Empirical Paper

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Trends in income taxation: are taxes converging in Central and Eastern European countries?

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Abstract: The paper examines the convergence of tax systems in Central and Eastern European countries (CEECs) over the period 1995–2018. Due to the increasing impact of tax competition, we have focused on income taxes, in particular, corporate ones. We have identified the factors that influence the taxation system and trends in income taxation in the CEECs by adapting the hidden Markov model approach. We find that many CEECs have reduced income taxation in the analysis period, mainly by lowering tax rates. Corporate income taxes have also decreased in many CEECs in the same period; however, the reverse has been observed too. Both convergence and divergence have been identified among the CEECs over the period considered. The speed of these processes based on the used variables varied depending on both exogenous and endogenous factors. These factors have been diagnosed as being specific to the periods of tax reforms, i.e., before and after accession to the European Union (EU) and the global financial crisis.

Keywords: income tax, tax competition, tax convergence
JEL Classification: H2, O52, O57

1 Introduction

Taxes are one of the most critical instruments of social and economic policy; therefore, countries are not willing to give up national sovereignty in this area. A well-designed taxation system (i.e., structure with its tax base and tax rates) may give a country a comparative advantage over its competitors. Although the European Union (EU) requires its member states to take specific steps that would lead to tax harmonization (in the scope of indirect taxes and partial harmonization of direct taxes), the EU member states may pursue their individual tax policies that respond to their specific needs and are adjusted to the respective level of economic advancement of these countries.[1] When competing for capital and investment projects, countries adopt different measures, one of which is tax competition. In combination with market mechanisms, tax competition produces a situation in which optimum tax policy depends not only on decisions driven by the internal social and economic policy agenda but also on taxation systems in neighboring countries. Taxation

1 The Common Consolidated Corporate Tax Base has not been implemented yet.

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systems in the EU member states are based on two fundamental pillars: (1) indirect taxes (value-added tax and excise duty); and (2) income taxes (corporate income tax [CIT] and personal income tax [PIT]).

The paper focuses on CITs and PITs (viewed by tax theory as more damaging to economic growth), which, however, centers on tax competition between the EU member states.[2] Our thoughts take account of the specific tax policies of the Central and Eastern European countries (CEECs) that joined the EU in 2004, 2007, and 2013. They are treated as transition countries whose fiscal policies are often perceived as aggressive. The contemporary tax system of the CEECs is composed of 11 different national tax systems. Differences between them stem from fundamental principles of taxation (traditional income taxes versus tax paid on distributed income/profits), diverse tax structures (regular income tax, dual income tax, and flat rate tax), different ways of calculating the tax base, and also aspects of decisions concerning the quality of tax regulations (frequent changes in regulations, law interpretation difficulties). It is worth paying attention to the Baltic countries. In 2021, Estonia's tax system was recognized as the most competitive among countries of the Organisation for Economic Co-operation and Development (OECD) for the eighth time in a row [Bunn and Asen, 2021]. The second place in this ranking was taken by Latvia, and in the sixth place was Lithuania (with a score very similar to that of the next country, namely, the Czech Republic).

The research period (1995–2018) was selected intentionally because all these countries were implementing tax reforms in this period to adapt their tax legislation to the current level of their economic advancement. In addition, we intended to include any changes during the pre- and postfinancial crisis periods. Eurostat was the primary source of data used in our study.

The goal of the paper was to find out whether there is convergence or divergence between the CEECs with respect to income taxation (primarily corporate) and to determine whether the process is permanent or temporary by nature. To achieve this goal, we posed the following research questions:

1. Can convergence/divergence be observed between countries and, if yes, does it happen throughout the entire research period or only in certain subperiods?
2. Which factors have influenced convergence/divergence between the CEECs and groups of homogeneous countries based on the adopted indicators?

The literature review and statistical data prove that there are distinct differences in the taxation regime and the structure of government income derived from different categories of levies between the so-called "old" (EU-15) and "new" (joining in 2004 and later) member states of the EU. In the EU-15,[3] direct taxes exert an important role in the structure of tax revenues, while in most of the new member states, indirect taxes are explicitly visible, e.g., in Bulgarian tax policy. The new EU member states are viewed as countries pursuing often-aggressive tax policies. For example, CEECs rather follow and implement similar tax solutions after lowering the income tax rate. It is only one of their practices. This happened in Romania, Bulgaria, Croatia, and Hungary.

CEECs conduct clearly diversified tax policies, which may be the effect of different factors (such as, e.g., international capital mobility or international tax competition) as also a strong pressure exerted by the fiscal and short-term needs of the state budget. In our research, we identify both tax convergence and tax divergence among these countries throughout the entire period covered; further, we point some exogenous and endogenous factors that strongly affect those processes.

The paper consists of three parts. The first part reviews the literature and studies on tax convergence. A systematic examination of the similarities and differences between taxation systems has been launched as late as in the 21st century mainly for the EU and OECD member states. The authors are convinced that because of the thematic scope covering trends in taxation policies of the CEECs and the proposed research methods, this study makes a contribution to the subject-matter literature. In the second part, we have

2 The literature that documents the impact of taxes on economic growth is vast. A review of such literature may be found in Leibfritz et al. [1997]. Income taxes negatively influence economic growth in the long run through market distortions, crowding-out effects, and a decline in labor supply. In general, an increase in tax burdens reduces the GDP growth rate [Barro, 1990].

3 Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Spain, the United Kingdom, and Sweden.

selected and analyzed motivations driving contemporary tax policies and discussed synthetic solutions in income taxes in the CEECs. The third part discusses research methodology and includes findings.

To show similarities in fiscalism between the countries in quantitative terms, we deployed one of the latest approaches in convergence analysis based on hidden Markov models (HMMs) and Viterbi paths. This method, consisting of automatic pattern recognition, has been so far successfully used in, e.g., speech, signal, and handwriting recognition, bioinformatics, or DNA sequencing but rarely in economics. Meanwhile, due to the less-rigid assumptions underlying its application, this tool fits perfectly into, *inter alia*, convergence studies. The approach proposed in this paper is an interdisciplinary method combining computer science, mathematics, econometrics, and operational research; thus, it can be easily applied in the automatic determination of time series similarity. The states on the Viterbi path determined by computer simulations give the most probable course of the convergence process for a selected pair of countries in terms of selected tax indicators. Taking into account many such pairs, it is possible not only to determine which countries are more similar to each other but also to identify the degree of this similarity. The use of the term "simulation" should not raise doubts as to the reliability of the results, because in the context of HMMs, the term is not related to the randomness of the input data but is a purely technical procedure aimed at verifying the stability of the model parameters and related robustness of the results.

2 Literature review

2.1 Concept and measurement of convergence

The concept of convergence, used in many fields, means the process of gradual similarity ("getting closer") to each other or to the adopted pattern. It should also be remembered that convergence does not have to mean a qualitative improvement in the situation of the studied entities, because the similarity can be both "upward convergence" and "downward convergence", which means approaching toward the worst or the weakest [see, e.g., Eurofound, 2020].

When researching convergence, we must always confine ourselves to a certain, relatively limited set of indicators that measure a selected aspect (or aspects) of the economy covered by the study. Based on the selection of variables, many types of convergence can be distinguished. There is, e.g., nominal convergence, which refers to the requirements for joining the euro area. These requirements, known as the Maastricht convergence criteria, focus on inflation, interest rates, volatility of exchange rates, and deficit and public debt. The EU legislation requires also the laws of candidate countries to comply with the Treaty on European Union and with the Statute of the European System of Central Banks and of the European Central Bank (legal convergence). Economic literature provides also many other types of convergence, such as the real ones focusing on the gross domestic product (GDP) (or GDP-related measures), productivity, competitiveness, labor market outcomes [e.g., Barro and Sala-i-Martin, 1992; Boyle and McCarthy, 1999; Borys et al., 2008; Halmai and Vásáry, 2010; Marelli and Signorelli, 2010; Szeles and Marinescu, 2010; Alexe, 2012; Monfort et al., 2013, Diaz del Hoyo et al., 2017], or structural convergence [Palan and Schmiedeberg, 2010; Vandenbroucke, 2017; Raleva, Marikina, 2021].

The studies also address tax convergence defined by Bénassy-Quéré et al. [2014] as a reduction of tax rate differentials and base differentials motivated by tax coordination and competition. Delgado and Presno [2017] stress that tax convergence may limit, control, or identify tax competition; but it may also be used to check the prediction from the theory of international tax competition, while the achieved results may contribute to a better understanding and design of tax policy.

There exist many methodological approaches to convergence in economics [Bernardelli et al., 2017]: e.g., beta-convergence based on the growth theory [Solow, 1956], which occurs when poor countries/regions grow faster than rich ones (and catch up with them); and sigma-convergence, which refers to the reduction of disparities over time [Barro and Sala-i-Martin, 1992; Quah, 1993; Sala-i-Martin, 1996; later, e.g., Monfort, 2008; Young et al., 2008; Lessmann and Seidel, 2015], broken down into subgroups (club convergence – introduced by Baumol, 1986, developed by, e.g., Durlauf and Johnson, 1995; Galor, 1996; Canova, 2004; Phillips and Sul, 2007; Alexiadis, 2012; Maynou et al, 2021; Ripollés, Vidal-Meliá, 2022).

The theoretical background of the concept of convergence in terms of the macroeconomic variables is well known for decades in the form of models of economic growth. A range of approaches have been developed to date, beginning with simple linear regression models, through the econometrics of panel data and Bayesian averaging, ending with very advanced and complicated mathematical constructions. Due to the changes in economic and political conditions, new approaches to the issue of convergence are constantly being developed.

The most common in the literature on economic growth models, namely, neoclassical models and endogenous models, have one common flaw in the form of the restrictive assumptions of application. Compared to these conventional econometric methods, an approach based on HMMs, which was used in the analysis presented in this article, is much more flexible in terms of the assumptions of a statistical or asymptotic nature and gives a wider possibility of applicability. Moreover, it can be adapted to a variety of input data (not only GDP), which makes it a perfect tool for tax convergence analysis. This field of application of the HMM is relatively new in scientific research and was used for the first time by Felis et al. [2020]. The authors have attempted to analyze and assess the directions of evolution of income taxation in EU countries. The concept of HMMs, as well as the description of the explored procedure of convergence analysis based on the HMM and Viterbi paths, is presented in the Appendix.

2.2 Tax convergence in research studies

Studies related to tax convergence have a different scope with respect to time and geography, and their authors follow diverse methodological approaches. Wang [2007] used time series and cluster analyses to examine tax burden and economic growth convergence among China, Taiwan, and the OECD countries in the 1970s, 1980s, and 1990s. His research indicated tax burden convergence in the group of China, Taiwan, and Korea; however, this was not pairwise. The methodology of Phillips and Sul [2007] was used by Apergis and Cooray [2014] to investigate tax policy convergence across the Association of South-East Asian Nations (ASEAN) countries and the Asia–Pacific and Oceania countries in the years 1990–2012. Empirical evidence has revealed that there was no full convergence across the analyzed countries and that the tax policies remained national. The Phillips-and-Sul methodology [2007, 2009], beta-convergence, and sigma-convergence were also adopted by Chen et al. [2016] in the study of corporate tax rate convergence across 15 countries from the Asia–Pacific region. Their research showed significant dynamic tax convergence and identified three convergence clubs within the period 1980–2014. While studying worldwide corporate tax rate convergence, Slemrod [2004] found a strong link between the top individual rate and the top statutory corporate rate in the years 1980–1995.

Fiscal pressure and fiscal policy convergence across the EU countries were investigated by Esteve et al. [2000], who focused on convergence in fiscal pressure, defined as the total fiscal revenue/GDP ratio, during the years 1967–1994. They used cross-sectional convergence indicators and time series analysis to find, inter alia, both convergence (1979–1994) and divergence (1967–1979) periods. Similar research was also conducted by, among others, Sosvilla-Rivero et al. [2001], Blot and Serranito [2006] (Economic and Monetary Union [EMU]) countries), and Delgado and Presno [2010, 2011]. According to Delgado and Presno [2011] – who applied the time series method using unit root and stationarity tests with an endogenous break – over the period 1965–2004, only the United Kingdom and Germany exhibited signs of long-term convergence although there were some other countries for which convergence could be observed. Tax convergence in the EU member states was also addressed by Tibulcă [2015], who studied the sigma-convergence using the coefficient of variation and the Gini coefficient. The author identified several convergence periods for the years 1965–2012, of which the last one began in 1997 and ended in 2008. Regis et al. [2015], while investigating convergence in statutory corporate tax rates between 1980 and 2014, report that four clubs of converging European countries can be observed.

Tax convergence measuring the dispersion of tax-to-GDP ratio (sigma-convergence) was investigated in a study carried out for the OECD member countries in the years 1995–2016 [OECD, 2018]. This investigation also measured the convergence of tax structures taking into account the share of diverse income categories in total tax revenue. The D-index [Delgado, 2013], an indicator showing the extent to which a country's tax

structure differs from the OECD average structure, was used. It was found that, over the period covered by the study, both the distribution of countries around the OECD average tax-to-GDP ratio and the average tax structure had become more similar. The OECD countries were getting closer to a higher level of taxation and since the dispersion of tax-to-GDP levels had decreased, the level of the tax-to-GDP ratio was increasing. Nevertheless, a clear heterogeneity was observed for the tax-to-GDP ratio in different countries; thus, they were divided into four groups (with low, low-mid, high-mid, and high tax-to-GDP ratios). In each group, convergence unrolled along different lines. In the OECD member countries, convergence of tax structures was also reported for value-added tax (VAT), and quasi-fiscal charges (social security contributions) and CIT increased their share, however to a lesser extent. Over the examined period, eight countries moved away from the OECD average structure (Lithuania, Poland, the United States, Italy, Mexico, New Zealand, Hungary, and Estonia).

The OECD countries[4] were also studied by Godbout and Robert-Angers [2022], who showed, among other things, that in the years 1981–2018, there was a reduction in the general dispersion around the average for the tax burden and the analyzed components of the tax structure, such as PIT, CIT, social security contributions and payroll tax, tax on property, consumption tax, and customs and import duties. They also noted that majority of the countries were closer to the OECD average in 2000–2018 than in 1981–1999.

Delgado et al. [2019] investigated the convergence of effective CIT rates in the EU (EU-27) over the years 2000–2016 using the club approach. They argue that since the emphasis is primarily on the harmonization of indirect taxes, the EU member states deploy different patterns of corporate taxation. Member states covered by the study were divided into three clubs: (1) France, Malta, Spain, and Portugal – countries with high effective tax rates, where poor relative convergence was observed (convergence speed: 0.007); (2) Belgium, Germany, Greece, Luxembourg, Italy, Austria, the Slovak Republic, Hungary, Poland, and the Czech Republic (average-level tax rates; convergence speed: 0.146); and (3) the 13 remaining member states with low effective tax rates, showing average convergence speed equal to 16.99.

3 Contemporary tax policy factors in the CEECs

The structure of the tax systems in the CEECs depends on the social and economic changes that happened both in the CEECs and the remaining parts of Europe. The factors that influenced the shape of tax systems comprise systemic changes, in particular, changes in tax law caused by the EU accession and economic crises, including the financial crisis of 2008–2009 and since 2020.

3.1 Tax reforms before the EU accession

Systemic change and the adoption of market economy principles were the major factors that triggered the reform of tax systems in the CEECs. For instance, the split of Czechoslovakia into the Slovak Republic and the Czech Republic was linked with the transition from a centrally planned economy to a market economy, which would have not been possible without fundamental tax reforms. Reforms in these countries started already in the early 1990s. The timing of the launch of the first fundamental change in the tax system in January 1993 accidentally coincided with the birth of the Slovak Republic. The establishment of an independent state, however, did not have any direct impact on the shape of the system. The new system incorporated relevant components of the tax system in the EU countries. Its basic pillar was a VAT with two rates, which were later changed a few times. The PIT was progressive, with six income brackets and rates ranging from 15% to 47%. However, the system also included five other tax rates applied to specific sources of income. The CIT was set with a linear rate of 45% [Miklos et al., 2005].

4 This analysis covered 24 OECD countries, such as Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

According to Ebrill [1999, p. 8] and Stepanyan [2003, p. 13], the Baltic countries managed very quickly to dismantle the Soviet Union tax models and successfully implement new solutions consistent with internationally approved practices. In 1994, Estonia introduced a PIT flat rate and reduced the CIT rate, both at the level of 26%; since 2000, the CIT taxpayers are allowed to defer payment of that tax until profit distribution. Latvia replaced the tax on profits with a corporate tax in 1995. Initially, the Latvian CIT rate was set at 29%; the country then reduced it to 24% in 2000 and to 15% since 2002 for several consecutive years, which significantly increased the competitiveness of this country.

Undergoing reforms also included stimulating foreign direct investment in order to modernize the postsocialist economy and to meet enormous capital needs. The goal was to adapt the tax systems of these countries to models operating in the other member states of the EU. In most cases, reforms embraced PITs and CITs, in particular, the reduction of tax rates or tax exemptions. Tax incentives were the main factor to attract foreign direct investments in the CEECs. For example, in the 1990s, Poland introduced income tax holidays for companies with foreign capital. Investment incentives took different forms and were offered within the framework of targeted programs. One of the most significant examples of supporting economic and social goals was the setting up of special economic zones (SEZs), accompanied often by subsequent exemption from property taxes. For example, 14 SEZs were created in Poland as a regional aid instrument. Investors in SEZs were allowed tax exemptions for 10 years and partial exemptions for the following 10 years. In turn, in 1992 and 1993, Hungary introduced a 10-year tax holiday for foreign investors [Krajewska, 2006].

3.2 Tax reforms after the EU accession

When the CEECs joined the EU, the principal objective was to enhance the competitiveness of their tax systems in relation to the systems of the "old" EU member states. Reforms at that time introduced fundamental changes in many tax structures to ensure stable and long-lasting economic growth. The race to the bottom could have been observed to make the tax system more competitive, manifested to a large extent in the reduction of income tax rates and tax reliefs, as well as in the simplification of the entire taxation system. For example, the rate of 19% for businesses in Poland was introduced. The reduction of direct taxes shifted also the source of tax revenues to indirect taxes. This was happening with the introduction or broadening of the scope of VAT and excise duties. In 2006, an important priority for the Czech government was to simplify tax law and strengthen incentives for investment. At that time, shortened depreciation periods for movable property and research-and-development (R&D) tax credits were introduced.

The second and the most fundamental reconstruction of the tax system in the Slovak Republic (effective from January 2004) was to no longer copy the standard tax systems of Western Europe. It was rather based on a fundamental change of some taxation principles. A larger emphasis on the competitiveness of the economy made the tax system more attractive and motivating. The implemented reform consisted primarily in the introduction of a flat rate of 19% in direct taxes and the reduction of a number of exemptions and special tax regimes, although allowance for children in the PIT was left untouched. The reduction in the amount of direct taxes shifted the source of budget revenues to indirect taxes. Increase in certain rates of excise duty on selected goods (e.g., mineral oils, beer, and tobacco) and unification of VAT rates were implemented. Instead of the previous two rates of 20% and 14%, a single VAT rate of 19% was introduced [Miklos et al., 2005].

3.3 Global economic and financial crises

The global financial crisis of 2008–2009 affected the performance of public finances in most European countries and, as a consequence, a necessity to revisit fiscal policy tools emerged. For example, in 2009, the GDP of the EU member states decreased by 4.2% on average (Latvia suffered the most, with a decrease of 18.0%, and Poland, on the contrary, reported a growth of 1.7%).[5]

5 *Taxation Trends in the European Union*, 2011 edition, European Commission, https://taxation-customs.ec.europa.eu/taxation-1/economic-analysis-taxation/taxation-trends-european-union_en

The actions of the governments of the member states were geared toward ensuring sufficient revenues to the budget, e.g., by limiting the income and VAT tax preferences and exemptions and by increasing the tax rates of indirect taxes. The biggest change was observed in Hungary, where the VAT rate – which was 20% in 2008 – was first increased to 25% in 2009 and then to 27% in 2012.

As of January 1, 2009, almost 40% of Lithuanian tax legislation was changed, and the changes concerned the key elements of the system and applied to the vast majority of taxpayers. In the PIT, a lower uniform rate of 15% was introduced, while in the CIT, the rate was raised to 20%, the tax base was extended, and new preferences were implemented [Skačkauskienė and Tunčikienė, 2012]. The increase in the CIT rate was a one-off event: since 2010, the rate is 15%, same as before.

Countries that increased the tax rates declared that the change was only temporary and to mitigate the effects of the crisis. However, for instance, Poland introduced a higher VAT rate (23%), which was supposed to be binding only between 2011 and 2013 but, in fact, still remains in force.

The coronavirus disease-2019 (COVID-19) pandemic crisis also entailed adjustments to tax systems. Different measures have already been adopted (e.g., tax payment deferrals, accelerated depreciation, and double deduction of expenses incurred to alleviate the pandemic from the taxable base or from the tax liability) to reduce the tax burden to entrepreneurs locked down. The ongoing pandemic prompts further research in the future.

3.4 Impact of globalization

The tax systems of the EU member states are influenced by globalization and its key elements, such as tax harmonization, tax competition, and combating tax avoidance or evasion.

The tax systems of the member states are similar to some extent in their tax constructions due to the harmonization process that had been going on, in particular, in the 1990s and in the first decade of this century. This is especially true with respect to indirect taxes as a result of the free movement of goods and services in the internal EU market. Therefore, the member states must ensure uniform taxation of supplies of goods and services. Harmonization of direct taxes is much more difficult, which is partly related to the reluctance of the member states to give up their sovereignty in the area of tax policy and largely is influenced by the different design of direct taxes in the member states. The concepts emerging around tax base harmonization in corporate taxes, ranging from the least intrusive with the tax-raising powers of the member states (e.g., Home State Taxation) to the most radical one (European Union Corporate Income Tax), which assumes the existence of a single EU-wide tax ensuring revenue flows to the EU budget, are rather unrealistic in the current political situation.

Since the 1990s, progressing trade liberalization, no control over the movements of capital and foreign exchange convertibility at a global level, regional integration programs, the EU Single Market, the North American Free Trade Agreement (NAFTA), and new communication and transportation technologies have reduced transaction costs related to the movement of goods, services, capital, and people. All these factors have provided fertile ground for crawling tax competition or even to some extent unfair/harmful tax competition. The main reason for tax competition was economic growth by creating optimum tax conditions for business and attracting foreign capital. Differences in taxation systems of individual member states may thus affect the investment decisions of enterprises [Genschel and Schwarz, 2011].

Increasing tax competition between the EU member states, especially after the accession of the CEECs to the EU, has led to further differences in tax rates, reliefs, and ways of collecting taxes. In order to become competitive for attracting international capital and retaining domestic investment capital, the CEECs have reduced the nominal tax rates. However, tax competitiveness is influenced not only by tax rates but also by reliefs and exemptions, tax base, tax preferences, or favorable tax procedures. The Czech Republic and the Slovak Republic are examples of countries that attract foreign capital through taxes. Favorable rules of taxation for CIT and the lack of restrictions in VAT deduction make entrepreneurs choose precisely these countries when looking for a place to do business. Tax competition between countries takes the form of a "race to the bottom," which – in extreme cases – may result in the tax rate being reduced to zero.

An example is Estonia, where the CIT on retained earnings is 0%, which is a form of tax deferral until its payment. A similar construct has been implemented in Poland in 2021.

Parallelly, the trend to secure tax revenues is visible in all the EU member states whose tax base has been/is being eroded. The Anti-Tax Avoidance Directive (ATAD) contains legally binding antiabuse measures. In particular, ATAD-I includes rules on hybrid mismatches, controlled foreign companies (CFCs), switchover rule, exit taxation, interest limitation, and general antiabuse rule. ATAD-II adds rules on mismatches with third countries, which apply to all taxpayers subject to corporate tax in one or more member states, including permanent establishments (PEs) in one or more member states of entities resident for tax purposes in a third country. Rules on reverse hybrid mismatches also apply to entities treated as transparent for tax purposes.

Broadly sketched measures with regard to the above have also been undertaken under the auspices of the OECD/G20 within the framework of the project Base Erosion Profit Shifting (BEPS) 1.0 and, currently, BEPS 2.0.[6] The OECD/G20 Inclusive Framework on BEPS has agreed on a two-pillar solution to address the tax challenges arising from the digitalization of the economy.[7] Under BEPS 2.0 Pillar 1, automated digital services (ADSs) and consumer-facing businesses (CFBs) would be taxed in the jurisdiction that the revenues are sourced from. BEPS 2.0 Pillar 2 introduces new rules granting jurisdictions additional taxing rights in cases where either another jurisdiction has not exercised its primary taxing right or the income is subject to a "low tax rate" of 15%.

3.5 Characteristics of income taxation in CEECs

Income taxes (on company or personal income) are, along with sales taxes, one of the main pillars of the tax systems in the CEECs. It was demonstrated that contemporary models of taxation in the analyzed countries were determined by several factors.

Income taxes (PIT, CIT) may have a negative impact on the economic situation of taxpayers as they deprive them of some (determined by tax base and tax rates) of the financial resources that they have earned, in addition to distorting the market mechanism. Therefore, it is desired to reduce the negative effects of taxation on economic growth by tax reforms while maintaining an appropriate level of public goods and services. However, the impact of these factors on the implemented solutions differed across individual countries. In the CEECs, significant differences in the construction of income taxes can be observed (Table 1), as follows:

- various system principles regarding tax transparency of taxpayers, in particular, in respect to partnerships;
- different assumptions as to the moment of taxation: tax paid on profits (income) that have been earned versus tax payable upon the distribution of profits (Estonia, Latvia, and Poland);
- diverse links between financial accounting law and tax accounting law (a connection between taxable income and balance sheet profit, permanent differences, and temporary differences);
- different principles guiding the occurrence of a taxable event (revenue/cost): accrual basis versus cash basis;
- diverse approaches to the calculation of tax base (e.g., scope of tax revenues and tax-deductible expenses, scope of exclusions, exemptions, or deductions, transfer pricing adjustments).

Most CEECs have reduced tax rates for both CIT and PIT. Low CIT rates are in force, inter alia, in Bulgaria (10%) and Hungary (9%). Many countries have carried out radical tax reforms and introduced flat PIT rates, e.g., Bulgaria, the Czech Republic, Lithuania, Romania, the Slovak Republic, and Hungary. Importantly, this clear downward trend in CIT was coupled with the broadening of the tax base. Among the solutions

6 On October 12, 2020, the OECD published the *Blueprints for Pillar 1 and Pillar 2*, together with accompanying documentation, including an impact assessment; https://www.oecd.org/tax/beps/public-consultation-document-reports-on-pillar-one-and-pillar-two-blueprints-october-2020.pdf.

7 https://www.oecd.org/tax/beps/statement-by-the-oecd-g20-inclusive-framework-on-beps.htm

Table 1. Selected characteristic features of taxation systems and applied tax incentives

Bulgaria	• Low flat tax rate • Tax incentives for regional development, creating jobs, transfer of technologies, or promoting exports • Tax preferences in industrial zones
Croatia	• A hybrid system (components of income and consumption taxation) • R&D tax relief • Tax preferences for the SME sector
Czechia	• Lump sum tax-deductible expenses • Tax losses can be carried forward • R&D tax relief • Tax reliefs for investment projects • Shortened depreciation period for selected fixed assets • Fixed-flat-rate income tax rates
Estonia	• Profits are not taxed until they are distributed • Simple tax system with limited set of tax preferences • From 2018, lower tax rate for companies making regular profit distribution
Lithuania	• Many tax preferences designed to promote entrepreneurship and innovation • Some incentives limited in time • Tax preferences offered in the SEZs
Latvia	• Profits are not taxed until they are distributed • Favorable tax rates for small businesses • Tax preferences in the SEZs and free ports (Ventspils and Riga)
Poland	• Tax preferences designed to share development risks between entrepreneurs and the state budget (tax losses can be carried forward) • R&D tax relief • Tax preferences in SEZs
Romania	• Tax preferences for microbusinesses • R&D tax relief • Tax preferences in SEZs
Slovakia	• Tax-deductible expenses – real or lump-sum costs • R&D tax relief • Tax reliefs for investment projects
Slovenia	• Special solutions applicable to funds (*venture capital,* investment, and pension) • Tax incentives
Hungary	• Alternative minimum tax • Many tax reliefs and exemptions

Source: Based on Felis et al. [2020].
R&D, research-and-development; SEZ, special economic zone; SME, small and medium enterprises.

implemented in Poland were, inter alia, preferences for small taxpayers (e.g., lower CIT rate, accelerated depreciation, quarterly frequency of advance payments). Estonia and Latvia brought tax reliefs and exemptions down to a minimum level. However, in Latvia, tools that support the desired socioeconomic objectives or encourage taxpayers to engage in specific economic activities (e.g., in the field of innovation, in an investment project, or the acquisition or production of new technologies) have not been abandoned straight away. Many countries use R&D tax relief or accelerated depreciation, offer preferential tax treatment to the SME sector, allow tax losses to be carried forward (often for extended periods),[8] or put regional policy instruments in place (SEZs).

Tax system assumptions in Croatia and Estonia may deserve special attention. Croatia has been a precursor in this part of Europe of a consumption-oriented approach to income taxation. The CIT has been initially designed to offer allowances for corporate equity. Estonia, on the other hand, exempted income

8 An interesting presentation on recognizing losses backward or forward was presented by W. Stiller in 2012.

retained in the company from corporate tax. Estonian CIT is levied only when profit earned is distributed. The deferred moment of taxation can cause the desired lock-in effects. A similar solution was also implemented in Latvia (in 2018).

4 Empirical study: similarities and differences among countries

4.1 Research methodology

To find out how much similar are countries when it comes to the tax burden, we selected four indicators and carried out convergence analysis for each of them separately. The study was conducted for 11 countries (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia) and covered the period 1995–2018. We used the following indicators as variables that describe taxation systems[9]:

1) IND.1: current taxes on income, wealth, etc. as percentage of GDP;
2) IND.2: taxes on the income or profits of corporations, including holding gains, as a percentage of the GDP;
3) IND.3: taxes on the income or profits of corporations, including holding gains, as a percentage of the total;
4) IND.4: taxes on individual or household income, including holding gains, as a percentage of the GDP.

Therefore, a differentiated approach was adopted in the selection of indicators – with reference to both the total tax revenue of the state, as well as the income resulting from taxation of corporations and separately of households.

Basic descriptive statistics for the selected indicators for the CEECs and EU-15 countries are presented in Table 2. For each of the four indicators describing the taxation systems, the corresponding values (minimums, maximums, quartiles, and arithmetic averages) for the EU-15 countries are much higher than for the CEECs. This could be explained by the tax reforms that were introduced in most CEECs since the mid-1990s, mainly in the area of income taxes attracting the interest of this article. In the case of IND.1 and IND.4, the values are approximately twice as large. For IND.2 and IND.3, the differences are not that big, but still distinct. In fact, only in two cases, the values of the taxes on the income or profits of corporations as a percentage of the total (IND.3) are greater for the CEECs compared to those for the EU-15 countries. The first case is during the financial crisis of 2007–2009, when incomes were strongly determined by macroeconomic factors. In 1995 also, IND.2 for CEECs exceed the value recorded for EU-15 countries (2.7 versus 2.6). For all other years and the other two indicators, the values for EU-15 are always greater than those for CEECs, in most cases significantly. Such an observation is a quantitative argument for the diversity of these groups of countries and an additional premise for a more detailed analysis of the CEECs.

Usually, the convergence analysis is conducted on pairs of entities [Pesaran, 2007] or – in the case of a group of entities – with regard to some benchmark. For the considered group of countries and set of indicators, it is difficult to provide an adequate benchmark; therefore, some kind of leader was selected. The country for which the value of a given indicator was the highest in the last year of the analyzed period was identified with the reference time series. The reasons for using this selection criterion were – on the one hand – in line with the concept of the most recent leader and, on the other hand, this criterion is the solution of the problem in which, over the years under consideration, the highest values of indicators were observed for different countries. In order to ensure that the reference values in each year were not lower than those reported for other countries, the values of the analyzed indicator for the selected reference country were previously recalculated using an appropriate multiplier. The multiplier is the minimal real number such that, after multiplication, the resulting reference time series is not smaller than the indicators

9 Data from Eurostat as on 31.08.2020; https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=gov_10a_taxag&lang=en

Table 2. Descriptive statistics for the selected indicators of the CEECs and EU-15 countries

Statistics	IND.1		IND.2		IND.3		IND.4	
	Current income taxes (% of GDP)		Corporation income taxes (% of GDP)		Corporation income taxes (% of total)		Individual income taxes (% of GDP)	
	EU-15	CEE	EU-15	CEE	EU-15	CEE	EU-15	CEE
Min	13.6	6.2	2.4	1.8	6.4	5.7	9.9	4.1
Mean	14.2	7.3	3.0	2.2	7.6	6.9	10.3	4.8
Q1	13.9	6.9	2.6	2.0	6.8	6.2	10.1	4.4
Median (Q2)	14.2	7.3	3.0	2.2	7.8	6.7	10.3	4.7
Q3	14.4	8.0	3.2	2.4	8.3	7.5	10.5	5.0
Max	14.8	8.6	3.6	3.0	9.1	9.0	11.0	5.7

CEEC, Central and Eastern European country; EU, European Union; GDP, gross domestic product; IND., indicator; max, maximum; min, minimum.

for the other countries in the entire period. This approach allows for easy observation of changes in the distances between the values of the indicators for different countries for each year consecutively, and the convergence or discrepancy is counted against a hypothetical maximum (changing over the years). This technical adjustment does not affect the convergence dynamics but facilitates the interpretation of the results, whereby changes in distances or speed of those changes are read in terms of convergence. Changing the reference time series is likely to change the results and the related interpretation, which informs about the convergence of the selected country toward the group of other countries. However, such a change would not allow for the analysis of the convergence defined as a determination of the degree of similarity between the CEECs over time. Therefore, as a reference, a leader in recent years was selected.

The classic convergence analysis commonly uses econometric models[10] that require the meeting of many assumptions of a statistical or asymptotic nature (particularly important for the short time series). In this study, this is one of the restrictions that have to be taken into consideration. In addition, this convergence is analyzed as indicator by indicator, and in this case, multifactorial relationship study is not needed. Indeed, the comparison of the indicators in the considered group of countries should be treated as a similarity analysis between time series. However, there are relatively few adequate measures of the dependence of the time series, and some of them require meeting certain complex statistical assumptions. Simplified and inadequate measures, such as the linear correlation coefficient, have not been used. One of the latest approaches to this issue is the procedure of using HMMs.[11] It has been successfully used to assess the degree of cyclical convergence and the leveling of income levels between Poland and the EU-27 on the basis of GDP per capita according to purchasing power parity (PPP) or the real GDP growth rate and related macroeconomic variables [Bernardelli et al., 2017, pp. 59-80]. The same method has also been used for the convergence analysis in this study. Compared to the conventional econometric methods, an approach based on HMM does not require many assumptions, because it works rather in terms of automatic pattern recognition. The advantage of using this approach is the ease of interpretation and wide applicability in terms of input data (including missing data), while the disadvantage is the difficulty to precisely quantify the speed of convergence, which is obvious in the case of econometric modeling.

Among the group of 11 countries considered in the paper, subgroups representing specific features may be selected. However, for such short time series and under rapidly changing tax reality, it is not possible to identify them unequivocally. When dividing countries into groups, automatic grouping into three groups

10 For instance, the Blundell–Bond estimator in Barro regression in studies on β-convergence [see Blundell and Bond, 1998, pp. 115–143]. For more details on convergence methods, see, e.g., Novales et al. [2009] and Bernardelli M. et al. [2021].
11 See Bernardelli [2018].

using the *k*-means algorithm has been applied to avoid subjectivity, where the Euclidean norm has been adopted as a measure of the distance [Hartigan and Wong, 1979, pp. 100–108]. The grouping has been applied on the basis of observations placed in multidimensional space, where each of the coordinates was related to a specific indicator in a specific year.

4.2 Results of empirical study

Indicators for each country are presented in Figure 1. Before the latest pandemic period, many CEECs exhibited a clear tendency to reduce income taxation. Reduction of revenue from income tax stemmed to a large extent from the reduction of tax rates. Revenue generated by direct taxes and other levies in the CEECs ranged on average between 6% and 8% of GDP. These amounts are important for the equilibrium of general government, although they are clearly smaller than the revenue generated by other categories of taxes: consumption taxes and social insurance contributions. For example, on analyzing direct taxes in the Czech Republic, there is a downward trend with regard to the share of the CIT in the GDP. Its share in GDP in 1995 was +4.6% and, in 2010, –3.2% of GDP. Undoubtedly, it is related to the reduction of the rate of this tax. It should be noted that the CIT rate has been lowered many times in the Czech Republic over the past 27 years. Currently, it is 19%, while in 1993, it was 45%.

Examples of countries where IND.1 clearly dropped include Estonia, Lithuania, Poland, Romania, and the Slovak Republic. In the CEECs, the fiscal relevance of taxes imposed on corporate income is rather small; they represent on average 3%–4% of the GDP and approximately 8%–10% of all revenue from taxes. Reasons can be sought in the negative impact of this category of taxes on taxpayers' economic activity. Considering that taxes on capital (and CIT is one of them) generate the highest losses in prosperity, the decreasing levels of IND.2 and IND. 3 should be assessed positively in countries such as Bulgaria, Romania, and the Slovak Republic.[12] For example, the reason for positive assessment in Bulgaria is that this country focused, in the long-term policy, on additional revenues from indirect taxes to compensate the revenue losses caused by lowering the CIT rate. However, there are countries such as Croatia and Slovenia in which revenue from these levies have been growing in recent years. In other countries, fiscal relevance of tax measured with IND.2 and IND.3 varies. For PIT, the situation is more complicated (IND.4) as the tax base must be divided into two components: income from work (e.g., part of the income from business activities attributed to an entrepreneur as remuneration for her/his work) and income from capital gains (including part of the income from business activities attributed to an entrepreneur as return on invested capital).[13] In most countries, this indicator was either gradually decreasing or remained at a rather unchanged level. It needs to be underlined that over the period 2008–2009, the above-mentioned indicators were on the rise, meaning that most of the countries covered by the study decided to change their previous tax policies. The global crisis drove government revenue down; however, on the other hand, it triggered measures designed to avoid any further economic slowdown and to stimulate the economy. It also turned governments' attention to measures intended to increase tax revenue (increased tax rates, broadening of the tax base, and sealing the tax system).

The convergence analysis was conducted for each indicator according to the adopted methodology for the group of 11 countries covered by the study. A collective representation of the examined indicators is presented in Figure 2. Values (left *Y*-axis) vary between "0" and "1", where "0" indicates perfect similarity between countries and "1" indicates divergence from the reference country. For the comparison on the right *Y*-axis, there are the original time series of the considered indicators: IND.1, IND.2, IND.3, and IND.4, respectively.

12 Taxes on corporate income are considered the most harmful. Their collection triggers externalities, thus disrupting the market mechanism, which generates additional losses in welfare (excess burden). However, the scale and scope of the excess burden may be different [Rosen and Auerbach, 1980; Grądalski, 2006; Harberger, 1964].

13 Personal income tax is also commonly used to mitigate inequalities in the income of the society [Aronson et al., 1994]. By using such tax structures, the state can, e.g., effectively reduce the differences in the distribution of income and thus influence the maximization of the welfare of the society.

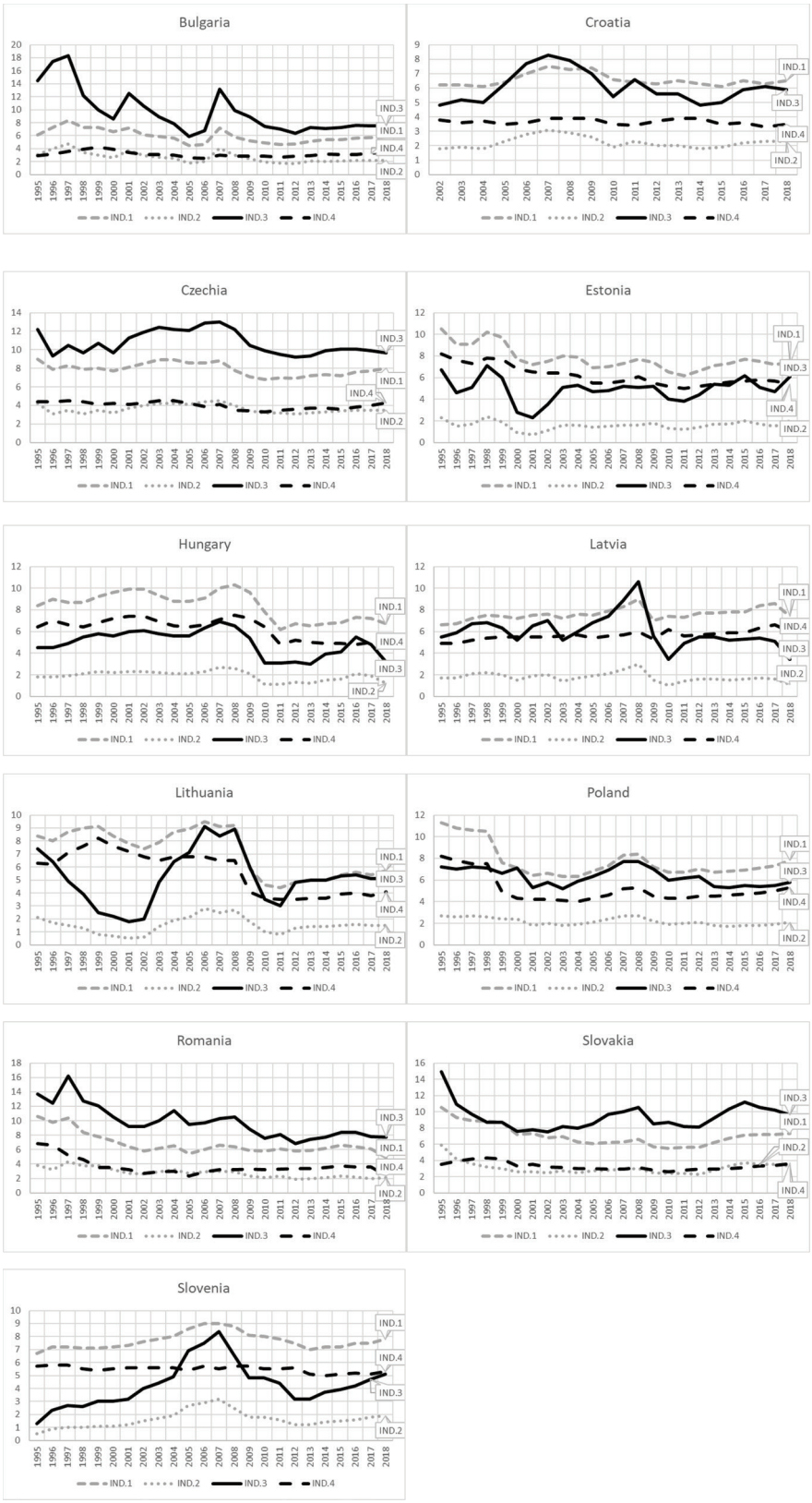


Figure 1. Indicators showing the characteristic features of the tax systems in the countries covered by the study. IND.1: current taxes on income, wealth, etc., as a percentage of the GDP; IND.2: taxes on the income or profits of corporations, including holding gains, as a percentage of the GDP; IND.3: taxes on the income or profits of corporations, including holding gains, as a percentage of the total; IND.4: taxes on individual or household income, including holding gains, as a percentage of the GDP. GDP, gross domestic product; IND., indicator.

The examination of graphs reveals strong similarity in the course of convergence for indicators IND.1, IND.2, and IND.3. In other words, the CITs as a percentage of the total and as a percentage of the GDP, as well as current taxes on income as a percentage of the GDP, indicate analogous behavior in the analyzed countries: they are more similar or more dissimilar in relation to the Czech Republic (reference country) at approximately in the same time period. Divergence growth since the end of the 20th century was stopped at the outbreak of the global financial crisis in 2007, when convergence processes intensified. At that time, the countries covered by our study, taken together as a group, became very similar and stabilized at a relatively permanent level. Only the IND.1 indicator informs about slightly more powerful processes that would suggest some divergence between these countries in terms of the direct taxes-to-GDP ratio.

While the results of the studies demonstrate that tax policies pursued by these countries in corporate taxes over the recent 10 years were similar, a totally different conclusion can be drawn for PIT (IND.4). Since 1998, a rather systematic divergence from Latvia (reference country) can be observed in the PIT. As for Latvia, the PIT rates have remained at the level of 25% or lower for many years. Only once – in 2010 – the rate was increased to 26%. In 2018–2020, the standard flat rate was replaced by a progressive PIT, with rates of 20%, 23%, and 31.4%. Our results do not mean that the countries concerned have completely different and dissimilar tax policies in this area. It should be noted that the adopted indicator of the level of fiscalism contains data on taxation of capital and labor. Income taxes on work and income from capital have many common features, but they are also distinct. In the case of income tax on work, it is not only about solutions that may lead to the inflow of capital and migration of wealthy and educated people, but also about personalization and social circumstances and, hence, the greater or lesser progressiveness of PIT (the tax-free amount, number of tax thresholds, and range of tax reliefs).

Valuable data can be obtained from the convergence analysis conducted for subgroups of countries identified using *k*-means algorithm, whereby, after incomplete data had been removed, grouping was carried out in a 68-dimensional space, one dimension for each indicator in a given year (four indicators, 17 years from 2002 to 2018; the shorter time interval was due to the lack of data available for Croatia for the years preceding 2002). The resultant division into groups, with the arithmetic means for indicators in the individual groups, is given in Table 3.

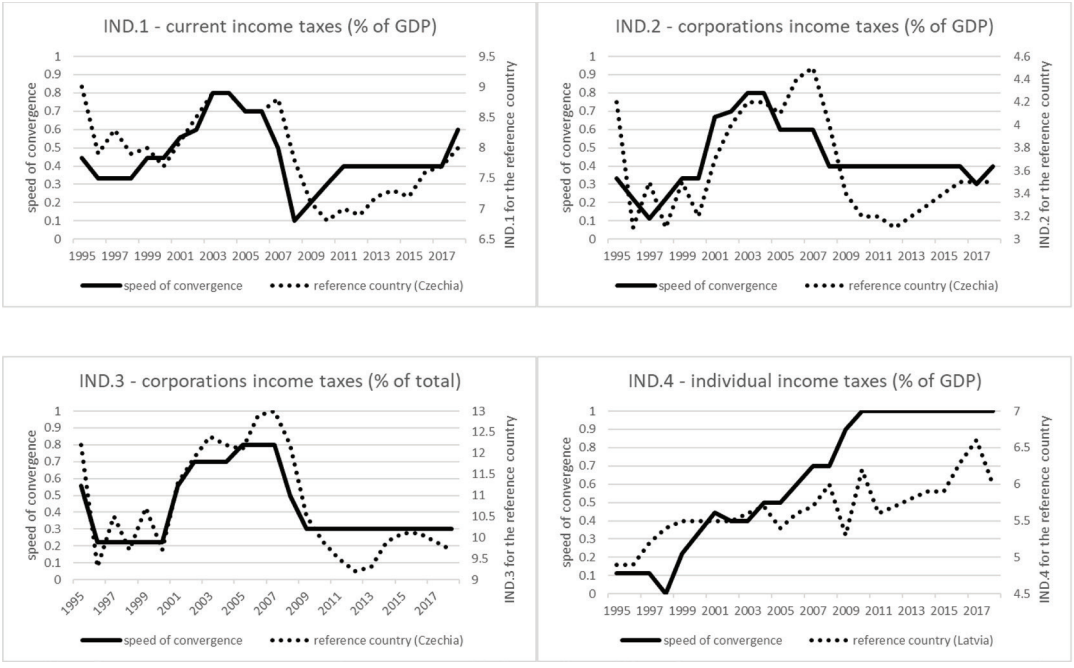


Figure 2. Speed of convergence to the reference series in the years 1995–2018. The value "0" indicates perfect similarity between countries, and "1" indicates divergence from the reference country. GDP, gross domestic product; IND., indicator.

Table 3. Division into groups of the most similar countries using *k*-means clustering method

Country	Group 1	Group 2	Group 3
Bulgaria	√		
Croatia	√		
Czechia		√	
Estonia			√
Hungary			√
Latvia			√
Lithuania			√
Poland			√
Romania	√		
Slovakia		√	
Slovenia			√
Arithmetic mean			
IND.1 - Current income taxes (% of GDP)	6.42	7.50	7.71
IND.2 - Corporation income taxes (% of GDP)	2.59	3.35	1.76
IND.3 - Corporation income taxes (% of total)	8.76	10.07	5.28
IND.4 - Individual income taxes (% of GDP)	3.45	3.64	5.71

Source: own compilation.
Arithmetic means for each group are given to show the relative position of the groups in relation to each other.
GDP, gross domestic product; IND., indicator.

Clustering produces groups of the most similar countries in terms of tax policy during the first 17 years of the 20th century. The countries are not grouped by a detailed analysis of tax systems, but rather based on the contribution of individual tax entities to the total taxes or GDP. It is done year by year in a completely algorithmic way. Therefore, it is not easy to give the ideal description of the groups obtained by automatic division; but, based on the averages, we can interpret the relative ordering of individual groups. In accordance with the clustering, Group 3 is made up of countries for which the values of indicators IND.1 and IND.4 were on average the highest, while values of indicators IND.2 and IND.3 were the lowest. Group 1 brings together countries with the lowest values of IND.1 and IND.4 and moderate values of the two remaining indicators that inform about corporate taxes (taxes on corporate income or profits). It should be emphasized that the resulting clustering applies to the selected indicators for a given group of countries in a specific period. Changing the indicators or study period will potentially affect the groups' composition.

A research procedure that identifies the speed of convergence with the reference country in a given group was carried out for all three groups of countries included in Table 3. The comparison of results of analyses for the four indicators is presented in Figures 3–5. The value "0" indicates the period of convergence between the countries and "1" indicates the period of divergence of the considered group of countries from the reference country. Compared to the global convergence for the total group of 11 countries, the behavior in the subgroups shows some differentiation, which means that some groups are more similar than others in terms of the tax policy (at least in the considered time period).

In Group 1, due to the lack of data available for Croatia for the years preceding 2002, the analysis was confined to the period 2002–2018. For all indicators in this group, except for IND.3, Croatia turned out to be the reference country. For IND.3, convergence was researched with reference to Romania. It could be understood that, in Romania, the relation between tax revenues received on the basis of CIT and other taxes was the highest in comparison to the same in other countries. Group 2 consists of only two countries, and every time, we studied the speed with which the Slovak Republic converged with the Czech Republic. Finally, in Group 3, the reference countries for the individual indicators were Poland (IND.1 and IND.2), Estonia (IND.3), and Latvia (IND.4).

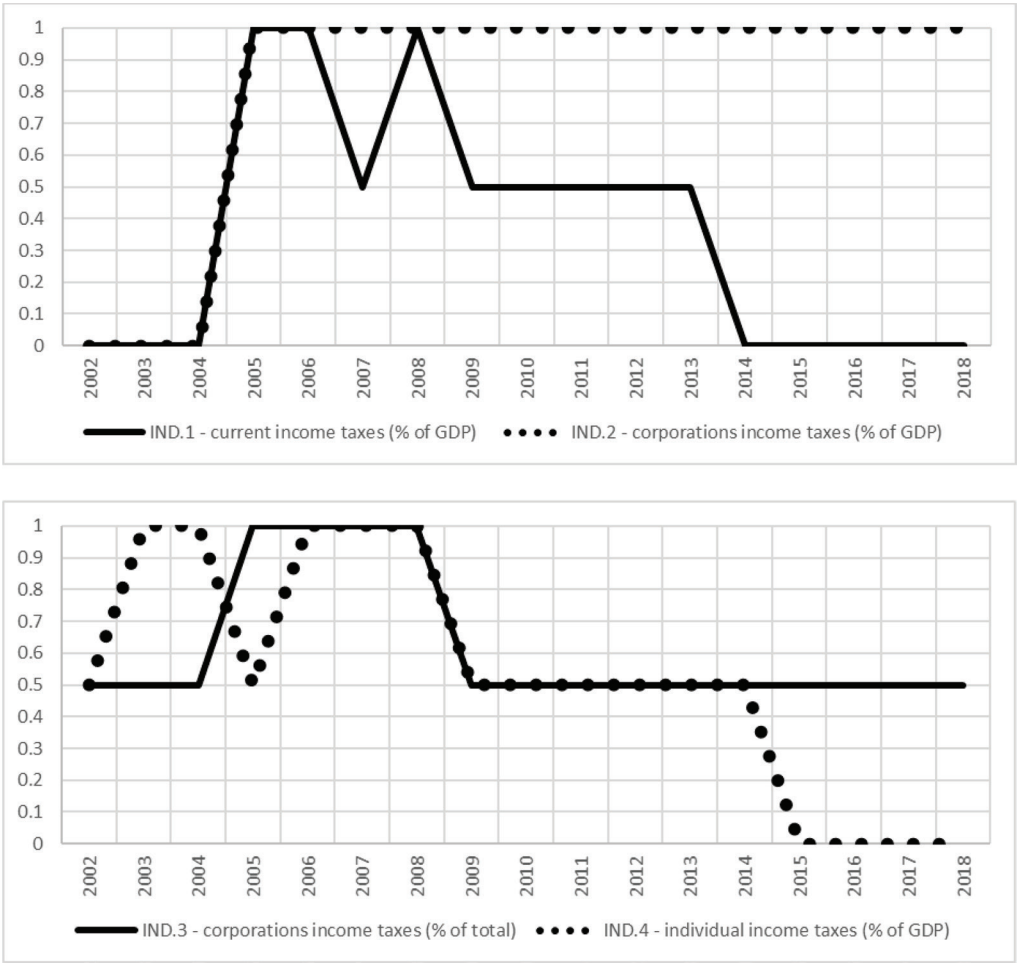


Figure 3. Speed of convergence to reference series in Group 1 (Bulgaria, Croatia, and Romania) in terms of the particular indicators. The value "0" indicates perfect similarity between countries, and "1" indicates divergence from the reference country. GDP, gross domestic product; IND., indicator.

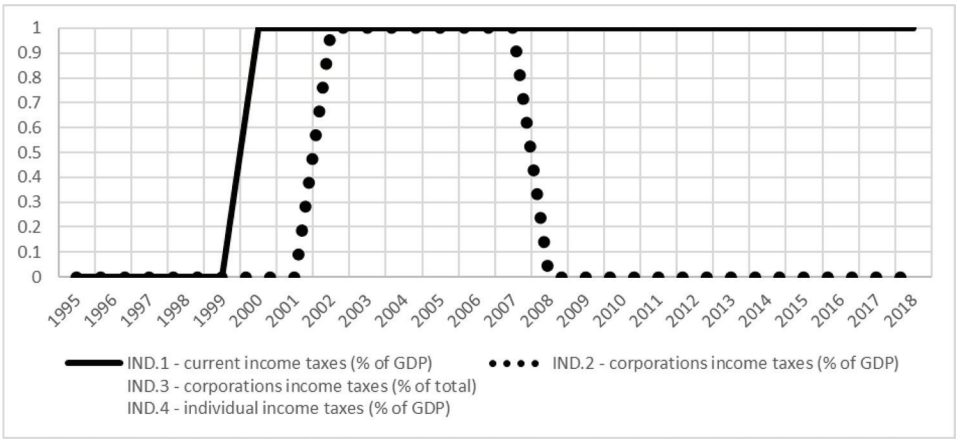


Figure 4. Speed of convergence to reference series in Group 2 (Czechia and Slovakia) in terms of the particular indicators. The value "0" indicates perfect similarity between countries, and "1" indicates divergence from the reference country. GDP, gross domestic product; IND., indicator.

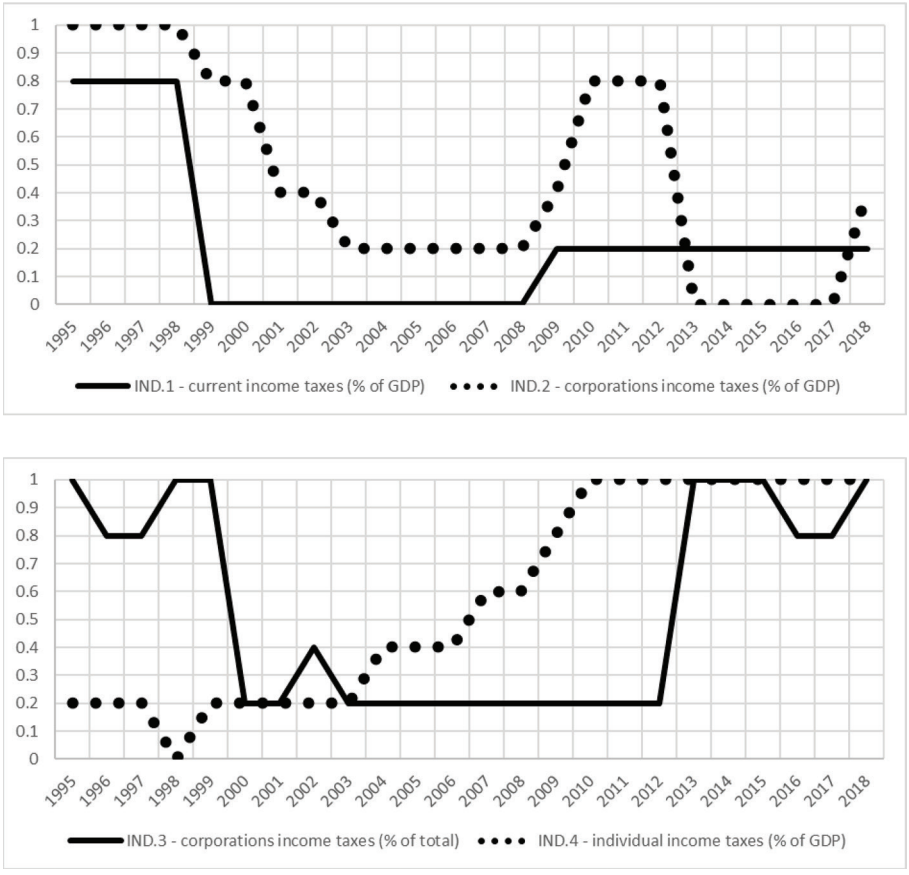


Figure 5. Speed of convergence to reference series in Group 3 (Estonia, Hungary, Latvia, Lithuania, Poland, and Slovenia) in terms of the particular indicators. The value "0" indicates perfect similarity between countries, and "1" indicates divergence from the reference country. GDP, gross domestic product; IND., indicator.

From the group perspective, conclusions about the course of convergence processes may differ significantly from those drawn collectively for all countries. One reason is the change of the reference country and its tax policy (changes in CIT and PIT), and the other lies in the homogeneity of groups of countries with regard to all the indicators under consideration. These differences can be observed in the course of the IND.4 indicator, which clearly shows a divergent behavior pattern for all the countries covered by the study (when applied to Group 1 only, it reveals a clear convergence). Attention should also be paid to changes in the rate of convergence over the period under consideration, e.g., for taxes on corporate income or profits (IND.2), especially for countries from Groups 2 and 3, in which a significant change in the speed of convergence occurred with the outbreak of the global financial crisis 2007–2009. At that time, some countries became similar in terms of the rate of CITs (the Czech Republic and the Slovak Republic, Group 2), but some countries began to differ in some degree when hit by the crisis (Group 3). Concerning the characteristics of individual tax systems, this can be explained by similar tax solutions applied by the countries in Group 2 (flat tax in PIT, lump-sum tax-deductible costs, and a similar range of tax preferences), i.e., a common source of tax regulation and the legal legacy of a common state. For example, an instrument that only occurs in the Czech Republic and the Slovak Republic is the lump-sum tax-deductible costs of running a business. It can therefore be said that the structural elements of CIT in both these countries are at a very similar level.

Group 3 countries, due to their heterogeneity and diversity of tax solutions, do not satisfy this condition. Let us recall, e.g., the so-called Estonian income tax, i.e., tax deferral until the profits are distributed (Estonia and Latvia); different CIT rates (e.g., 9% in Hungary, 15% in Lithuania, and 19% in Poland and Slovenia); and different tax preferences (reliefs for innovation, SEZs).

Despite differences in the tax policies of the CEECs manifesting themselves in the original method that the authors applied (by grouping CEECs), some regularities can be observed over the period under examination. First of all, income taxes paid on corporate income, which are far from the theoretically effective models, do not prevail in the structure of tax revenues of these countries. Moreover, in most countries, a reduction of the income tax burden has been noticed. However, the process of reducing the tax burden should be seen not only in the context of globalization-driven tax competition but also as an exploration of tax rates that would be consistent with long-term economic growth.

5 Conclusion

The article aimed at exhibiting trends in tax policy in the CEECs with respect to CIT. Research questions related to the convergence and/or divergence processes among CEECs have been examined; in particular, the key factors accounting for these processes have been identified and explained. The research has allowed the bringing of a proof for tax convergence in the CEECs. The method used for convergence estimation was intended to analyze large groups of countries, as well as to make comparisons between individual pairs of countries. This was possible due to algorithmic clustering of data, the time series similarity method using HMMs, and experts' analysis of data available for each of the countries covered by the study.

Both convergence and divergence processes can be observed between the CEECs. The speed with which they unroll in relation to the adopted variables (indicators characterizing the national tax systems) throughout the entire examined period varied and depended on both exogenous and endogenous factors. The factors identified as having an obvious impact on the tax policy in the CEECs were tax reforms carried out before and after the EU accession, as well as the global financial crisis. In the first subperiod, taxation systems in the analyzed countries were, as a rule, similar to those used in the 1990s, when taxation reforms were started. The change in the economic and political system in this region of Europe was associated with the need to build a tax system and give taxes an economic meaning that is adequate to the role that they play in the market economy. At the end of the 1990s and in the beginning of the 21st century (second subperiod), an increasingly intensifying process of divergence could be observed. A number of significant modifications to the tax systems were carried out, which was a consequence of changing tax policies, whereas the key factors were the implementation of the fiscal function (different levels of fiscalism) and the use of tax preferences to various degrees to achieve important economic and social goals. The decisions that were made with regard to taxes resulted from the specific economic, social, and political situation of the CEECs. In the years 2004–2009 (third subperiod), an intensifying pace of the convergence process could be observed. Initially, it resulted from the harmonization of tax systems within the EU and, later, from the impact of the global economic crisis on the tax policies of individual countries. After the crisis began, the CEECs usually decided to implement solutions that would increase their current tax revenues and reduce their budget deficit. In the postcrisis period (fourth subperiod), the continuation of convergence processes, as the CEECs pursued aggressive tax policies, could be mainly observed.

Within the scope of income taxation, divergence had grown since the end of the 20th century and has stopped at the outbreak of the latest global financial crisis, when convergence processes intensified. Tax policies pursued over the recent 10 years (consequent to the outbreak of the COVID-19 pandemic) in corporate taxes can be considered as similar. A different conclusion can be drawn for PIT (IND.4). Since 1998, a rather systematic divergence can be observed in PIT. In the period considered, changes in the rate of convergence can be observed. For corporate taxes (IND.2), especially for the countries from Groups 2 and 3, a significant change in the speed of convergence occurred with the outbreak of the global financial crisis in 2007–2009.

Reforms were not uniform in nature, due to only a fragmentary harmonization of direct taxes. In turn, the period of the global crisis marks a breakthrough from the point of view of the directions of changes in the structure of income taxes in the CEECs.

From the point of view of contemporary tax policy trends, globalization triggered international tax competition, especially in terms of the growing importance of foreign direct investments. Tax competition

in the CEECs focuses on the principle of income taxes. It is worth mentioning that it would not have happened if these countries had decided to increase the share of neutral taxes, above all, lump-sum taxes. Tax competition may lead to different consequences. Initially, divergence processes intensify through the adoption of different tax solutions (implementation of a flat rate tax, reduction of tax rates, tax preferences offered to innovation projects, simplification, and reduction of the number of applicable taxes). However, through the so-called tax mimicking of, e.g., neighboring countries (significant geographical proximity), tax systems have become similar. The problem of the effectiveness of tax policy also needs to be addressed, but this issue was not the subject of this paper and should be further explored (fiscal policy is not the only criterion determining the migration of capital and inhabitants among countries).

Current challenges, such as the COVID-19 pandemic crisis, will contribute to the redesigning of tax systems, and it may be expected that crawling tax competition intensifies even more. In the area of international taxation, the impact of a two-pillar solution to address the tax challenges arising from the digitalization of the economy will also require further research.

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Appendix

Hidden Markov models and applicability to the convergence analysis

Hidden Markov models (HMMs) or Markov-switching models have been known in literature since the 1960s. This method has been used in all fields where pattern recognition is desirable, such as speech and hand gesture recognition, modeling DNA sequencing errors, turning point identification, or business cycle synchronization analysis. The Baum–Welch algorithm (Yang et al., 2017) is a deterministic procedure allowing to estimate the parameters of the HMM, which can be defined by the three sets of probabilities (A, B, π):

- matrix of transition probabilities $A = \left\{ P\left(s_i | s_j \right) \right\}_{i,j=1}^{N}$;
- matrix of observation probabilities $B = \left\{ P\left(v_i | s_j \right) \right\}$ for $i = 1,...,M$, $j = 1,...,N$;
- vector of initial probabilities $\pi = \left\{ P\left(s_i \right) \right\}_{i=1}^{N}$,

where $S = \{s_1, s_2,...,s_N\}$ is the finite N-element state space and M-element set of observations $V = \{v_1, v_2,...,v_M\}$. States are not visible and the idea behind the model is to determine the path of states based on the visible set of observations.

In fact, as an output from the Baum–Welch algorithm, we get the set of probabilities of being in a given state. One way of changing this set of probabilities into the most probable sequence of states in the whole period covered by the analysis is to use the so-called Viterbi algorithm (Viterbi, 1967). The concept of HMM with the Viterbi path can be used in convergence analysis. The procedure explored in this paper can be divided into three stages. In the first stage, time series of differences of the reference series and indicators have been created for each of the analyzed countries. In the second stage, for each of the time series of differences determined in the first stage, the two-state HMM parameters have been estimated by using Monte Carlo simulation and the Baum–Welch algorithm, and then, two-state Viterbi paths have been determined. State 0 on this pathway indicates the period in which the countries were similar in terms of the analyzed indicator, while the state denoted by "1" indicates a discrepancy (with respect to the reference series). In the third stage, we have calculated the averages of all countries (except the reference one) for each year from the Viterbi path states. Lower values (closer to zero) indicate the existence of convergence, i.e., countries becoming increasingly more similar in terms of the indicator under consideration. On the other hand, higher values (closer to one), indicate divergence, i.e., a decrease in the similarity between the reference series and the group of examined countries. Simply to reflect the idea underpinning convergence analysis based on HMM, we can say that this is an automated way of determining on a scale from "0" (ideal similarity) to "1" (no similarity) how many countries were similar to the reference country on average in a given year. The results of the convergence analysis can be presented in the form of a linear graph corresponding to these average similarity values. It shows the changes in the speed of convergence of the group of countries to the reference series. The use of a hidden Markov chain allows for more precise readings, which is richer in the number of states, but the shortness of the time series and the resulting lower numerical stability of the calculations argue for using the two-state HMM. More details with the application can be found in Bernardelli et al. [2021].

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