer chooses between safe and risky portfolios. In the safe portfolio, the taxpayer truthfully declares his or her income and pays all his or her tax liability. Conversely, a risky portfolio means the taxpayer understates his or her income and avoids tax. They found that tax evasion depends on the penalty imposed for its committing.

Some sources focus on various non-economic factors that their authors believe may influence tax evasion. Richardson (2006) conducted a regression analysis based on the data from 45 countries and focused on non-economic factors that he found to impact tax evasion significantly. The complexity of the tax system positively affects tax evasion, and other important factors include education, source of income, fairness, and tax morale. The higher the educational attainment, the higher the income, fairness, and tax morale, and the lower the propensity to tax evasion. On the other hand, Ryšavá and Zídková (2021), when examining the VAT loophole, find that education does not play a significant role in tax compliance.

Pommerehne and Weck-Hannemann (1996) empirically analysed income tax evasion in Switzerland. They found a positive effect of the tax incidence rate on tax evasion and a negative impact of potential control, but no statistically significant negative effect of deterrence was found. On the contrary, inflation positively affects tax evasion, as Caballe and Panades (2004) revealed. McGee and Tyler

(2006) studied 33 countries worldwide and examined the taxpayers' attitudes toward tax evasion. The study considered demographic characteristics such as gender, age, income, and education. The authors found that women were more likely to reject tax evasion than men; older people more than younger people; less educated people more than more educated people; and poorer people more than wealthier people. Finally, Tabandeh et al. (2012) considered tax burden, measured by instrumental (proxy) variables such as the share of direct or indirect taxes in the gross domestic product or the share of tax revenue in the gross domestic product. Taxpayer income, however, is where theoretical and empirical studies diverge, and it seems to play a role in whether the economy is a developing or developed one (of the EU or OECD type). The authors, therefore, used gross domestic product per capita, the size of the government sector (public sector), and the level of regulation within the economy. For these purposes, they chose the share of government consumption in gross domestic product. According to the authors, a higher inflation rate contributes to the tendency of taxpayers to evade taxes as they try to preserve their purchasing power. Regarding the openness of the economy, its greater closeness may contribute to tax evasion, as the economic and administrative constraints imposed regulate business activities.

However, most articles focus on the mix of macroeconomic, institutional and individual factors. Buehn and Schneider (2012) estimated the size of the informal economy and the resulting tax evasion for 38 OECD countries between 1999 and 2010. For their estimation, they considered personal income tax, indirect taxes, tax morale, unemployment, self-employment, and entrepreneurial freedom. They also considered the tax burden on personal income, emphasising labour taxation and potentially noticeable savings if employees' wages are paid within the informal economy, the quality of public institutions, given the efficiency of applying tax laws without overburdening taxpayers, and the area of regulation of business freedom, such as the labour market regulation or regulation of business activities. The size of the informal economy is undoubtedly affected by public sector services; if the state fails to collect sufficient taxes to secure tax revenues, it cannot provide citizens with quality public goods and services. Thus, countries with higher tax revenues while maintaining lower tax rates, and with a good legal system and lower levels of corruption typically have a smaller informal economy. They also included tax morality, which can be fostered by the state providing quality public goods and services to its citizens in return for the taxes collected, psychological aspects of how tax authorities treat taxpayers, and intimidation of taxpayers through penalties and sanctions. The results show that these factors are not equally important in all countries. However, general patterns can be observed, suggesting that indirect taxes, self-employment, unemployment rates, personal income tax,

tax morale, the index of business freedom, and GDP growth have a predominant influence in all countries. Using the same sample of 38 OECD countries for 1999 – 2010, Buehn and Schneider (2016) subsequently estimated based on the Multiple Indicators and Multiple Causes Model (MIMIC).

Yalama et al. (2013) also focused on tax morale and tax and fiscal factors such as the level of nominal rate or rates, tax incidence rate, etc. The economic factors included the rational behaviour of individuals, cost-benefit analysis, utility maximisation, etc. Demographic characteristics were represented by age, gender, marital status, and the number of children. Political features included the level of democracy in the country or the fair (normal) distribution of income, which is not typical for developing countries. They also considered administrative factors – tax penalties or tax audits, and additional factors, such as the informal economy. The regression analysis results showed a statistically significant positive relationship between tax evasion and tax and fiscal factors; if there is an increase in the tax burden as part of the tax burden, there will be an increase in tax evasion. Similarly, there was a positive relationship between tax evasion and administrative factors; conversely, economic factors and education had a negative effect, with taxpayers with less education being more likely to evade taxes than taxpayers with more education. Also, in the case of higher income, it has been shown that these taxpayers are not tax evaders and are more likely to pay taxes.

According to Rantelangi and Majid (2017), it is appropriate to consider tax knowledge/education (tax education) or tax literacy (i.e. how well the taxpayers understand tax laws and can apply this knowledge to pay taxes) among the main factors. They hypothesised that tax education harms the taxpayers' perception of tax evasion. In the case of tax morale, namely, the motivation to comply with the tax reporting and payment obligations and to participate in the financing of the public goods and services that the state financially provides, they also predicted a negative effect, namely, that higher tax morale reduces the rate of tax evasion. They also see lower incentives for tax evasion in a properly designed, fair, and understandable tax system. As an additional factor, they consider the cost of tax compliance, including not only the taxpayer's time but also the time of the tax expert, the psychological costs, and the overall costs that the taxpayer has to incur. If the costs are high, then taxpayers tend to evade or avoid tax, so compliance costs positively affect tax evasion.

Tax evasion in Greece was addressed by Diakomihalis (2020), who considered the following factors: the human and cultural capital of taxpayers, the distribution of a tax burden, the tax burden, the management of public finance, the structure of the tax system, the organisation and level of tax services, the development and organisation of the national economy, the organisation of the market, and the

structure of national income. He first listed the area of education and included business ethics, tax ethics, and educational attainment among the sub-criteria. He also identified the area of legislative complexity (frequent changes in laws, incomprehensibility of laws, bureaucracy, and ignorance of current tax legislation). The third area was the opacity of public financial management (waste of public resources, propensity for corruption among tax administrators, poor management, and lack of transparency in tax administration). The fourth area was impunity for tax evasion (light penalties for tax evasion, corruption among tax administrators, and tax amnesty). The fifth and final area was excessive taxation (additional taxation over and above regular and unfair taxation).

One of the most recent is the study by Safuan et al. (2022), which analyses the magnitude of tax evasion in Indonesia during 1980 – 2019. They examine the causes of tax evasion based on income (economic development), financial development, tax burden, and urbanization. They also include the ratio of trade to GDP, the level of corruption, and the level of education. Their results confirm the expected impact of financial and economic development.

If we were to mention specifically one of the most frequently affected taxes in terms of tax evasion, it would undoubtedly be VAT. The VAT gap (the difference between the theoretical VAT liability across the economy and the actual VAT collected) affects VAT collection and impacts income tax revenues and, for individuals, overlaps with social security contributions. Holá et al. (2022) analysed VAT evasion for 25 EU countries using panel data from 2002 to 2018. In addition to tax factors (implicit consumption tax rate, number of tax rates) and anti-avoidance measures (such as the introduction of VAT listings or reverse charges), they also analysed the impact of the economic factors (maturity of the economy, final consumption of households and non-profit organisations, unemployment, the openness of the economy) and institutional (perceptions of corruption, economic freedom). The study results show that, for example, the introduction of VAT listings accounts for 21 percent of the average VAT per capita gap. Final consumption, the implicit tax rate on consumption, and the size of the openness of the economy increase the VAT gap. At the same time, the corruption perception index and the prevalence of credit card payments decrease it. Youngrok et al. (2022) focus on cash and non-cash payments, for which they also conclude the positive effect on VAT evasion. Lesnik et al. (2018) focused on the Slovenian government's measures for better VAT collection. According to their conclusions, the number of VAT audits is important and can reduce the VAT gap. Zídková and Pavel (2016) find that an increase in VAT revenue reduces the VAT gap and that a higher difference between the standard and reduced VAT rates increases the VAT gap. Finally, the share of household consumption in GDP increases the VAT gap.

A similar method we used for our analysis can be found in the paper by Anastasiou et al. (2021). The survey showed that the level of tax rates, the level of unemployment, the rule of law index, the level of GDP, the level of non-performing loans, the efficiency of government, the corruption perception index, and the level of final consumption expenditures, significantly affects the extent of tax evasion in Greece.

2. Tax Evasion in the Czech Republic

Nchor (2021) used the MIMIC model and estimated tax evasion in the Czech Republic, Poland, and Hungary from 1990 to 2019. He first estimated the size of the informal economy and then the tax foregone corresponding to the informal economy. He split the estimate into the tax on sales of goods and services and the tax on income and profits. The estimate of the foregone tax on goods and services in the Czech Republic was 3.13 percent as a share of GDP, while the share of the foregone tax on income and profits in GDP was 2.83 percent. The author concluded that the extent of tax evasion is related to self-employment, which is higher in the Czech Republic and Poland. According to the author, the effect of self-employment on the size of the grey economy in both countries is statistically significant. He also found a positive effect of a higher tax burden and more bureaucracy (for example business registration) on the size of the informal economy. The effect of unemployment rates was also statistically significant in all countries.

Stavjaňová (2018) estimated the scope of tax evasion in the Czech Republic between 2008 and 2015 based on a method that is derived from the size of the undetected economy according to the CSO. Again, the estimate includes consumption, income taxes, and social insurance contributions. The estimate of the scope of tax evasion is also significant from a macroeconomic perspective. Thus, in 2018 the Czech Republic lost an estimated EUR 5.16 billion. For this reason, it is also economically relevant to look at the factors that influence tax evasion in the Czech Republic and thus contribute to the lower-than-potential tax collection.

Due to the features of the tax system in the Czech Republic and the different levels of taxation of dependent and independent activities, the importance of the so-called svarcsystem, employees who are taxed on their income in the context of independent activity rather than dependent activity, is also subject to estimations. Finardi and Melicharová (2021) looked at this estimate. They concluded that the Czech Republic collected about EUR 609 million less due to the svarcsystem, or about 3 percent of the total personal income tax revenue. The estimate includes not only tax foregone but also social security contributions.

The European Commission regularly publishes the Centre for Social and Economic Research (CASE, 2022) estimate of the VAT gap across the EU countries. The estimate is based on national accounts data and compares the theoretical tax revenue that could be collected with the actual tax revenue. Data for the Czech Republic show that the size of the VAT gap has been gradually decreasing since 2016.

The VAT gap in the context of the effectiveness of the measures against carousel fraud in the Czech Republic, which is the most serious type of VAT evasion, was addressed by Arltová et al. (2020). They divided the influencing factors into three groups. The first group of variables was the variables that form the VAT base (household consumption expenditure, non-financial investment of government and households, intermediate consumption of government and financial enterprises). The second group was based on the parameters of the VAT system (basic and reduced VAT rates and a variable capturing the shift of almost all services from the reduced to the basic VAT rate in 2004, when the Czech Republic joined the EU) and the third group was related to the implementation of the adopted measures against VAT evasion. Based on an analysis of the quarterly time series of VAT revenue from 1999 to 2016, the authors showed that the total annual increase in tax collected as a result of the measures introduced was, according to the model, approximately EUR 2.16 billion at the end of 2015, representing 14.5 percent of total annual VAT revenue.

2.1. Anti-Avoidance Tools in Place

Since entering the EU, the Czech Republic has introduced several measures to combat tax evasion; what follows are the most important of them.

Within corporate income tax, the OECD's BEPS (Base Erosion and Profit Shifting) initiative is one of the key measures to prevent the dilution of tax bases and the shifting of profits to jurisdictions with more favourable tax regimes. The Czech Republic was one of the countries that took an initiative approach to this action plan and started implementing individual measures in 2017. In addition, the Anti-Tax Avoidance Directive (ATAD) was implemented in the Czech legal system and it is effective from 1 April 2019. These measures are particularly relevant for large corporations with more diverse options for creative tax planning. Starting from the tax year 2020, a regulation for transferring assets without a change of ownership (the so-called Exit Tax, another measure under the ATAD) has been introduced against circumventing the Czech Income Tax Act and shifting taxation away from the Czech Republic to lower tax jurisdictions. Thanks to this arrangement, the Czech Republic does not lose tax revenue. The transfer is treated as a transfer for consideration at arm's length between unrelated parties, subject to Exit Tax.

In the case of VAT, several measures have been introduced, the most important of which is the reverse charge, which is aimed at carousel fraud, where under the standard regime, the supplier deducts VAT from the provided supply. Under the reverse charge, the customer pays VAT on the supply received and s/he is entitled to deduct it. It was first introduced on gold (2006) and later extended to waste and scrap, and emission allowances (2011), grain, industrial crops, metals, mobile phones, tablets, laptops, and integrated circuit systems (2012), and electricity, gas, and electronic communication services for resale (2016) (Arltová et al., 2020). For cross-border reverse-charge, the control instrument is the summary report, where the taxpayer reports goods or services provided cross-border to a person registered for tax in another Member State.

Additional tools have been introduced in the form of control reporting and EET. Since 2016, taxpayers have been required to electronically submit control reports with details on individual buy and sell transactions, allowing the tax authorities to review the VAT levies and claims in more detail. Electronic sales registration (EET) was introduced in the same year to straighten the business environment and improve tax collection. However, this measure was abolished on 1 January 2023. Other measures include the introduction of the institute of liability for unpaid tax (2011), the institute of the unreliable taxpayer, and the institute of the unreliable person.

3. Analysis of Tax Evasion in the Czech Republic

3.1. Data

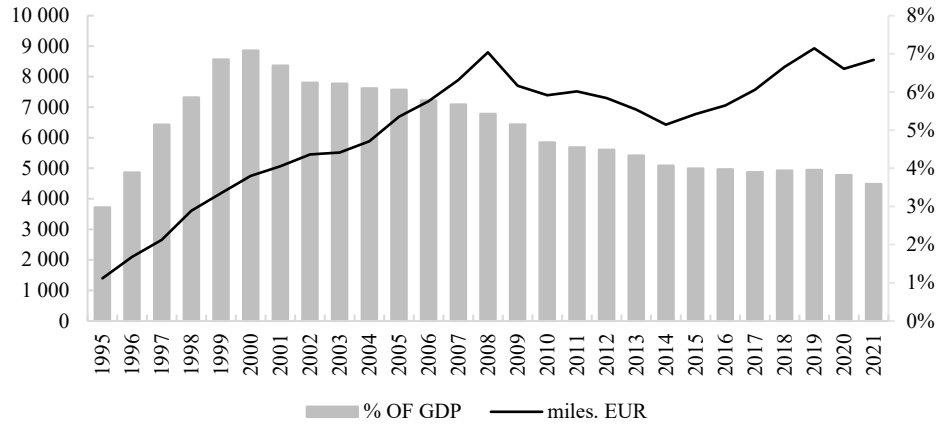
Estimation of Tax Evasion

If we want to conduct a quantitative analysis of tax evasion, we first need to estimate it. One possibility is using the monetary cash/deposit ratio (Gutmann, 1977). The method assumes that the cash/deposit ratio is only affected by changes in taxation and other government regulations that change how people make payments. These changes are because people want to hide certain activities to avoid taxation and restrictions (OECD, 2002). This method has been adapted by Pickhardt and Sarda (2011a; 2011b) and used by, for example, Habibullah et al. (2017) and Safuan et al. (2022). Our estimate is based on Josková (2022). The base year was set in 1993 when the independent Czech Republic was established and the monetary reform has begun. The assumption was that the informal economy operates only on a cash basis and that the money turnover rate of the informal and official economies is identical, defined as the ratio of GDP at current prices to the monetary aggregate M1. This was the assumption used to make estimates until

2001. Since 2002, the calculations have been modified following Hanousek and Paldo (2006), who pointed out the development in banking and the trend of cashlessness. 2001 has marked a boom year in cashless payments and the method thus became inapplicable for transition economies due to the intense innovations in the financial sector. After estimating the informal economy to determine tax evasion, the size of the informal economy was multiplied by a composite tax quota. The resulting estimate of tax evasion in millions of euros and as a percentage of GDP is presented in Figure 1.

F i g u r e 1

Estimated Tax Evasion in EUR Million and Percents of GDP in the Czech Republic



Source: Own calculation.

From the estimate in Figure 1, it is clear that the share of tax evasion in GDP in the Czech Republic has been gradually decreasing since 2000. From a value of over 7 percent in 2000, the share in GDP reached 3.6 percent in 2021. In absolute terms (millions of EUR), the downward trend can be marked only during a short period of 2009 – 2014, which may be caused by the consequences of the financial crisis in the years 2008 – 2009, and during the period affected by the COVID-19 pandemic, which started to significantly impact the Czech economy in 2020.

Selected Factors

What are the most important determinants of tax evasion in the Czech Republic? The size of tax evasion depends on many factors. The literature summarised in the introductory part of this paper highlights the specific causes and indicators used. Some of these measures will be also adopted here along with additional measures which were introduced in the Czech Republic to curb tax evasion.

Our selected factors are divided into three groups (Table 1). This section describes each factor and justifies its inclusion in the analysis.

T a b l e 1

Selected Factors

Variable	Description	Predicted impact	Data source
	Economic		
GDP	Gross domestic product (EUR million)	(+)	Eurostat (2023)
I	Inflation (represented by the consumer price index, percent)	(+)	CZSO (2023b)*
S	Gross national savings (EUR million)	(+)	CZSO (2023a)*
U	Unemployment rate (percent)	(+)	CZSO (2023a)
W	Average wage (EUR)	(+)	CZSO (2023c)*
	Tax		
AA	Tax audits overpayments (EUR million)	(–)	MFCR (2023)*
AQ	Number of tax inspections	(–)	MFCR (2023)
TR	The personal income tax rate	(+)	Eurostat (2023)
TB	Tax burden index (0 – 100)	(+)	Heritage (2023)
PIT	Personal income tax collections, composed of PIT collections from returns and employment (EUR million)	(–)	Financial admin. (2023)*
CIT	Corporate tax collections from returns (EUR million)	(–)	Financial admin. (2023)*
VAT	VAT collection (EUR million)	(–)	Financial admin. (2023)*
D11	Extension of reverse-charge to waste and scrap, and emission allowances (dummy, = 1 in 2011, = 0 otherwise)	(–)	Own
D12	Extension of reverse-charge to grains, industrial crops, metals, mobile phones, tablets, laptops, and integrated systems circuits (dummy, = 1 in 2012, = 0 otherwise)	(–)	Own
D16	Extension of reverse-charge to electricity, gas, resale electronic communication services and introduction of VAT listings and EET (dummy, = 1 in 2016, = 0 otherwise)	(–)	Own
D19	ATAD implementation (dummy, = 1 in 2019, = 0 otherwise)	(–)	Own
D20	Exit Tax implementation (dummy, = 1 in 2020, = 0 otherwise)	(–)	Own
	Institutional		
GI	Index government integrity (0 – 100; values from 1: the lowest government integrity to 100: the highest government integrity)	(–)	Heritage (2023)
MF	Index monetary freedom (0 – 100)	(+)	Heritage (2023)
TF	Trade freedom index (0 – 100)	(+)	Heritage (2023)
BF	Index business freedom (0 – 100)	(+)	Heritage (2023)
CN	Number of credit card transactions	(–)	BCA (2023)*
CV	Transaction volume (thous. EUR)	(–)	BCA (2023)

Note: * converted from CZK to EUR

Source: Own processing.

The first group consists of economic factors. As one of the key economic indicators, Gross Domestic Product (*GDP*) shows the economy's performance. If it grows, new jobs and new companies are being created, which can increase the scope for tax avoidance. Inflation (*I*) refers to a general rise in the price level. In times of rising prices, people can buy less with their income, and the real interest

rate falls, which can discourage individuals and firms from saving and encourage them to spend more. The deteriorating living situation of one group and the increasing consumption of the other one may lead to increased tax evasion. Those who consume more may shift their activities to the informal economy. Gross National Savings (*S*) is the sum of public and private savings in a country. If public savings rise, people may believe that the government is not investing in public goods; instead of paying taxes, they may resort more to tax evasion. When private savings grow and savings accounts remain unattractive, savings may be spent on goods and services outside the scope of the formal economy (i.e. no receipts issued), intending to circumvent the tax system. The unemployment rate (*U*) characterises the share of those unemployed in the total labour force. The unemployed are paid state social assistance benefits but can earn extra money. When the average wage (*W*) rises, people earn more on average and thus have to pay more taxes, so they may tend to engage in tax evasion.

The second group consists of tax indicators. A higher number of tax audits by the tax administration (*AQ*) and higher tax deductions from them (*AA*) may make taxpayers fear a possible tax audit and thus avoid tax evasion. Conversely, a higher personal income tax rate (*TR*) may increase the incentive for tax evasion, as entrepreneurs declare less revenue to be taxed; similarly for a higher taxpayer burden index (*TB*). Higher personal income tax (*PIT*) collection means the opposite: no tax evasion. With the development of computerisation in filing corporate income tax (*CIT*) returns, tax collection increases while tax evasion drops down. The increase in *VAT* collections may be due to the effectiveness of anti-avoidance tools and the computerisation of the tax code, which makes it more difficult to evade taxes. The anti-avoidance instruments that were introduced are described separately in the previous section, so we will give a brief list of the indicators used, all of which are in the form of zero-one dummy variables (where = 1 in the year of the introduction of the measure, = 0 otherwise): *D11* and *D12* is the extension of the reverse-charge, *D16* is the further extension of the reverse-charge and the introduction of VAT listings and EET, *D19* is the implementation of ATAD, *D20* is the introduction of Exit Tax.

In the third group, we include institutional factors, which we draw on Heritage (2023). The Government Integrity Index (*GI*) is derived from the Corruption Perception Index; when taxpayers perceive the government as transparent and capable, they are less likely to resort to tax evasion. The Monetary Freedom Index (*MF*) is determined using the weighted average inflation rate over the last three years and price controls. Price stability without microeconomic interference is ideal for a free market, and market activity is not distorted. The market allows the free movement of labour, capital, and goods. However, taxpayers may see more

significant opportunities for tax avoidance. The trade freedom (*TF*) index is a composite measure of the absence of tariff and non-tariff barriers that affect the import and export of goods and services. Free trade can result in less government surveillance and better agreement between partners on tax evasion (e.g. in carousel deals). The business freedom (*BF*) index is an indicator that considers government regulation; the more freedom the businesses have, the more they take advantage of tax evasion. The number of credit card transactions at merchants (*CN*) and the volume of payments made by merchants (*CV*) are based on the assumption that illegal activities are cash-based. Therefore, the more people use credit cards, the less tax evasion they perform, and the more cashless payments are recorded, the more people comply with the law.

3.2. Methods

The above factors are available as annual time series for 1995 – 2021. Multivariate time series analysis is an appropriate method for analysing their impact on the estimated size of tax evasion. Given the assumptions set, this will be a single-equation model in which the estimated tax evasion (*TE*) will be an endogenous variable, and the factors from Table 1 will be exogenous variables.

The type of model is evident after testing the order of integration of individual time series using ADF unit root tests (Dickey and Fuller, 1979) because their construction is based on the assumption that only time series that are of the same order of integration as the variable being explained can be included in the model. The results in Table A1 in the appendix show that at the 5 percent significance level, the explained variable *TE* is non-stationary of type I(1) and non-stationary of type I(1) are the other time series, except *BF*, *CN,* and *CV*, which are of type I(2). In the case of the business freedom index, the number of credit card transactions, and the volume of credit card transactions, we can already conclude that these factors cannot affect tax evasion because they follow a different dynamic than the explained variable.

Based on the above, it is clear that the model will be constructed from non-stationary time series of type I(1). Therefore, the estimated models may contain both short-run and long-run relationships. We verify whether long-run relationships can be shown by the Engle-Granger cointegration test (Engle and Granger, 1987), which is based on the analysis of the residuals of a static regression model

$$y_t = \alpha + \beta x_t + \varepsilon_t \tag{1}$$

If the residues $\hat{\varepsilon}_t$ of the model (1) are stationary I(0), then the time series are cointegrated; if they are non-stationary I(1), it is a spurious regression. Due to the nature of economic data, which is often loaded with autocorrelation, the model (1)

is usually not sufficient and needs to be dynamised by adding time-lagged explanatory and explanatory variables, and this dynamic model is then referred to as ADL(m, n, p) (Autoregressive Distributed Lag) (Hendry et al., 1984)

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{p} \sum_{i=0}^{n} \beta_{ij} x_{jt-i} + \varepsilon_t \tag{2}$$

where t represents time, y_t is an explained variable, x_{it} is a *k-dimensional* vector of p explanatory variables, α_0 is the constant, α_i are the short-run parameters of the lagged explained variable, β_j are the short-run parameters of the explanatory variables, and $\varepsilon_t \sim \text{IID}(0, \sigma_{\varepsilon_t}^2)$.

The Error Correction Model (ECM, Engle and Granger, 1987) separates short-run and long-run relationships and expresses how much the explanatory variable deviates from an equilibrium relationship with the explanatory variables. According to Banerjee et al. (1993), it can be written as

$$\begin{aligned} \Delta y_t = \alpha_0 + \sum_{i=r+1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{p} \beta_{j0} \Delta x_{jt} + \sum_{j=1}^{p} \sum_{i=1}^{r} \zeta_{ji} x_{jt-i} + \sum_{j=1}^{p} \sum_{i=r+1}^{n} \beta_{ji} x_{jt-i} + \\ + \sum_{i=1}^{r} \gamma_i (y_{t-i} - \sum_{j=1}^{p} \theta_j x_{jt-i}) + \varepsilon_t \end{aligned} \tag{3}$$

where $\theta_j = -(\sum_{i=1}^{r} \gamma_i + \sum_{i=r+1}^{m} \alpha_i)^{-1} \left[\sum_{i=1}^{r} (\zeta_{ji} - \gamma_i) + \sum_{i=r+1}^{n} \beta_{ji} \right]$ is the long-run multiplier, and $\gamma_1 = \alpha_1 - 1$, $\gamma_i = \alpha_i$, $\zeta_{j1} = \alpha_1 - 1 + \beta_{j0} + \beta_{j1}$, $\zeta_{ji} = \alpha_i + \beta_{ji}$, $i = 2, ...,$ $r = \min(m, n)$. The assumptions made on the non-systematic component of the model will be tested with the Breusch-Godfrey (Breusch and Godfrey, 1986), ARCH (Darnell, 1994), and Jarque-Bera (Jarque and Bera, 1980) diagnostic tests. The results of all these tests, performed at the 5% significance level, are shown in Table 2 with the model estimates.

3.3. Results

In addition to the spurious regression problem already considered, the predictive power of time series models is often affected by the multicollinearity of exogenous variables, which was also identified in our group of exogenous variables. In order to eliminate this problem, and not to lose important information if we were to exclude these variables from the model a priori, five regression models were estimated for the time series of tax evasion (*TE*) such that there are no multicollinear variables together in one model; thus, the model A is based on Equation (2) and the models B-E on Equation (1).

Table 2

Model Estimates

Dependent: TE	Model A		Model B		Model C		Model D		Model E	
Variable	*Coeff.*	*Prob.*	*Coeff.*	*Prob.*	*Coeff.*	*Prob.*	*Coeff.*	*Prob.*	*Coeff.*	*Prob.*
C	–5642.9	0.0000	–11732.2	0.0008	–14919.4	0.0000	–9140.3	0.0003	–13599.0	0.0004
TE(–1)	0.645	0.0000								
AA			–3.047	0.0074	–4.891	0.0001	–5.131	0.0004	–4.834	0.0001
PIT			0.894	0.0000						
GDP	0.048	0.0000								
GDP(–1)	–0.032	0.0000								
I					55.517	0.0003				
MF					87.274	0.0096			111.295	0.0011
CIT							0.706	0.0000		
S	0.084	0.0002								
TF	21.685	0.0161	117.581	0.0005	133.288	0.0011	157.401	0.0001	128.781	0.0020
TR	251.783	0.0000	309.131	0.0299						
U	148.607	0.0004	304.458	0.0005			170.728	0.0549		
VAT	–0.332	0.0005								
W									2.476	0.0004
D20	–466.67	0.0234					–1158.6	0.0920		
R-sq.	0.9977		0.9606		0.9388		0.9350		0.9376	
Adj. R-sq.	0.9965		0.9512		0.9277		0.9195		0.9263	
Engle-Granger	–4.1396	0.0038	–4.6648	0.0010	–4.3247	0.0023	–4.4801	0.0016	–4.4552	0.0017
Breusch-Godfrey	0.1774	0.8393	0.6595	0.5285	0.8621	0.4374	0.1486	0.8629	0.6051	0.5557
ARCH	0.8570	0.3642	0.9167	0.3479	0.1319	0.7196	0.3784	0.5442	0.4179	0.5241
Jarque-Bera	2.2486	0.3249	4.0316	0.1332	5.9752	0.0504	6.2700	0.0435	3.2311	0.1988

Source: Own calculation.

The Engle-Granger test for cointegration was performed on the residuals of the estimated models. At the 5% significance level, the test rejected the apparent regression for all models and therefore the time series are cointegrated. Thus, long-run relationships can be identified between the time series, whose equation[2] expression is as follows

(A) $\widehat{TE}_t = -15899.3 + 0.05GDP_t + 0.24S_t + 61.10TF_t + 709.42TR_t + 418.71U_t - 0.94VAT_t - 1314.9D_{20}$,

(B) $\widehat{TE}_t = -11732.2 - 3.05AA_t + 0.89PIT_t + 117.58TF_t + 309.13TR_t + 304.46U_t$,

(C) $\widehat{TE}_t = -14919.4 - 4.89AA_t + 55.52I_t + 87.27MF_t + 133.29TF_t$,

(D) $\widehat{TE}_t = -9140.3 - 5.13AA_t + 0.706CIT_t + 157.40TF_t + 170.73U_t - 1158.6D_{20}$,

(E) $\widehat{TE}_t = -13599 - 4.83AA_t + 111.29MF_t + 128.78TF_t + 2.48W_t$.

Diagnostic tests of all models (Breusch-Godfrey, ARCH and Jarque-Bera) indicate that the unsystematic component has the properties of a white noise process.

It may seem that five estimated models are too many. However, given the large number of exogenous variables and the fact that parameter estimates of the factors repeated in multiple models do not differ much, we feel their number is justified. At the same time, it is not important to focus on specific numerical estimates of each parameter as only their signs, that is the direction of their effect on tax evasion, will be of interest.

Our results show that the factors of tax audit avoidance (*AA*), VAT collection (*VAT*), and the implementation of tax measures introduced in 2020 (*D20*) have an inversely proportional effect on tax evasion; thus, an increase in the values of these factors causes a decrease in tax evasion in the Czech Republic. However, in the case of the measures introduced in 2020, it can be assumed that in addition to them, economic measures adopted during the COVID-19 pandemic had also a significant impact.

On the contrary, gross domestic product (*GDP*), personal income tax collections (*PIT*), corporate income tax collections (*CIT*), inflation (I), monetary freedom (*MF*), gross national savings (*S*), trade freedom (*TF*), personal income tax rate (*TR*), unemployment (*U*), and average wage (*W*) act in direct proportion to tax evasion. For all these factors except *PIT* and *CIT*, our assumptions about the direction of the effect on our estimated tax evasion are confirmed, so there is no need to change our justification of these assumptions in Section 3.1. However, we need to reflect on the estimated positive effect of corporate income tax (*CIT*) collections, where an increase in CIT collections increases tax evasion compared to our assumption.

[2] In the case of the model (A), these are the recalculated parameters θ_j from Equation (3).

This can be justified by the fact that firms are trying to optimise their taxes more, distorting their tax bases and, last but not least, also shifting their profits to jurisdictions with lower tax rates. The electronic filing of tax returns seems to be still in its infancy and thus has no impact on reducing tax evasion.

In addition to the factors for which a statistically significant effect was identified, we also identified factors that, contrary to our assumption, do not affect tax evasion. In addition to business freedom (*BF*), the number of credit card transactions by merchants (*CN*), and the volume of payments made by merchants (*CV*), for which an effect was already ruled out after ADF tests, no statistically significant effect was found for the number of tax audits (*AQ*), government integrity (*GI*), and tax burden (*TB*). Similarly, the impact of anti-avoidance tax measures in 2011, 2012, 2016 and 2019 was not demonstrated, which can be explained by the fact that these measures were not targeted at tax evasion in general but were specifically targeted at VAT evasion.

3.4. Discussion

Tax evasion in the Czech Republic is counteracted by tax audits (Pommerehne and Weck-Hannemann, 1996; Lesnik et al., 2018), VAT collection, and measures taken in 2020, consistent with our assumptions. For VAT collection, it should be emphasised that this tax is administratively very demanding (Heinemann and Stiller, 2023; Kitsios et al., 2020; Madzharova, 2020, Holá et al., 2022). Tax authorities have on a routine basis access to multiple control mechanisms, such as control reports or summary reports. In contrast, the results of our analysis confirm that factors such as gross domestic product (Buehn and Schneider, 2012), PIT collection (Buehn and Schneider, 2012), CIT collection, inflation (Pommerehne and Weck-Hannemann, 1996; Caballe and Panades, 2004; Tabandeh et al., 2012; Buehn and Schneider, 2012), monetary freedom, gross national savings, trade freedom, PIT rate (Yalama et al., 2013), unemployment (Buehn and Schneider, 2012), and average wage contribute to tax evasion.

The econometric analysis we used can be compared with that of Anastasiou et al. (2021). Here too, the authors examined similar factors to those included in our analysis. These are the unemployment rate, GDP and other similar variables.

Conclusion

Estimating factors that positively or negatively affect the size of tax evasion is particularly important for a country's tax policy. For our analysis of tax evasion, multivariate time series cointegration analysis was used, where the presence of

multicollinearity of explanatory variables was creatively dealt with so as not to lose information from the excluded variables.

This paper focuses on data from the Czech Republic which fact eliminates the possibility to compare the results with different types of economics. Furthermore, tax evasion is nothing which can be statistically expressed. There are several types of methods which can be used for the estimation of tax evasion. We used cash/deposit ratio which is one of the monetary methods. Alternatively, another monetary method or a different type of method can be used.

However, there are always limitations in every used method. This paper can be supplemented by further factors which affect tax evasion. Our results support the validity of economic paradigms from the research on tax evasion factors in other countries as they apply also to the Czech Republic. Moreover, they are complemented with results specific only to the Czech Republic's tax system which has over the last decade introduced a number of anti-avoidance measures both in the area of VAT and income taxes.

For PIT collections, it is worth noting the interdependence with social security contributions, whose collection is also affected by PIT evasion. In the Czech Republic, we have a relatively liberal approach to the taxation of the income of individual entrepreneurs, who legally reduce their tax bases through lump-sum expenses.

On the other hand, for a long time we have lacked an effective instrument for controlling the actual income collected by individual entrepreneurs, which leads to the fact that this income is concealed and, therefore, not included in the real statistics of the tax administration. Although the electronic registration of receipts was gradually introduced in several waves, its full implementation was halted by the COVID-19 pandemic, and subsequently, this measure was abolished entirely. The so-called 'svarcsystem' where some employees legally shift to another subbase and thus tax their income as sole traders has a partial impact as well.

In the case of VAT, income registration is on the other hand comprehensive, as legal entities are obliged to keep accounting records. However, globalisation and the degree of economic freedom have a negative impact in this respect, as it allows tax bases to be legally diluted and, in particular, shifted to other countries where the level of taxation is significantly lower. This is typically achieved not only through tax havens but, in particular, through international double-taxation treaties.

Therefore, it would be advisable to strengthen measures to curb aggressive tax planning in this area. Based on the results of our analysis, it can also be assumed that factors such as PIT collection, monetary freedom, and trade freedom will have a synergistic effect and are interrelated.

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Appendix

Table A1

ADF Tests of Unit Root

	y_t		Δy_t		$\Delta^2 y_t$		**Type of integration**
	Stat.	***Prob.***	***Stat.***	***Prob.***	***Stat.***	***Prob.***	
TE	–2.801	0.0719	–3.186	0.0027			I(1)
AA	–1.205	0.2028	–5.597	0.0000			I(1)
AQ	–0.606	0.8528	–4.021	0.0050			I(1)
BF	–2.465	0.1371	–1.607	0.1101	–11.269	0.0000	I(2)
CIT	–2.252	0.1943	–3.712	0.0114			I(1)
CN	2.304	0.9998	3.967	0.9999	–3.455	0.0092	I(2)
CV	0.805	0.9908	8.280	0.9999	–2.510	0.0238	I(2)
GDP	–2.096	0.5238	–4.960	0.0005			I(1)
GI	0.665	0.8533	–3.840	0.0005			I(1)
I	–1.801	0.3717	–3.301	0.0257			I(1)
MI	–2.821	0.0691	–4.881	0.0000			I(1)
PIT	–2.429	0.3573	–5.275	0.0000			I(1)
S	–2.015	0.5664	–5.263	0.0003			I(1)
TB	–2.520	0.1226	–4.610	0.0001			I(1)
TF	0.534	0.8243	–4.254	0.0002			I(1)
TR	–2.724	0.0835	–4.272	0.0001			I(1)
U	–0.675	0.4141	–3.856	0.0005			I(1)
VAT	5.088	1.0000	–4.814	0.0008			I(1)
W	5.004	1.0000	–2.210	0.0288			I(1)

Source: Own calculation.