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Unstable government revenues in uncertain times: which taxes are especially volatile?

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Abstract

Motivation: External shocks affect the performance of economies. This is especially true recently after COVID-19 pandemics and ongoing war in Ukraine. States struggle to maintain their revenues in order to avoid skyrocketing public debts. Yet, especially now, governments face challenges connected with high uncertainty of inflows from the taxes.
Aim: The aim of the article is improvement in understanding of the variability of government revenues sourced from selected taxes binding in the EU Member states as well as the potential reasons for their fluctuations.
Results: The calculations are made based on empirical data for EU Members states for the period 1996–2021. There are ten taxes that were considered — both those of key importance for budgets in most jurisdictions as well as some sectoral or specific more niche levies. Study is executed with usage of statistical tools that include calculation of coefficient of variation, modified trend curve estimation with use of Hodrick–Prescott filter, correlation of such trend with empirical data, comparison of coefficient of variation for empirical data with numbers produces by Hodrick–Prescott filter and two-way ANOVA without replications, while controlling for the states. Corporate income taxes, Excise duty as well as most specific and sectoral taxes that include Taxes on capital transfers, Car registration taxes, Taxes on insurance premiums or Tax on lotteries, gambling and betting are generally characterized by greater variability in terms of revenues they provide than Payroll taxes, Real estate taxes or Value added taxes. Due to insufficient research in previous studies in this respect, findings presented in this article may provide for a useful hint for policy-

makers in further design of optimal tax system that would provide for stable and predictable sources of income to the government.

Keywords: public finance; government revenue; taxation
JEL: H20; H21; K34; E62

1. Introduction

Numerous countries struggle with significant public debts. At the end of second quarter 2022, six EU Member states (Belgium, France, Spain, Portugal, Italy and Greece) feature government debt that exceeds 100% of their local GDPs. Although sharp increase of those numbers during COVID pandemics has been to some extent amortised by accelerated inflation, expansionary monetary policy cannot be further continued to avoid harming the economy in the long term. Thus, there is a need for consolidation of fiscal policy. Taking into consideration expenditure requirements, which are difficult to cut from political perspective, focus should be laid on maintenance of tax revenues.

Taking into consideration the above, there is need to track the performance of different taxes in terms of revenues they produce. The topic receives increased attendance in recent period, which is confirmed in several studies that deal either with tax buoyancy or the issue of sustainability of public finance (e.g. Arachi et al., 2015; Arnold, et al., 2011; Baiardi et al., 2018; Gemmell et al., 2014; Jinjarak et al., 2019; Lagravinese et al., 2018; 2020 or Ormaechea & Yoo, 2012).

This research contributes to this body of knowledge. Study is done on empirical data for EU Member states by application of several statistical calculations. This study considers budget revenues from different taxes earned by all (or at least most — depending of data availability) countries belonging to the Community. The cornerstone was the analysis of as many different taxes as possible. However, due to limitations with access to figures it was limited to 10 different levies — Personal income tax, Social security contribution, Corporate income tax, Value added tax, Excise duty, Real estate tax, Taxes on capital transfers, Car registration tax, Taxes on insurance premiums and Tax on lotteries, gambling and betting.

The article is organised as follows. The literature review highlighting consequences of instable government expanses is followed by findings on volatility of tax revenues in various jurisdictions. Consequently, a research gap is identified and presented. Then data used and research methodology applicable to the study are discussed in detail. Finally, strengths and weaknesses of the applied methodology are underlined. Subsequently, results of the analysis are presented. In discussion section, the results are additionally interpreted and assessed from the perspective of their novelty and compared with findings of other authors. Eventually, conclusions are drawn that include general summary of the article, its results and findings. Moreover, practical recommendations for policymakers are outlined. Finally, research limitations are indicated which are followed by suggestions for future research.

2. Literature review

2.1. Volatility of government expenses

Available literature is predominantly oriented on analysis of government spending rather than on revenues. For example, a number of research has focused on desirable composition of public expenditure from the perspective of fostering economic growth. Commonly raised issues are education (Lucas, 1988), public infrastructure (Barro, 1990) or R&D (Romer, 1990). Furthermore, most available studies with respect to buoyancy of fiscal policy were done for USA and for OECD countries. In particular, several papers were published on the impact of volatility of fiscal policy on the scale of business cycles (Alesina & Bayoumi, 1996; Canova & Pappa, 2004; Lane, 2003; Poterba, 1994). These studies found that restrictions of government expenditure result either in slower adjustment of economies to long-term balance or such restrictions are insignificant. Ramey and Ramey (1995) found that there is a negative relationship between the GDP growth and the volatility of government spending. According to Furceri (2007), who analysed a set of 99 countries in the period 1970–2000, a 1 percent increase in government spending volatility transforms into 0.78 percentage point decrease in long-run growth of the economy. Alesina and Ardagna (2010) who considered data for the OECD in the period 1970 to 2007 concluded that tax reductions are more likely to boost economic growth rather than expansionary fiscal policy. They found that spending cuts are also more effective in terms of deficit and debt reductions. Concurrently, they estimated that 1% increase in the tax revenue cyclicality transforms into smaller growth pace of 1/3 percentage point. Gnangon, who worked on a set of data for 146 countries for the period 1981–2016, arrived at the conclusion that instability of government revenues leads to a lower share of the tax revenues in GDP that transforms into public expenditure instability, whereas the negative effect is particularly visible among the less advanced economies (Gnangnon, 2022).

Blanchard and Perotti (2002) indicated that the tax shocks affect investment, consumption and output. Some studies, while focusing on the design and maintenance of tax system, stressed the redistribution function of taxes (Cornia, 2010 or Gordon & Li, 2009).

In this view — as this was suggested — tax revenues need to be stable to assure the role of public policy is fulfilled (Fricke & Süssmuth, 2014). Those research — although generally tackled volatility of fiscal policy — did not precisely analyse revenue side. Nevertheless, findings of these studies highlight the necessity for uninterrupted flow of sources to the state budget.

2.2. Volatility of tax revenues — studies for US

Studies focusing specifically on volatility of revenues from different taxes are limited. In addition, most of them focus on US. One of the first contributions in this respect was made by Wilford (1965) as well as Shapiro and Legler (1968), who were concerned about stable financing of government expenditures. Williams et al. (1973) made their study based on data for all US states for the period 1952–1970 and sought to analyse the stability of seven different taxes. They concluded that their findings did not meet the initial assumptions as revenues from individual income tax, alcohol and tobacco taxes were more volatile than expected. White (1983) was concerned about optimal composition of revenues from various taxes from the perspective of minimization of their responsiveness to business cycles. Fox and Campbell (1984) measured elasticity of sales tax, which they found procyclical and hence unstable. Skinner (1988) underlines that removal of uncertainty related to future tax policy should produce a welfare gain of 0.4 percent of national income.

Dye and McGuire (1991) observed that under certain circumstances sales taxes are more volatile than those relying in income. Holcombe and Sobel (1997) argued that in practice it is not possible to avoid cyclicality. They suggested that instead governments should save some surplus money in prosperous times in order to use them in periods of economic downturn. Bruce at al. (2006)estimated that income elasticity of profit taxes is higher than that of sales taxes. Cornia and Nelson (2010) suggest that states should adjust their tax systems to composition of local economies. They propose that the more stable economy the more aggressive tax portfolio could be used.

Yan (2012), who used data for US states for the period 1986–2004, observed that diversification of revenue sources generally reduces instability. However, he argues that the benefits of revenue diversification are not always clear. Kwak (2013) observes that volatility of sales and income tax is connected with the legal composition of its tax base. For example, he proposes to use different income elasticities of particular goods to assure stable revenues from sales tax. At the same time, he acknowledged that such approach may not be fully in line with the idea of optimal tax system. While taxing goods with small income elasticity, economic justice will fall and sales tax will become more regressive. Felix (2008) also stresses the issue of optimal taxation — especially equity and efficiency — in course of design of a tax system that would be characterized by low variability.

2.3. Volatility of tax revenues — studies for other countries

One of the first contributions covering jurisdictions other than US was made by Lim (1983), who focused on developing economies in the period 1965–1973. He observed that instability in government revenue may be followed by instability

of government expenditure. This in turn could result in ineffective development planning, underinvestment or less business confidence.

During 70's and 80's budget expenditures and revenues of most European countries increased (Afonso & Furceri, 2010). From mid-90's in most EU Member states the size of government have been relatively stable. However, still states found it difficult to estimate future inflows from taxes. This may result from several reasons — fiscal drag for progressive taxes, amendments in the tax law (i.e. level of tax rates and size of the tax base) or attitude of economic agents to tax avoidance/evasion (Creedy & Gemmell, 2008).

Afonso and Furceri (2010) claim that both buoyancy of government revenues and public spending has negative effect on economic growth. They found that social security contributions and indirect taxes (such as VAT) affect growth in EU and OECD states. According to their research direct taxes (e.g. income taxes) proved not to have significant impact on GDP increase. Their study revealed that volatility of indirect taxes and buoyancy of social security contributions negatively affect economies in OECD countries and EU states, respectively. Alesina et al. (1995) also investigated data for OECD members. According to their research budget adjustments are more successful when transfers to the public are reduced, wages are lowered and employment cut. At the same time they claimed that increases in taxes are less likely to avoid excessive budget deficit and stop their growth. However, they did not focus specifically on volatility of tax revenues.

Akitoby et al. (2006) claim that due to instable tax revenues public investments are particularly under pressure, whereas spending on current public goods or services is less affected, which could be connected with political costs of such actions. Interestingly, they claim that even in the periods of economic revival public investments do not rise proportionately.

Riscado et al. (2011) analysed 10 EU states for the period 1991–2007 and found that buoyancy of inflows from VAT and income taxes support public expenses for investments. Concurrently, increased revenues from ad-hoc taxes (e.g. capital tax) result in governments spending being directed more on consumption, whereas taxes on production and imports are not statistically significant in this decision-making process. According to their research, volatility of tax revenues highly correlate with GDP changes.

Bleaney et al. (1995) observed that instability of tax revenues takes place primarily among developing countries, with higher inflation and open economies. This is confirmed by Malkina (2021), who considered impact of COVID pandemic on tax revenues in Russian regions and claimed that most vulnerable were those of them, which had less diversified economy. Ebeke and Ehrhart (2012) focused on thirty-seven Sub-Saharan African states for which they analysed data for the period 1980–2005. They concluded that instable government revenues from taxes result in increased volatility and lower level of public investments as well as induces instability of government consumption. They

believe that taxes imposed on domestic sources provide for more stable tax revenues than those exposed to international factors.

Bilicka (2019), who analysed data for OECD states for the period 1990–2016 estimated that corporate income tax revenues are more volatile in states with more generous tax loss offset provisions. Hence, such countries experience significantly more unstable CIT inflows during economic business cycles and especially in recessions.

There is also a novel literature than concerns COVID pandemics and tax revenues. In this respect scientists sought to measure tax revenue elasticities (Chernick et al., 2020) or predict possible tax revenues without pandemics with ARiMA models (Malkina, 2021).

De Pascale et al. (2021) spotted that environmental taxes are particularly rigid, which shields countries from excessive deficits in downturn periods but at the same time this fact poses a threat for energy sector, that may suffer from economic cycles.

To summarise research in the field of volatility of tax revenues is available predominantly for US as well as for OECD countries or selected jurisdictions. Specifically, there is no comprehensive study of several taxes that exist in the whole EU or most jurisdictions belonging to the community. Moreover, available studies usually are focused on consequences of instable budget expenditures or tax revenues. Furthermore, the data used in most papers is not always up to date. Analyses that were made previously usually focus on potential impact of volatile tax inflows on real economy rather than their aim was to identify reasons for unstable fiscal inflows or compare performance of different taxes. Therefore, there is a clear research gamp in this respect which should be filled both from scientific as well as practical reasons in order to provide a hint for policymakers in design of optimal tax system.

3. Data

Calculations are made for all (or in some cases for most) countries of the EU. The advantage of this set of jurisdictions from the perspective of quantitative analysis is the fact that Member states use comparable tax law. Furthermore, the data for revenues from particular taxes are provided by one institution — Eurostat — which assures consistent methodology of their collection. Analysis is made for longest time — span possible taking into consideration availability of data — i.e. from 1996 to 2021. Moreover, this period includes tax law amendments resulting from Maastricht Treaty from 1992 and from subsequent Stability and Growth Pact of 1997. Finally, adoption of such period allows for tracking both the economic downturn from 2000–2003, followed by crisis of 2007–2013 and recent depression that started in 2000.

The value added of this research should be a hint for policymakers in creation of sustainable tax system. As a tax system is built of several taxes regulated by law differently, the focus should be laid on each specific levy.

Eurostat publishes often aggregated figures for a bunch of similar levies. For example "Taxes on production and imports" according to European System of Accounts 2010 classification ("ESA 2010") consist of all taxes that are imposed on products (i.e. VAT, other taxes and duties on imports, taxes on goods and services that become payable as a result of the production, export, sale, transfer, leasing or delivery of those goods or services, or as a result of their use for own consumption plus all other taxes that enterprises incur as a result of engaging in production). The aim of this article is to assess the variability of revenues from different taxes over time but on standalone basis. Therefore, the performance of separate taxes rather than their groups (as provided in the example above) should be studied. Consequently, only specific taxes (or their narrow groups) are selected for the research, whereas compositions of different taxes (although they might be similar in terms of taxation subject or object but the linkage sometimes is not close enough) are not considered.

Data in national currencies were selected for calculations. There are several reasons for such approach. Firstly, euro did not exist prior to 1999. Whereas considered data are also from 1996, denomination of tax revenues in common currency would be to a certain degree artificial and less accurate. Secondly, the analysis considers all EU countries and not only Eurozone states. Therefore, use of national currencies eliminates the issue of foreign exchange fluctuations. Lastly, Eurozone were enlarged several times over the years and hence also the set of countries using common currency has changed.

The time-span analysed is a long one and there were periods of inflation in various jurisdictions. Therefore, all data was adjusted by use of Harmonised Index of Consumer Prices. Such exercise provides for more robust results of the analysis without tracking for unnecessary variability of tax revenues connected with changes in prices.

The aim of the research is assessment of both variability of (i) key taxes and (ii) selected sectoral or specific niche taxes that should serve as a comparison platform. The following levies were selected for the research:

General taxes:

1. Value added tax — value added type taxes are classified under code D.211 according to ESA and are understood as taxes on goods or services collected in stages by enterprises and ultimately charged in full to the final purchaser. VAT is a harmonized tax binding in all EU states, which means that goods and services as well as mechanism of its calculation is alike in all jurisdictions. Universality of this tax provides for good platform also for statistical reasons.
2. Excise duties ("EXD") (D.2122C) — similar as in case of VAT, Excise duty is also harmonized, however only partly. In particular common rules for all Member states are foreseen for such products as: energy products, electricity, alcohol, alcoholic drinks and tobacco products. More complete data are available for the category of "excise duty and consumption taxes". Nevertheless it was decided not to use the latter option. This is because these are

aggregated sets of different taxes, whereas the aim of this article is to track the performance of taxes on standalone basis rather than a bunch of levies — that although alike in terms of taxation subject or object — are regulated by law differently.

3. Taxes on individual or household income including holding gains ("PIT") (D.51M) — consist of taxes on incomes of individuals, households and owners of unincorporated enterprises (e.g. income from employment, property, entrepreneurship, pensions) as well as assessed on holdings of property, land or real estate when these holdings are used as a basis for estimating the income of their owners.
4. Taxes on the income or profits of corporations including holding gains ("CIT") (D.51O) — correspond to taxes on individual or household income including holding gains, but are payable by corporations or non-profit institutions. Tax rules in case of corporate income tax vary among jurisdictions and harmonization is only partial and limited — generally to provisions set out by Parents-Subsidiary Directive, Mergers directive or Interests and Royalties directive.
5. Net social contributions ("SS") (D.61) — are the actual or imputed contributions made by households to social insurance schemes to make provision for social benefits to be paid. Social security contributions are collected by all Member states and are understood similarly, therefore their comparison is sensible.

Data for above taxes for all 27 countries and periods are available except for excise duty, where figures for few countries/periods are missing and therefore only 19 jurisdictions are studied.

Sectoral and specific taxes:

1. Taxes on lotteries, gambling and betting ("Lottery tax") (D.214F) — this category includes taxes on the turnover of enterprises that organise gambling or lotteries and they are treated as taxes on products (unlike "Taxes on winnings from lottery or gambling", which are payable on the amounts received by winners). Tax of this category is imposed by vast majority of Member states. Depending on a jurisdiction — either (i) one overall tax law is foreseen or (ii) more detailed separate taxes of this category are imposed (e.g. in Denmark there are even seven different taxes of this nature, whereas in Poland or Belgium only one complex tax exists). However, as the objects and subjects of taxation are mostly alike it was decided to use these set of taxes for the calculations. Data for 22 states were available and hence included.
2. Taxes on insurance premiums ("Insurance tax") (D.214G) — such taxes are in force in most Member states. Moreover, their object and subject of taxation is similar across jurisdictions, which makes comparisons feasible and sensible. Data for 19 states were included.
3. Car registration taxes ("Car tax") (D.214D) — are also imposed by majority of countries and the construction and composition of these taxes are comparable. Data for 18 states were included.

4. Taxes on land, buildings or other structures ("RET") (D.29A) — depending on jurisdiction there are one or more taxes allocated to this category. In some states real estate taxes are based on the value of property, whereas in others — on space. Nevertheless, those taxes are similar in nature. Moreover, as most countries use them, it was decided to implement these data into calculations. Data for 25 states were included.
5. Taxes on capital transfers ("Transfer tax") (D.91A) — this category of taxes is related to donations and inheritance and exist in almost all EU states. Data for all 23 states were included.

Charts 1 and 2 serve as an overview of revenues gained from said taxes by budgets of EU Member states. Data presented on those graphs are aggregated for 27 jurisdictions and as such are not analysed in this paper, which focuses on detailed data for separate countries. Therefore, perception of low volatility of particular taxes based on those charts can be misleading. The aim of the charts is just to give the reader the impression of importance of particular taxes.

There are some taxes or their groups that are also levied by some Member states, but it was decided not to consider them in this study because they are either typical just for selected countries or are grouped by Eurostat in a common category although they significantly diverge among jurisdictions in terms of taxation object and subject. Hence, it was decided that for such specific and niche taxes the sample available for the analysis would be too low, whereas the outcomes could be less conclusive or even misleading. This is the case of for example with Stamp taxes, Taxes on financial and capital transactions, Taxes on entertainment, Taxes on the use of fixed assets or Business and professional licences.

Import taxes are also not considered because customs duty cannot be fully controlled on national levels in the customs union. In particular according to EU law the same tariff rates apply to goods imported from outside the EU throughout the EU, the same rules of origin apply for products imported from outside the EU and a common definition of customs value applies.

Taxes on pollution, although present in most countries, were not considered as well due to various compositions of those levies among jurisdictions. Moreover, the legal tax base has been significantly increasing in case of those taxes over the last years due to legislative changes. Therefore, analysis of their stability would produce misleading results.

4. Methods

Analysis was made with use of several approaches:

1. Traditional descriptive statistics — in this respect the key information was coefficient of variation that was calculated separately for each tax and state. Next average coefficient of variation for each tax was estimated and results were compared.
2. Hodrick–Prescott filter — a modified trend curve (that unlike traditional trend line is not straight but smoothes the trend and better fits the empirical

values) was estimated for each tax and state. Then again descriptive statistics was used for such figures.

– Comparison of empirical and modified data — average coefficient of variation calculated for empirical data was divided by average coefficient of variation estimated with HP filter ("HP coefficient ratio"). The role of HP filter is to smooth the trend. Hence, HP filter is particularly effective, when there are several outliers. In such a case the coefficient of variation for such estimated data should drop significantly. As a result it is possible to observe in case of which taxes such ratio is especially high, which suggests more outliers — thus, less stable revenues.
– Pearson correlation — figures produced by HP filter were compared with actual numbers. Hence, it was possible to observe to what degree real fiscal results follow the trend ("HP correlation").

3. Two-way ANOVA without replication — Results could be interpreted from two perspectives — i.e. from the point of view of (i) countries and (ii) years. As the data that were used were expressed in national currencies and it is obvious that revenues from different taxes in nominal terms significantly differ across states and there is no use to interpret data from country perspective [as certainly for all taxes p-values should be close to zero and F-statistics significantly larger than F critical, which of course confirms that null hypothesis (stating that there are no differences between the means) should be rejected]. While focusing on years, it may be expected that revenues from particular taxes may behave differently. Such approach is more interesting and should contribute to the research.

   In the calculation two-way ANOVA seems to fit better than single factor ANOVA. This is because the data (tax revenues) are analysed more precisely, when countries function as blocking variables. Hence, the sample is not fully random because it is grouped by states. As a result the variance connected with states has been "subtracted" from the total error variance. Thus, it is easier to detect actual variances connected with revenues from particular taxes. Assignment of certain part of variation to particular countries in practice would be consistent with regression approach. In other words it was allowed for variation between countries since by definition they are specific (i.e. national tax systems differ across states). In the analysed case the two-way ANOVA allows to account for state-specific natural variation to assess more precisely if there are differences between years (groups or columns) without country-specific variation potentially "hiding" year differences. Summarising, it can be concluded that natural variation between the countries was extracted and only variation specific to revenues from particular taxes are analysed.

   By usage of two-way ANOVA the sum of squares of error is minimized and so MSE. As MSC both under one and two-way ANOVA stays the same, the F-statistics, which is calculated as MSC/MSE is greater for two-way ANOVA (because of smaller denominator). Thus, MSC significantly higher

than minimized MSE results in high F-ratio, which if higher than F-critical leads to a conclusion that indeed there are differences in columns (years). Therefore, under two-way ANOVA results of this study are more robust as the applied method is more sensitive simply because MSE is smaller than under one way ANOVA and hence any differences — in this case among revenues from taxes — become more vivid.

Finally, it should be noted that although two-way ANOVA assumes randomness — whereas years that are analysed are consecutive — this does not make this method in this research redundant as it is the overall variability that is analysed and not changes in specific periods. Moreover, the built panel of data is balanced in a sense that for each year and country only one value is assigned. At the same time this is also the reason why it was decided to apply two-way ANOVA without replications.

Due to high number of explanatory variables (26 years and up to 27 countries) it was decided not to perform any pairwise comparisons (such as Fisher LSD or Bonferroni) as their results would provide for a very complex and blurred picture, which would be neither informative nor in any way would contribute to the explanatory value of the research.

For any of methods mentioned above a balanced panel is not required from statistical reasons. Therefore, although observations for some jurisdictions/states are missing (although this happens in seldom cases) this does not pose a problem.

A limitation of the study consists in the fact that discretionary tax changes are not considered although they can be controlled by the government. Yet, this approach is widely accepted in the literature as tax buoyancy by default is measured as changes in tax revenues in comparison to GDP fluctuations, while tax law amendments are not controlled for. Furthermore, even if discretionary tax changes were to be taken into account, such exercise would be in practice very difficult as this would require detail analysis of tax law amendments in every jurisdiction and in each year, while at the same time any of such changes should have been weighted according to their importance rather than to treat them as categorical values (Belinga et al., 2014; Dougherty & de Biase, 2021; Dudine & Jalles, 2017; Lagravinese et al., 2020).

5. Results

The study was performed with use of several methods discussed above to provide for a more comprehensive picture. The results are presented separately for each approach and are discussed below (Table 1).

According to descriptive statistics coefficient of variation is lowest for payroll taxation — i.e. for Social security and Personal income taxes it amounts to 21.1% and 22.2%, respectively. Such outcome is reasonable as it should be expected that the tax base in case of those levies is especially stable. Statistics for VAT is 23.1%, which again meets the expectations taking into consideration low volatil-

ity of consumption and relatively stable VAT rates over time. Significantly higher value of 30.3 % was recorded for CIT, which could be connected with the fact that this is especially buoyant tax, very sensitive to economic cycles. Moreover, with respect to CIT rates especially harsh tax competition was recorded among EU states over last decades. Surprisingly the coefficient of variation for Excise duty reached very high figure of 47.6% although it is also a consumption tax. The reason might be that EXD strongly depends on changes of prices of energy resources, which fluctuate significantly.

For sectoral and specific taxes coefficient of variation is lowest for RET with 30.3%. Higher numbers are calculated for Lottery tax (39.1%), Car tax (42.7%), Insurance tax (49.5%) and Transfer tax (54.8%). Overall, for traditional taxes the figures are smaller. There could be several reasons for such behavior. In particular both the legislation in case of sectoral and specific taxes change more and the tax base is generally narrower — thus any changes have huge effect. For example, among sectoral and specific taxes RET feature lowest coefficient, which may be connected both with limited tax law amendments and stable tax base (i.e. which is generally either space or value of real estate existing in a given country depending on legislation binding in a jurisdiction).

While dividing average coefficient of variation calculated for empirical data by average coefficient of variation estimated with HP filter it turned out that the ratio for SS is 1.07, while for PIT it amounts to 1.16. Although the values are low, this time the number for VAT of 1.08 suggests that this consumption tax belong to most stable sources of revenues. The ratio is also smaller for EXD (1.36) than for CIT (1.40), which suggests especially numerous outliers in case of corporate income tax. Interestingly, for sectoral and specific taxes the values are not necessarily higher. Ratio for RET with 1.10 is among the lowest in general. Lottery tax, Insurance tax, Car tax and Transfer tax produced ratios between 1.24 and 1.28.

Similar results to the above where recorded while calculating correlation of empirical data and figures estimated with HP filter. The only visible change in the order is EXD and CIT, which switched places.

Other findings are delivered by two-way ANOVA. Null hypothesis assumes that there are no differences between the groups. At standard 0.05 confidence level it was rejected in case of VAT, PIT, CIT, Social security, Car tax and RET (Tables 2, 4, 5, 6, 9 and 10, respectively). With respect to EXD, Lottery tax, Insurance tax and Transfer tax (Tables 3, 7, 8 and 11, respectively) null hypothesis was accepted and hence it should be assumed that no differences exist. In other words in those cases 26 groups representing tax revenues earned in particular year are similar enough to assume that they origin from single population. Interestingly, all general taxes except for Excise duty seem to be more volatile. At the same time sectoral and specific taxes — except for Real estate tax and Car tax — might be treated as those that provide more stable tax revenues. However, such conclusions might be too far reaching. This is because the coefficient of variation in case of most of sectoral and specific taxes is almost always higher

(Table 1). Therefore, the comparison of groups, where all of them vary a lot, may produce a result confirming that in practice all of them are similar in their composition (whereas all of them are highly volatile). At the same time some traditional taxes may actually be more stable in providing tax revenues but this is enough that one (or few) groups diverge slightly, which would lead to rejection of null hypothesis.

6. Discussion

Although the source data employed in each method was either identical or similar (empirical data or modified with HP filter), the results are not always convergent. Methods based on HP filter provide for very similar findings. However, descriptive statistics based on empirical data and HP filter differ to certain degree (Table 1). Especially striking is the fact that actual revenues from Insurance tax and Transfer tax were characterized with particularly high coefficient of variation, whereas correlation of empirical numbers with data smoothed with HP filter were quite high for those taxes. Hence, it could be assumed that these two taxes in practice do not perform as poorly (in terms of their stability) as it might be expected from pure verification of coefficient of variation of empirical data, because in the long term they follow some trend curve and therefore provide for less volatile revenues as it might be expected. Moreover, according to results of two-way ANOVA there are no differences between the means both with respect to revenues raised from Insurance tax and Transfer tax (Tables 8 and 11, respectively). However, in those cases the reason might be naturally greater volatility of those taxes, which transformed into a broad general population and hence particular samples (in this case tax revenues recorded in years) are believed to be part of that bigger set.

On the contrary revenues from CIT seem to be characterized by average coefficient of variation. However, the average coefficient of variation calculated for empirical data divided by average coefficient of variation estimated with HP filter proved to be the highest among analysed taxes (Table 1). Hence, it should be assumed that HP filter was very effective in case of CIT. This happens when either there are a number of outliers or the actual trend is not clear — which is confirmed by low correlation. At the same time results of two-way ANOVA confirm that there are differences between the means among the groups (Table 5). This suggests that although real values in case of CIT are not exceptionally volatile, in practice it may be very difficult for governments to predict the revenues from that tax. Instability of revenues earned from CIT was spotted in the literature, where its dependence on economic cycles was underlined. Mathai et. al. (2007) also observed that CIT revenues are particularly buoyant. Similar finding was made by other researchers calming that volatility of tax inflows is considerably higher for CIT than for other taxes, especially in periods of economic downturn (Dudine & Jalles, 2017). Belinga et al. (2014), assessed high buoyancy for corporate income taxes. Yet finding presented in this very

article is still novel, as it provides for a broad background of taxes and ability for direct comparison and the study is made for other countries and periods. It is interesting that CIT even surpass most specific and sectoral taxes in term of high volatility. Yet, these are primarily small taxes with usually narrow tax base that are traditionally believed to be particularly buoyant (Morrissey et al., 2016).

The best performing levy in most categories is Social security, which feature lowest coefficient of variation, the trend line seems to be close to horizontal over the years and number of outliers should be small (Table 1). Similar conclusion was reached by Karpowicz et al. (2020). Only the results of two-way ANOVA imply that there are differences between the means among the groups (Table 6). However, this might be connected with overall small variability of revenues from Social security, whereas just one (or more) groups differ — even slightly — from this general picture. Revenues from PIT in terms of their low volatility are very similar to those from Social security, but are more buoyant and it seems that there are periods with more extreme values (Table 1). Malkina (2021) also came to similar conclusions, while she estimated that regions with high shares of revenues from PIT in proportion to total revenues were less affected by COVID pandemics and this tax feature greater stability.

Revenues from VAT seem to be also a stable source of revenues — probably because of broad tax base and relatively stable consumption (Table 1).

Among sectoral and specific taxes it is Real estate tax, which provides for especially predictable government revenues as they follow a modified trend curve estimated with HP filter even better than VAT or PIT and only revenues from Social security perform better (Table 1). Results of this paper are also in line with those of Dougherty and de Biase (2021), who concluded that central governments were more severely affected by COVID-19 crisis than municipalities. That results inter alias from the fact that local governments rely primarily on taxation of real estate or in selected cases on taxation of income of individuals, whereas central government include usually corporate income taxes, which are more volatile.

Findings presented in this paper are to some degree comparable to those of Belinga et al. (2014), who assessed low tax buoyancy for real estate taxes. However, they estimated low buoyancy also for excise duty and high for personal income taxes, which is not confirmed in this study. Among traditional taxes it is Excise duty which seems to be least reliable source of revenues (Tables 1 and 3). All criteria indicate its instability — i.e. high coefficient of variation, only average correlation with the trend, significant number of outliers and rejection of null hypothesis (stating that there are no differences between the means).

Lottery and car tax according to all methods employed are in the middle of the stake, with lottery tax performing always slightly better in terms of low volatility (Tables 1, 7 and 9).

7. Conclusions

Traditionally EU Member states derive the most significant part of their tax revenues from taxation of labour — i.e. from PIT and Social security contributions (57.8 % of total tax revenues of EU countries in 2021, Chart 1). Such approach of the governments is reasonable inter alia from the perspective of stability of budget revenues they provide. Both levies feature smallest coefficient of variation. Yet with respect to PIT the trend curve seems to be less clear than for Social security, which may be connected with the fact that this tax depends on income and hence is more buoyant (Table 1).

VAT is the next key source of revenues in EU countries (Chart 1). At the same time this tax assures quite comparable inflows to the state budgets over time. It follows quite well a trend appointed by HP filter and is characterized by relatively small number of outliers (Table 1).

Yet states use a number of different taxes that not necessarily meet the criteria of stability or predictability. Among them are CIT, Car tax, Lottery tax, Insurance tax, EXD or Transfer tax (Table 1). All of them in total provided for just 9.7 % of budget revenues, whereas CIT is responsible for more than 72% of that figure (Chart 1 and 2). It does not however mean that governments should resign from such sources of inflows. Quite on the contrary. The theory of taxation assumes that the deadweight loss rises to the square of tax rate. Therefore, it is probably better to maintain a lot of different taxes, while keeping the tax rates low rather than to focus only on few of them and elevate the rates. Multiple sources of inflows increase also the general stability of the budget (Yan, 2012). The objective of the states should be rather to stabilise the revenues from those taxes, which can be done by (i) broadening the tax base, (ii) adjustment of the tax law with respect to particular taxes or (iii) overall modification of taxes to assure that their mutual interactions result in the ability to balance the whole tax system. A good example might be RET, which remains a small tax in terms of revenues it provides, but a stable one. At the same time — if alterations of tax legislation are to be done — it should be kept in mind that all taxes should remain elastic (in the meaning of optimal taxation) and not harm excessively the taxpayers in unfavourable economic conditions.

The limitation of this research is the fact that it does not consider tax law amendments introduced over the years by governments. Consequently, there is a scope for future research in this area that will deal with this issue. However, this would be a very difficult (if even feasible) exercise to perform as this will require detailed analysis of all potential tax law changes in every tax, year and every single country and such information would need to be transformed into numbers that would show the value of increase/decrease of tax revenues that occur purely due to those changes.

A research gap that emerges from this article and should be closed in the future is the analysis of the impact of different categories of socio-economic events on the revenues produced by different taxes.

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Appendix

Table 1.
Variability of revenues from different taxes in the period 1996–2021 in EU member states

Tax	HP coefficient ratio	HP correlation	Average coefficient of variation	Are there differences between the means? (two-way ANOVA)
SS	1.070	0.954	21.1	yes
VAT	1.080	0.948	23.1	yes
RET	1.100	0.948	30.3	yes
PIT	1.160	0.916	22.2	yes
Insurance tax	1.240	0.919	49.5	no
Lottery tax	1.246	0.869	39.1	no
Transfer tax	1.250	0.870	54.8	no
car tax	1.280	0.860	42.7	yes
EXD	1.360	0.620	47.6	no
CIT	1.400	0.800	30.3	yes

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 2.
Two-way ANOVA for VAT

Source of variation	SS	df	MS	F	p-value	F crit
states	1.90579E+14	26	7.32995E+12	338.99	0	1.51
years	1.0383E+12	25	41531801106	1.92	0.00472	1.52
error	1.40548E+13	650	21622723984			
total	2.05672E+14	701				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 3.
Two-way ANOVA for EXD

Source of variation	SS	df	MS	F	p-value	F crit
states	9.752E+10	18	5417873527	219.14	1.68E-209	1.63
years	911710753	25	36468430.14	1.48	0.0666217	1.53
error	1.113E+10	450	24723678.72			
total	1.096E+11	493				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 4.
Two-way ANOVA for PIT

Source of variation	SS	df	MS	F	p-value	F crit
states	9.801E+13	26	3.77E+12	1008.18	0	1.51
years	2.26E+11	25	9.041E+09	2.42	0.0001521	1.52
error	2.43E+12	650	3.739E+09			
total	1.007E+14	701				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 5.
Two-way ANOVA for CIT

Source of variation	SS	df	MS	F	p-value	F crit
states	8.393E+12	26	3.228E+11	342.74	0	1.51
years	4.639E+10	25	1.855E+09	1.97	0.0034281	1.52
error	6.122E+11	650	941836143			
total	9.051E+12	701				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 6.
Two-way ANOVA for SS

Source of variation	SS	df	MS	F	p-value	F crit
states	4.159E+14	26	1.59959E+13	1128.02	0	1.51
years	8.005E+11	25	32020452865	2.26	0.0004802	1.52
error	9.217E+12	650	14180482332			
total	4.259E+14	701				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 7.
Two-way ANOVA for Lottery tax

Source of variation	SS	df	MS	F	p-value	F crit
states	8.098E+10	21	3855984295	154.23	6.78E-209	1.58
years	657661922	25	26306476.88	1.05	0.3956963	1.53
error	1.313E+10	525	25001684.84			
total	9.476E+10	571				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 8.
Two-way ANOVA for Insurance tax

Source of variation	SS	df	MS	F	p-value	F crit
states	2.091E+10	18	1161647703	20.43	1.442E-47	1.63
years	1.791E+09	25	71622225.27	1.26	0.1822765	1.53
error	2.559E+10	450	56861743.49			
total	4.829E+10	493				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 9.
Two-way ANOVA for Car tax

Source of variation	SS	df	MS	F	p-value	F crit
states	154567171	17	9092186.5	148.24	1.65E-166	1.65
years	3764060.6	25	150562.42	2.45	0.0001503	1.53
error	26067143	425	61334.455			
total	184398375	467				

Source: Own calculations based on Eurostat (2023a; 2023b).

Table 10.
Two-way ANOVA for RET

Source of variation	SS	df	MS	F	p-value	F crit
states	3.486E+11	24	14524066542	97.41	4.9E-189	1.54
years	8.059E+09	25	322363320.6	2.16	0.0009667	1.52
error	8.946E+10	600	149100509.9			
total	4.461E+11	649				

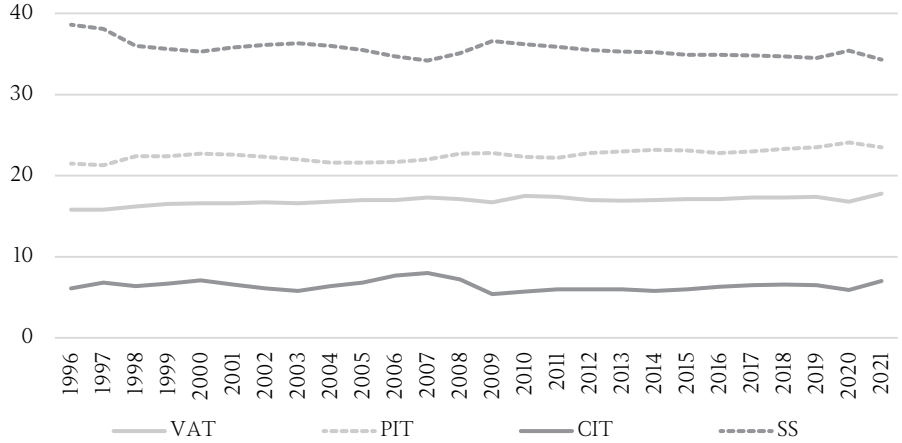
Source: Own calculations based on Eurostat (2023a; 2023b).

Table 11.
Two-way ANOVA for Transfer tax

Source of variation	SS	df	MS	F	p-value	F crit
states	5598572659	22	254480575.4	172.82	1.973E-230	1.56
years	55224029.05	25	2208961.162	1.50	0.057349463	1.53
error	809893269.1	550	1472533.217			
total	6463689957	597				

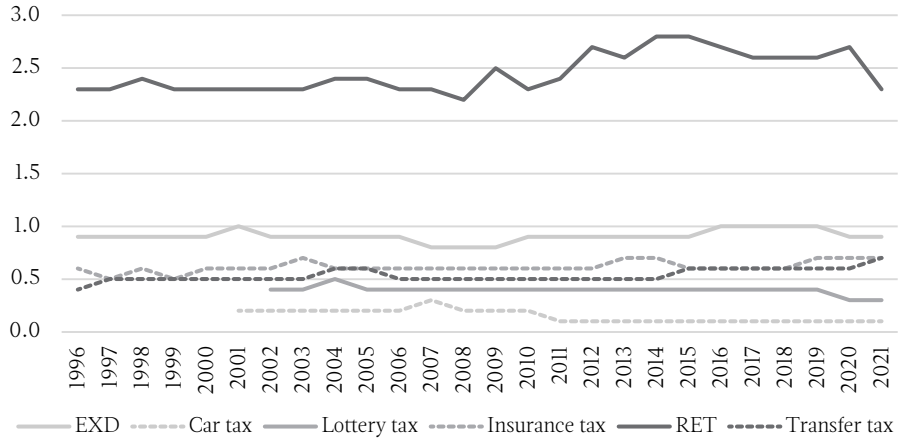
Source: Own calculations based on Eurostat (2023a; 2023b).

Chart 1.
Government revenues from key taxes (averages for EU-27, percentage of total government revenues)



Source: Own calculations based on Eurostat (2023a).

Chart 2.
Government revenues from selected taxes (averages for EU-27, percentage of total government revenues)



Source: Own calculations based on Eurostat (2023a).