THE CONCEPT OF TAX GAPS

Report II:

Corporate Income Tax Gap Estimation Methodologies

by FISCALIS Tax Gap Project Group (FPG/041)

Brussels, July 2018

ACKNOWLEDGEMENTS

Abbreviations and Acronyms

ATIN	Anonymized Taxpayer Identification Number
AETR	Average Effective Tax Rates
BEPS	Base Erosion and Profit Shifting
EC	European Commission
ETR	Effective Tax Rate
EU	European Union
CIA	Conditional Independence Assumption
CIT	Corporate Income Tax
C-NTB	Current year net tax base
CSC	Common Support Condition
C-TB	Current year tax base
DG TAXUD	Directorate-General for Taxation and Customs Union
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
ESTAT	Eurostat
ESA 1995	European System of Accounts 1995
ESA 2010	European system of national and regional accounts 2010
FAP	Financial Accounting Profit
FTE	Full-time equivalent
GDP	Gross Domestic Product
GNI	Gross National Income
GOS	Gross Operating Surplus
HMRC	Her Majesty's Revenue and Customs (United Kingdom tax authorities)
IBFD	International Bureau of Fiscal Documentation
IMF	International Monetary Fund
IRS	Internal Revenue Service (United States tax authorities)
MIMIC	Multiple Indicators, Multiple Causes model
MNE	Multinational Enterprise
NA	National Accounts
NRP	National Research Program
NPISH	Non-profit Institutions Serving Households
OECD	Organisation for Economic Cooperation and Development
PIT	Personal Income Tax

SMEs	Small and medium-sized enterprises
SSC	Social Security Contribution
SNA	System of National Accounts
TB	Tax base
TGPG	Tax Gap Project Group
US	United States
VAT	Value Added Tax

Table of Contents

Executive summary

The corporate income tax gap (CIT Gap) is the gap between corporate tax revenues as they "should be" collected and as they "are" collected. The gap is an indication of potential CIT revenue losses.

The topic has gained in prominence in the public domain given its impact on public finances, on the level playing field between companies and on the overall tax morale. Estimating the CIT gap is therefore very relevant. It is however also very complex. This report aims at mapping different methodologies and approaches for estimating the CIT gaps and explaining their advantages and disadvantages. The report does not provide an exhaustive review of the economic literature and statistical techniques for deriving at these estimates but it provides an overview of a number of methodologies used in Member States or other jurisdictions, devised by international institutions, or presented in the literature.

This report defines the CIT gap as encompassing both non-deliberate actions by taxpayers (such as errors or omissions) and deliberate actions (such as fraud, evasion and avoidance) that lead to shortfall in revenues. This report reflects the objective of the Tax Gap Project Group (TGPG) to map and share expertise and good practices.

The two main approaches to estimating the tax gap – the top-down and bottom-up methods – have both advantages and disadvantages. The choice of the estimation method depends heavily on the availability of data, resources and purposes of the estimate. While the top-down methods start from macroeconomic indicators or national accounts data to estimate the CIT gap, bottom-up methods start from data obtained from individual taxpayers and extrapolate them to a wider population. There are clear complementarities between both approaches.

From the findings of the report, it seems too early to identify a consensus methodology, which could be used across countries and provide for overall tax gap estimations. By providing an overview of the state-of-the-art and highlighting the strengths and weaknesses of each method, the report is nevertheless a first step to in that direction. However, the large differences in CIT systems point to the main difficulty of the exercise, which is to agree on one or more benchmarks. This makes international comparisons difficult because they depend to a large extend on the choice of the benchmark. The report also stresses that the focus should be on the trend of the results rather than on the absolute values.

Currently, about ten Member States have taken steps or already estimate a CIT gap with different scopes, techniques and periodicity.

Introduction

One of taxation's key functions is to raise revenues to finance public expenditures such as social protection, healthcare, education or public infrastructure. However, the amount of tax collected is in practice less than it should be if all taxpayers were fully compliant with their tax obligations, i.e. if they filed complete and accurate tax returns and paid all due taxes. This lack of compliance has numerous causes and can be deliberate on the side of the taxpayers or not. The loss of tax revenues owing to non-compliance is often referred to as the 'tax gap'.

The lack of tax compliance leads to a loss of tax revenues, with serious consequences for public finance. It also influences people's perception of tax fairness. It may have an impact on tax morale and tax consent as those who comply with their tax obligations may see it as a justification for no longer (fully) complying. Finally, an effective collection of taxes is essential for ensuring a level playing field between companies. Tackling the issue of unpaid taxes is therefore a collective responsibility that starts with understanding the scale and the scope of the issue.

There is a growing need and political interest to estimate tax gaps. Tax gap estimation processes are expected not only to help to learn more about the extent of non-compliance, but also about the practices and reasons behind it. Tax gap estimations can therefore be used to improve tax policy and tax administration. A recommendation from the European Parliament[1] called on the European Commission *'to create, on the basis of best practices currently used by Member States, a harmonised methodology, which should be made public and that can be used by the Member States to estimate the size of the direct and indirect corporate tax gaps'* and to *'use the agreed methodology and all the necessary data in order to produce and publish, biannually, an estimate of the direct and indirect corporate tax gaps across the Union'.* This report is a first step to comply with above recommendation by providing an overview of the state-of-the-art and highlighting the strengths and the weaknesses of each method. At present most tax administrations are still exploring ways to estimate (parts of) the corporate income tax gap. Although the determination of a harmonised methodology is clearly not yet feasible, Member States can learn from current practices.

While there is no doubt about the existence of the tax gap, it is difficult to measure it precisely and directly. It covers a variety of potentially missed tax revenues, which owe to different factors. There is a methodological challenge in estimating its various components. Furthermore, tax gaps can originate in a purely domestic context, as well as in a cross-border context. The complexity of corporate taxation in an international context requires complex analytical approaches and improved data coverage. Finally, the fiscal impacts but also the economic impacts, of tax avoidance in particular, are extremely relevant and should be considered.

Researchers, national (tax) administrations and international institutions have developed several methods to estimate revenue loss. In order to pool knowledge and share expertise, the Tax Gap Project Group (TGPG)[2] was established under the Fiscalis 2020 Programme.[3] The group initially focused on

---

[1] Motion for a European Parliament Resolution with recommendations to the Commission on bringing transparency, coordination and convergence to Corporate Tax policies in the Union, 2 December 2015. http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A8-2015-0349+0+DOC+XML+V0//EN&language=en

[2] http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3260&Lang=EN

[3] Fiscalis 2020 is an EU cooperation programme enabling national tax administrations to create and exchange information and expertise by bringing together national officials from across Europe. See further information on Fiscalis 2020: https://ec.europa.eu/taxation_customs/fiscalis-programme/fiscalis-2020-programme_en

the VAT gap, which led to the publication of a report on "*The Concept of Tax Gaps – Report on VAT Gap Estimations*" (Fiscalis TGPG, 2016). The Group subsequently focused on direct tax gap methodologies, particularly methodologies for corporate income tax gaps (CIT gap). The project group included national experts from 16 Member States (Belgium, Bulgaria, Czech Republic, Denmark, Germany, Spain, Italy, Latvia, Lithuania, Hungary, Netherlands, Poland, Portugal, Slovakia, Finland and Sweden) and the European Commission coordinated its work. The TGPG held seven meetings to discuss different methodologies available and benefited from presentations by participating members and external experts (from the academia and international organisations).

The present report is not intended to be an exhaustive overview of the literature on the subject. Rather, it provides an overview of a selected number of methodologies developed by tax administrations, researchers and international organisations. By providing an assessment of the various methodologies, it should help readers identifying which methodologies could be best suited to their needs.

The first chapter defines the concept of the CIT gap and scope of the report. The second chapter presents the main elements of CIT systems. The third chapter describes the use of CIT gap estimations. The fourth chapter provides an overview of different types of methodologies and data sources used for CIT gap estimations. The fifth chapter presents country experiences in estimating the CIT gap, including the results of a survey addressed to all Member States.

1. Definition of the CIT gap and scope of the report

A tax gap is the difference between tax revenue as it "should be" and as "it is" collected, for a given period and in a given jurisdiction or region. In the following, tax gap and compliance gap are used interchangeably, unless stated differently. This report focuses on Corporate Income Tax (CIT) gaps.

The **CIT gap** may be caused by numerous elements.

First, the tax gap may be caused by unclear legislation, negligent omissions, differences in interpretation, lack of knowledge, and non-deliberate errors leading to differences between the tax intended to be collected and the amounts actually collected.

Second, the gap may be caused by insolvencies, whose consequence is the impossibility for tax authorities to collect the taxes on bankrupt companies, even though there is a tax liability.

Third, taxpayers' deliberate actions such as tax fraud, tax evasion and tax avoidance are another source of the tax gap. Here it is useful to distinguish between:

-   Tax fraud and evasion, which are an illegal attempt to escape payment of taxes in part or in total by hiding or understating a source of income, overstating expenses or making false claims to tax reliefs.
-   Tax avoidance refers to "*the arrangement of a taxpayer's affairs that is intended to reduce his tax liability and that although the arrangement could be strictly legal it is usually in contradiction with the intent of the law it purports to follow*".[4] It includes the use of debt shifting, strategic transfer pricing and strategic location of intangibles, structured only or mainly for taxation reasons.

The tax gap[5] therefore stems not only from low tax morale among taxpayers, but also from the complexity of the tax system, the lack of clarity of the tax legislations and more generally the economic cycle, which impacts on insolvencies. This means that CIT gap estimates can show sizeable differences across countries and periods. While policymakers and public administrations can gain insight from all these estimates, one needs to proceed with caution when comparing different gaps, taking into account differences in the CIT systems, the economic cycle, and differences in methodologies used. More than the actual level, the focus should be on the trend in the CIT gap estimates.

Identifying the right methodology for estimating the tax gap leads to investigating its components and causes. This will be discussed later, in chapter 4.

While monitoring and addressing this lack of compliance is clearly central in the mission of tax administrations, it is also obvious that policymakers might dispose of powerful tools to prevent and reduce compliance gaps. Some of the most recent examples include the removal of bank secrecy rules

---

[4] OECD Glossary of Tax Terms.
[5] For further and related definitions on tax gaps, see Fiscalis TGPG (2016). Some national tax administrations may rely on different definition of CIT gap but for this report, the CIT gap is understood as defined in this chapter.

and the enhanced exchange of information.[6] Legislators can adapt the legal framework and provide new tools, while the tax administrations need to make the best possible use of it.

In conclusion, the present report will focus on CIT gaps that originate from non-compliance by taxpayers, either deliberately (e.g. tax fraud or evasion) or not (e.g. errors, insolvencies). This report will also cover tax avoidance. While such arrangements may be strictly legal, they are not following the spirit of the law and the intent of legislators, exploiting for instance loopholes and mismatches in the international tax framework. Fighting tax avoidance has been at the heart of several European initiatives, such as the Anti-Tax Avoidance Package[7] and other international initiatives, in particular the G20/OECD Base Erosion and Profit Shifting (BEPS) project. This report will however not examine shortfalls in revenues that stem from an intended policy choice (e.g. a tax deduction for R&D costs). This analysis is part of another strand of economic analysis that relates to the estimation of the tax expenditures. Finally, the report will examine the CIT gap from both a domestic and cross-border angle.

---

[6] In December 2014, a revision to the Administrative Cooperation Directive was adopted. This requires Member States to automatically exchange information on the full spectrum of financial information from 2017, and spells the end of bank secrecy in the Single Market. For further information on Administrative Cooperation Directive: https://ec.europa.eu/taxation_customs/business/tax-cooperation-control/administrative-cooperation/enhanced-administrative-cooperation-field-direct-taxation_en#ext_adm

[7] The Anti-Tax Avoidance package, proposed in January 2016 by the Commission, aims at ensuring that tax is paid where value is generated and that tax-related information can be effectively accessed. It includes the anti-tax avoidance Directive, adopted by the Council in 2016. It puts forward rules to prevent that income goes untaxed or is taxed at a very low level. Second, it provides for the exchange of country-by-country reports between tax authorities, which was adopted by Member States in May 2016. Third, it includes a Recommendation on Tax Treaty issues. Finally, the Communication on external strategy for effective taxation provides for a coordinated approach against external risks of tax abuse, but also supporting international tax good governance. For further information on the Anti-Tax Avoidance package: https://ec.europa.eu/taxation_customs/business/company-tax/anti-tax-avoidance-package_en

2. CIT systems

As the report focuses on the CIT gap, it is important to understand better how the CIT system works before entering into more detailed considerations on CIT gap estimates.

2.1. General presentation

Corporate income taxes are levied on the profits of corporate legal entities. They are typically levied annually (usually for the calendar year, but other fiscal years are also possible).

The economic literature lists several justifications for implementing a CIT. Its withholding function - "acting as a "backstop" to the personal income taxes" (OECD, 2007) - is commonly considered to be the main reason for imposing corporate income taxes. In particular, retained earnings and the income share of non-resident shareholders would otherwise be hard to tax. Moreover, the CIT also helps to alleviate possible distortions induced by differences in the tax treatment of labour and capital income, e.g. in cases where corporate owners can to some extent disguise labour income as capital income. Furthermore, CIT is also considered an effective instrument to capture economic rents and it provides governments with a powerful lever to influence corporate behaviour, in particular by modifying the conditions for tax allowances. CIT can also be a policy instrument.

A basic CIT system (legislation and administration process) usually includes the following steps:

1. Calculation of the tax base:[8]
    a. The starting point is the corporate annual profit in the financial statement of a corporate taxpayer under commercial law and applicable accounting methods in a country;
    b. The taxable annual profit is derived from the corporate annual profit by application of specific tax accounting and income correction rules in tax law;
    c. The calculation of taxable annual profits can result in a negative amount, a tax loss. Tax losses in many jurisdictions can be deducted from taxable profits in other years (i.e. carry-back and/or carry-forward of losses).
2. Application of the statutory tax rate on the resulting taxable annual profit (after deduction of losses);
3. Recognition of a provision for corporate taxes to be paid (i.e. a debt to tax authorities);
4. Collection of the indebted taxes (i.e. the payment of taxes to tax authorities);
5. Possible restatements for instance because of appeals or litigation.

This structure illustrates that CIT systems have many variables. Further to this basic structure, in Europe, each country has its own corporate income tax legislation and administration process, including the way in which tax authorities engage with taxpayers subject to CIT.

---

[8] For details on the elements of corporate tax bases, see the Taxes in Europe Database https://ec.europa.eu/taxation_customs/taxes-europe-database-tedb_en

2.2. Differences between the accounting annual profit and the taxable annual profit

The methods for calculating the CIT bases vary across countries and can be quite complex. Specific tax accounting rules and income correction rules are necessary to derive the taxable annual profit from the (accounting) corporate annual profit. The differences between the two concepts of profit calculation stem from the different purpose of these calculations. The annual financial accounts (balance sheets and profit and losses accounts) are prepared for external stakeholders and give them insight into the financial situation of the legal entity. Instead, the tax accounts and taxable annual profit are prepared for the corporate income tax return. From a business perspective, the CIT is primarily a cost, with direct effect on the gains (or losses) that the (ultimate beneficial) owner(s) of the business will receive in the form of dividends or capital gains. For a business, the impact of CIT is different from the impact of VAT, as the latter is collected on behalf of tax authorities but paid by the final consumer whereas the former is paid from the taxable profit of the company.

2.3. Differences in CIT systems

CIT systems differ across Member States for various reasons. This leads to the difficulty of defining a benchmark for comparison. First, tax authorities often use CIT as a policy instrument. Apart from raising revenues, taxes can also be used to spur economic growth, stabilise the economy, redistribute income and wealth, correct externalities and incentivize or dis-incentivize specific behaviours. Many differences between the tax rate that is effectively paid and the statutory rate reflect these government policies. As a result, CIT legislation is very often subject to changes. These can concern both the definition of the taxable profit and the statutory rate.

CIT systems may also differ because of traditions, historical reasons or differences in the origins of the legal systems. It is not the aim of this report to map out all the differences for all countries but to create awareness of these differences and of the consequences they can have in comparing and interpreting tax gaps.

Differences between jurisdictions include the following non-exhaustive list of items:

- Origins of the legal system (e.g. Common Law, Civil Law);[9]
- Commercial law and accounting principles;
- Entity classification: While typical corporate income taxpayers are limited liability companies and other incorporated legal entities, there may be differences across countries regarding the legal characterisation of some entities (e.g. partnerships);
- Treatment of activities of foreign entities as permanent establishments;
- Definition of the tax base, the taxable profit, and the treatment of book to tax differences. In most countries, the taxable profit is calculated based on different principles than the financial accounting principles. For example, the deduction of costs can be limited, goodwill can be capitalised and depreciated, capital gains can be taxed upon realisation or based on accruals;
- Tax deductions, for example, interest deduction;
- Tax exempt income;
- Compensation of losses;

---

9 See e.g. Glaeser and Shleifer (2002).

-   Possible group treatment / 'consolidation';
-   Treatment of business relocations involving different jurisdictions;
-   Treatment of - settling of withholding taxes;
-   Filing and assessment methods (e.g. postponement of filing of tax returns);
-   Tax rates and surcharges.

2.4. Differences in interpretation of tax provisions

CIT legislations are often complex and differences of interpretation between taxpayers and tax authorities may occur as a result. This creates tax uncertainty, as both the taxpayers and the tax authorities cannot be certain that the declared taxable profit and the levied and collected corporate income tax is the definitive indebted tax according to an unambiguous explanation to the law. In practice, many disputes between tax authorities and corporate taxpayers can be explained from the ambiguity of tax laws. Case law (decisions of tax courts), administrative guidance or published rulings may provide more clarity and guidance on the appropriate interpretation of the tax rules.

2.5. Impacts of international dynamics

Large business groups usually consist of several separated legal entities that can be liable to CIT in more than one jurisdiction, for instance if they have one or more permanent establishments in other jurisdictions. Decisions to organise a business in various entities can be driven by legal (liability), commercial, managerial, but also tax considerations. If a multinational enterprise consists of several entities located in different countries, the profit of that enterprise has to be divided in taxable profits between those (foreign) entities. This in itself is a complicated exercise. The difficulties become larger because – as described above – CIT systems do not necessarily match in terms of definitions and legal characterisations across countries. These differences surface in the interaction between the legal systems of two jurisdictions, and may lead to mismatches. Mismatches can lead to some elements of corporate annual profit being subject to double taxation or double non-taxation. To mitigate or avoid this effect, jurisdictions have historically concluded bilateral, or in rare cases multilateral, tax treaties. Transfer pricing regulations and bilateral tax treaties aim to give guidance to both international businesses and tax authorities on the allocation of profit and taxing rights. In practice, jurisdictions can still take different positions regarding their relative shares of the total profit of a multinational business, leading to possible tax disputes.

International businesses are often in a position where they can decide to allocate activities, assets (in particular intangibles) but also financial flows in a jurisdiction that offers, in their view, the best conditions. They can also reallocate or move some activities from one jurisdiction to another. When considering these (re)allocations of business activities or financial flows, tax consequences can be an important factor. It is clear that the reallocation from one jurisdiction to another can have effects on the tax bases of both jurisdictions and therefore on tax gap estimates.

Finally, tax avoidance by multinational enterprises has been under public scrutiny lately, and has been at the heart of several international and EU initiatives to tackle it. As discussed in chapter 1, tax avoidance is within the scope of this report.

2.6. Timing aspects

CIT is levied on a yearly basis. The annual corporate taxable profit is determined a few months after the end of the fiscal year and the tax return usually has to be filed within 5 to 12 months after the end

of the fiscal year. However, a postponement of the filing of the tax return is possible in several jurisdictions. The postponement can be a matter of months but in some cases, it can be a matter of years. After the receipt of the tax return, local tax regulations allow revenue authorities a period to assess it and undertake audit activities. This period can also be long (for instance two years). After the reception of the tax assessment, taxpayers can appeal it. As a result, tax positions of a certain fiscal year are often open for several years. Typically, these open tax positions often concern the more complicated and material tax issues.

2.7. Differences in engaging with taxpayers

The ways in which revenue bodies engage with taxpayers also differ per jurisdiction. These interactions have effects on the overall corporate income tax systems and the way they work. Indeed, for instance, if a jurisdiction succeeds in placing emphasis on preliminary consultations and other proactive supervisory activities, it will probably lead to less ex-post adjustments of tax returns, fewer appeals and less litigation procedures. Tax gap estimates based on samples and adjustments of the taxable profit do not reflect the efforts by these revenue bodies to mitigate the tax gap proactively.

2.8. The problem of identifying a benchmark

These various differences point to one of the main difficulties of the exercise of estimating the CIT gap, which is to agree on a benchmark as to how much corporate tax "should be" collected. The issue becomes even more complex when one seeks a common benchmark for different jurisdictions. Part of the problem is that, unlike the VAT gap, the CIT gap rests on a tax base that is not harmonised. This and other reasons mentioned above make international comparisons difficult because they dependent on the choice of the benchmark.

3. Use of CIT gap estimations

There is a growing public and political demand for tax gap estimations. Therefore, estimates of tax gaps in the area of VAT, but also in the area of CIT, have attracted increased interest over time. The fight against tax fraud, evasion and avoidance has been high on the international agenda. Initiatives have been taken at the European level, to boost tax transparency (e.g. the automatic exchange of information on tax rulings[10] and of country-by-country reports[11]) and to prevent that income goes untaxed or little taxed (e.g. the Anti-Tax Avoidance Directives[12]). In this context, the European Commission adopted in late 2016 a proposal to introduce the Common Consolidated Corporate Tax Base. At a world level, the G20/OECD led the BEPS project.[13] While the focus in the public and policy sphere has been mainly on tax avoidance and tax evasion, the reader has to bear in mind that a lack of compliance can have other causes, as outlined in chapter 1.

CIT gaps may be estimated for various reasons. In particular, it may help with the following goals:[14]

- Understanding the size of CIT losses;
- Understanding the components of the CIT gap and the reasons for the losses in the tax system;
- Evaluating the effectiveness of a tax system, i.e. the appropriate design of a tax system as well as its effective implementation;
- Evaluating the tax attitude among corporations and their managers;
- Providing an input to the evaluation of the performance of the tax administrations and enforcement practices;[15]
- Comparing this performance with tax administrations performances in other countries (provided that the results calculated according to the relevant method can be compared in a sensible manner);
- Assisting in the compliance risk management, i.e. quantification, comparison, and prioritisation of responses to risks across the tax system.

Tax gap estimates can therefore be useful to enhance both the tax policy and the administration of taxes. It should be stressed that the use that one can make of the CIT gap estimates will depend on the methodology for calculating it. Conversely, the choice of the methodology should be guided by the intended use of the CIT gap estimates. Indeed, depending on the methodology applied for the CIT gap estimation, the results will provide different information. It may be just an indication of revenue lost from CIT or it may give information on the components of CIT gap and causes of the losses.

---

[10] Council Directive (EU) 2015/2376 of 8 December 2015 amending Directive 2011/16/EU as regards mandatory automatic exchange of information in the field of taxation (OJ L 332, 18.12.2015).

[11] Council Directive (EU) 2016/881 of 25 May 2016 amending Directive 2011/16/EU as regards mandatory automatic exchange of information in the field of taxation (OJ L 146, 3.6.2016).

[12] Council Directive (EU) 2016/1164 of 12 July 2016 laying down rules against tax avoidance practices that directly affect the functioning of the internal market (OJ L 193 of 19.7.2016); Council Directive (EU) 2017/952 of 29 May 2017 amending Directive (EU) 2016/1164 as regards hybrid mismatches with third countries (OJ L 144 of 7.6.2017).

[13] More information on BEPS can be found: http://www.oecd.org/tax/beps/country-by-country-reporting.htm

[14] For further references, see the following papers: Allingham and Sandmo (1972), Franzoni (1998), HM Revenue and Customs (2016a); Swedish Tax Agency (2014)). Some elements were discussed in presentations in the Fiscalis TGPG meeting of 10 May 2017 on CIT GAP estimations in Denmark (by Mr Henrik Markociejski) and in Italy (by Ms Marta Gallucci and Mr Stefano Pisani) and during Fiscalis TGPG meeting on 16 March 2017) on IMF Revenue Administration - Gap Analysis Program (RA-GAP) presented by Mr Junji Ueda (IMF, Fiscal Affairs Department).

[15] However, one shall be cautious with the interpretation of tax gap as a performance indicator for tax administration as the size of tax gap depends on several factors, which are generally not directly controlled by tax collectors. To avoid misinterpretation, one shall take into account the institutional and legislative context, the tax design process, and the taxpayers' behavioural responses on different policies.

Thus, depending on the type of estimation methodology, the use of CIT gaps estimates could be grouped according to the following purposes:[16]

3.1. Improve tax policy

This goal is related mostly with top-down approaches:[17]

- Despite the fact that the CIT gap estimations are not sufficiently timely or precise enough to set performance targets, it provides information that help to understand the long-time efficiency of the tax system;
- Help to evaluate and monitor the effects of administrative or legislative changes on CIT revenue;
- Highlight the main channels to evade and/or avoid taxes;
- Provide insight into which tax policy strategies are the most effective at reducing the CIT gap;
- Help to allocate resources of the tax administration between different types of taxes.

3.2. Improve administration of taxes

This goal is related mostly with bottom-up approaches:

- Break the CIT gap down across taxpayer segments, sectors, etc.;
- Help to understand the reasons for and areas of the losses of revenue from CIT (depending on the methodology, insight into tax evasion, tax avoidance or other reasons for non-compliance);
- Provide input for risk analysis, revision of selection criteria of higher and lower-risk taxpayers, i.e. it enables to improve solid understanding of taxpayers behaviour;
- Provide input for prioritizing resources;
- According to the "problematic" components of the CIT gap, it may also provide input for designing new projects that are related to the fight against illegal and underground economy ("shadow economy").[18]

Regardless the method used to estimate the CIT gap, one should stress that all the results are conditional and only approximate. For the use and interpretation of the estimation results, it is crucial to understand what data and what method(s) were used in the calculations. For example, relying on final data allows enhancing the accuracy and reliability of the estimates, while the use of preliminary or provisional data provides more timely estimates. Furthermore, tax authorities have to periodically review the methodology, its assumptions and results to account for changes in circumstances such as taxpayers' behaviours, legal base changes, etc. Also, it is advisable to search for or develop new methodologies, which have not yet been evaluated but could provide insights in the causes of non-compliance. All these arguments also imply that the focus should be on the trend of the results rather than on the absolute values.

Finally, conventional measures of tax gap estimates do not take into account the behavioural responses of taxpayers. In other words, they ignore how the estimated missed "theoretical" tax revenue (and corresponding tax base) would change *ceteris paribus* in case of moving from an "undeclared state" to

---

[16] Rubin, M. (2011), Swedish Tax Agency (2014), IMF's methodology for measuring Corporate Income Tax Gap: RA-GAP presented by Mr Junji Ueda at the Fiscalis TGPG meeting on 16 March 2017.
[17] Rubin (2011), Finke (2013), Swedish Tax Agency (2014).
[18] Illegal and underground economy are part of non-observed economy, which is discussed further in chapter 4.1.2. below.

a "declared state". For example, if the profit of a corporation that produces a good or a service was effectively taxed (no tax evasion), it could possibly be expected that the demand for supply of that good or service by the (formerly not compliant) taxpayers would decrease. This in turn would lead to a reduction in the tax base and tax revenues. The missing corporate tax revenues estimated through tax gap estimates should therefore not be directly equated with the additional tax revenues that could be collected through enhanced compliance.

In conclusion, it is important at the beginning of the estimation process to identify clearly the purpose of the estimation, the available indicators, and the interpretation and use of the results. The choice of a tax gap method should assess whether the data needed are available and whether available data are used in the best possible way.

4. Estimation methodologies and data sources

This chapter considers various methodologies developed by researchers, international institutions and national tax administrations to estimate the CIT gap. It does not intend to provide an exhaustive review of the literature, but rather focuses on a number of papers and reports selected by the TGPG.[19] The focus has been on papers and reports that allow for an actual quantification of the gap (either total or partial gap). However, the number of such methodologies is limited. Therefore, this chapter also include papers that do not directly quantify the tax gap but allow giving insights on the extent of the phenomenon. These estimates aim at capturing the cross-border dimension of the CIT tax gap, in particular tax avoidance.

The theoretical total tax liability is the amount of tax that would be collected in the absence of any fraud, evasion, avoidance, debt or other losses due to a lack of compliance. This theoretical tax liability is then compared with the actual tax receipts to compute the gap.

Several methodologies exist for estimating the tax gap. We can group them into two general approaches: (i) the Top-down methods, also referred to as the macro or indirect methods, and (ii) the Bottom-up methods, also known as the micro or direct methods. The chapter is structured around those two types of methodologies, and includes a section devoted to an alternative approach using optimal routes (in chapter 4.3).

4.1. Top-down methods and data

4.1.1. Introduction

Top-down methods rely either on *"macroeconomic indicators or data from a country's national and financial accounts to estimate the theoretical tax liability or to identify discrepancies that can only be explained by the presence of economic activities which are not adequately reported to or observed by the tax authorities"* (Risk Management Platform, 2012).

The top-down method hence estimates the size of lost tax revenues (for a given activity or area) at an aggregated level. It seldom gives an answer to the question of what creates the tax gap in the first place and what the reasons are that a specific area or activity is not taxed. "*Most often the top-down method does not give detailed information regarding the distribution of the tax gap across sectors, geographical areas, or size classes of enterprises*" (Swedish Tax Agency, 2008).

The top-down approach relies on the following two requirements (Rubin, 2011):

1. The availability of adequate data (e.g. National Account – NA – data).

2. The ability to transform these data into theoretical tax liabilities.

On the first requirement, as pointed by Rubin (2011), the information on the tax base is only useful if it is both independent of the tax administration and sufficiently reliable. Data that are dependent from the tax administration, such as national income based on aggregating administration data, do not give the administration new knowledge. In general, NA data are based on different administrative data (and not only on tax administration data) as well as on surveys, censuses, combined data, extrapolations and

---

[19] For additional elements, see also the review of literature provided in the OECD (2015).

models, etc. Thereafter, both conceptual and exhaustiveness adjustments are done with the aim to ensure that the national accounts are exhaustive.[20] This compilation practice increases the independence of the NA data.

Regarding the second point, the complexity of the CIT system (for example the dependence of tax expenditures on individual circumstances) makes the measurement of theoretical liability difficult for direct taxes such as CIT. One also needs to keep in mind the importance of ensuring consistency between the theoretical and actual revenues (accrual national accounts). Moreover, external elements may also affect cash payments (e.g. court decisions issued years after, deferral by companies).

The top-down methods of estimating direct tax gap can be divided into two main groups, according to their source of information on the tax base:

- National Accounts Methods;[21]
- Macro Model methods.

4.1.2. National Accounts Methods

The national accounts methods are based on information from non-financial and financial accounts. Here again, the estimation of the CIT gap is done by calculating the theoretical tax liability, which is then compared with the actual tax revenues. The theoretical tax liability is calculated by applying the tax rate schedule to the theoretical tax base stemming from national accounts data (mixed income, gross operating surplus - GOS). However, the estimates based on national accounts methods capture only tax non-compliance on the activities/areas, which are traceable in the national accounts statistics. Therefore, the quality of the estimates depends on the exhaustiveness of the adjustments for non-observed economy in national accounts.

The national accounts needs to be exhaustive[22] and needs to cover both observed and non-observed economy.[23] Therefore, Eurostat Tabular Approach to exhaustiveness was designed to identify potential sources of underestimation of GDP estimates due to omissions from the source data used in compiling national accounts.[24] The seven types under this framework can be broadly classified into the four categories of (1) not registered, [25] (2) not surveyed, [26] (3) misreporting[27] and (4) other deficiencies.[28] Exhaustiveness adjustments are made implicitly as well as explicitly. The exhaustiveness adjustments made in the different Member States are not comparable as they differ in scope mainly because of the

---

[20] The NA data transmission by EU Member States is based on the methodology defined in the European System of National and Regional Accounts 2010, ESA 2010. It is consistent with the worldwide guidelines (The System of National Accounts, SNA 2008), which establishes internationally agreed standard set of recommendations, concepts, definitions, classifications and accounting rules.

[21] For further discussion, see Fiscalis TGPG (2016).

[22] There are legal requirements regarding the exhaustiveness of national accounts, for example Commission decision 94/168/EC on exhaustiveness. This decision describes the explicit and implicit exhaustiveness adjustments to capture absence, evasion or exemption. Moreover, there are legal requirements in the context of national accounts concerning VAT fraud, Commission Decision of 24 July 1998.

[23] Non-observed economy includes underground, informal, illegal activities, as well as activities omitted due to deficiencies in the basic data collection programme.

[24] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:SNA_Eurostat_tabular_approach_types_of_non-exhaustiveness,_2012.PNG

[25] Not registered category includes N1: producer deliberately not registering – underground, N2: producer deliberately not registering – illegal, N3: producer not required to register.

[26] Not surveyed category includes N4: legal persons not surveyed, N5: registered entrepreneurs not surveyed.

[27] Misreporting category includes N6: producer deliberately misreporting.

[28] Other deficiencies category includes N7: other statistical deficiencies.

differences in available data sources used for national accounts estimates and that the institutional organisations vary in different countries.[29]

The IMF has developed a CIT gap estimation methodology based on the national accounting data under the Revenue Administration Gap Analysis programme (RA-GAP).[30] The RA-GAP method, which is examined hereafter, uses macroeconomic statistical data to estimate the potential tax base and revenues and compares those with actual declarations and revenues.

a. Description of the methodology

The methodology provided for by the IMF introduces two different but strongly connected concepts of the gap: the CIT base gap and the CIT gap. The **CIT base gap** is the difference between the potential and the declared tax base from current-year operation.[31] The **CIT gap** is the difference between the potential CIT liabilities (i.e. the tax that would be declared and collected if all taxpayers were compliant with tax legislation) and the actually declared CIT liabilities.[32]

In order to compute the CIT base gap, the **potential CIT base** needs to be calculated. It starts from the Gross Operating Surplus (GOS), used in System of National Accounts (SNA).[33] The computation of the potential CIT base considers the theoretical differences between the statistical data in national accounts and the CIT base. Several adjustments are made in order to reflect the differences between the GOS and the tax base. These differences can be categorized into three types:

- (D1) differences between the GOS and the aggregate Financial Accounting Profit (FAP) of CIT taxpayers;
- (D2) differences between the aggregate FAP and the aggregate current year net tax base (C-NTB);[34]
- (D3) differences between the aggregate C-NTB and the aggregate tax base (TB) due to losses and carry-over losses.

The **potential CIT base** is calculated by using the following steps:

		POTENTIAL CIT TAX BASE
		GROSS OPERATING SURPLUS (GOS)
D1	+	Receipts of interests /dividends / rents
	+	Foreign source income (taxable)
	+	Capital gains / holding gains
	-	Payments of interest / rents
	-	Depreciation (accounting)
	-	Capital losses / holding losses

---

[29] For further discussion see Fiscalis TGPG (2016).

[30] The methodology was presented by Mr Junji Ueda (IMF, Fiscal Affairs Department), discussed at the Fiscalis TGPG meeting on 16 March 2017 and described further in Ueda (2018).

[31] The CIT base gap can be expressed as a ratio with respect to the potential tax base, as well as a percent of GDP.

[32] The CIT gap can be presented as a percent of GDP, as a percent of potential CIT liabilities or as absolute values.

[33] It uses the theoretical framework SNA2008 as defined by United Nations.

[34] 'Net' tax base means aggregated incomes reflecting both profit-making corporations and loss-making corporations in a current year; it is generally smaller than current-year tax base because losses made by loss-making corporations are netted out from aggregate profits in C-NTB.

	-	Other expenses not recognized as intermediate consumption
	=	**FINANCIAL ACCOUNTING PROFITS [FAP]**
D2	+	Increases in taxable income calculations (Denied costs / added revenues)
	-	Decreases in taxable income calculations (Deductions / allowances for tax)
	=	**NET TAX BASE (CURRENT YEAR) [C-NTB]**
	+	Losses of corporations (Current year)
D3	=	**TAX BASE (CURRENT YEAR)[C-TB]**
	-	Deductions for carried-over loss
	=	**TAX BASE [TB]**

In order to transform the C-NTB into the TB, it is necessary to add the current year losses and to subtract the losses carried-over.[35]

The **actual CIT base** is obtained from tax return data. The values should be (1) on an accrual base, (2) based on declared values, and (3) corresponding to economic activities in a particular calendar year. For that purpose, the actual CIT declarations need to be classified based on the 'tax period' in which economic activities have been performed, rather than on the timing of actual payments. In addition, it is useful to analyse separately the difference between the actual CIT collection and the CIT declarations, taking into account the timing of payments, coverage, and unpaid arrears (collection gaps). The data needed from the actual CIT collection database would include the value of CIT payments made (exclusive of interest or penalties), the date of payment, the tax period for which the payment is made, and the sector of the taxpayer that made the payment.

The **potential CIT liabilities** are calculated by applying the statutory tax rate to the potential CIT base, plus/minus tax credit and additions. The difference between the potential and the actual CIT liabilities is the tax gap. This method provides correct estimates if there is a perfect correspondence between the definition of potential and actual tax base. If this is not the case, it could be better to use an implicit tax rate, obtained by dividing the actual tax by the actual figures comparable with the NA data. For instance, if it were not possible to correct for the losses, an alternative would be to compute an implicit rate on C-NTB and then apply this to the corresponding potential aggregate.

b. Scope: Tax evasion, tax avoidance or both?

The methodology covers in principle tax evasion. It does only cover tax avoidance if the national accounts data have been amended to reflect such activity. Furthermore, it covers gaps caused by non-deliberate actions (such as errors, omissions etc.).

c. Assumptions, adjustments, bias corrections, common errors

The method relies on the following assumptions:

---

[35] Particular attention should be paid to the correctness of declared loss data. In that respect, it may be necessary to check internal inconsistency over time by comparing 'declared losses' with 'declared carried-over losses' in subsequent periods for the same taxpayers.

- The macroeconomic data are compiled independently of declared tax return data and cover non-observed economic activities;
- What taxpayers declare is assumed correct, but the component of missing payments (i.e. declared but unpaid liabilities) is to be isolated.[36]

In addition, the following adjustments have to be made:

- *Identification of "corporations"*: There are differences between the classification of entities by the National Accounts and by the Tax Administration. When estimating the tax gap, the target population is the set of corporations subject to CIT. Corporations subject to CIT are in theory included in the institutional sectors of financial and non-financial corporations in the National Accounts (Sectors S11 and S12 in Eurostat). However, there may be some discrepancies. Adjustments should therefore be made for (a) entities that are considered by NA as corporations but whose income is not subject to CIT (for example tax-exempt public corporations, and unincorporated (quasi-incorporated) businesses subject to personal income tax); and for (b) entities that are not considered by NA as corporations (hence with their income excluded from the GOS of corporations) but that are in reality subject to CIT.[37] Furthermore, it may be advisable to limit the analysis to the non-financial corporations as differences between GOS and tax base can be significant and not easily reconciled for financial corporations with limited data;
- *GOS*: The estimation of potential CIT revenues should start from the GOS of corporations (non-financial and financial corporations) and not from the total economy in the NA data. GOS of household, non-profit institutions serving households (NPISH) or general government should not be included;
- Regarding the *GOS of corporations*, several adjustments need to be made to obtain the potential tax base, as discussed above with differences D1, D2 and D3. One needs to make adjustments for foreign-source income;
- *Actual CIT data*: Some adjustments may be necessary to ensure that the declared values for CIT liabilities and corresponding CIT cover the same time span (calendar year) as the values arising from NA. If the economic activities or the periods of declaration of entities differ from those in the NA, adjustments and reallocation of declared amounts have to be made.

In terms of potential bias, the estimate may be biased if the data used to make adjustments for conceptual differences in calculating the potential gap is based on declared values in tax returns. The estimates will be downward-biased, because the data are not corrected for those components that could cause the under declaration of profits due to tax evasion.

Finally, a sufficient quality of the declared tax return data is crucial in order to have reliable estimates. Therefore, the declared amounts should be subject to a process of data validation to identify and correct for outliers.

d. Data

The following data and correspondent sources are required for the methodology:

---

[36] In some countries (e.g. Italy and Portugal) , all tax returns are subject to an "automated control" which verifies the absence of computational errors (e.g. does the amount of declared tax correspond to the product of tax base by tax rate?) and the correspondence of declared and payed liabilities.

[37] For example, foreign branches of resident corporations are not in the scope, while their income is subject to CIT (except if foreign income sources are exempted).

- *NA data*:
    - For institutional units (non-financial corporations and financial corporations), one needs the income generation, the allocation of primary income account, the secondary distribution of income account, the capital account,[38] and the inventory valuation adjustments;[39]
    - The documentation of the compilation methodologies for national income is needed to help understand the necessary adjustments between the GOS, the FAP and the TB;[40]
    - Data source: NA as produced by National Statistical Offices of each country. For the EU, this is being collected and published in the Eurostat database under the heading Economy and finance/National accounts (ESA 2010) (na 10), harmonised both under the heading "Annual national accounts" (nama 10) (for example main GDP aggregates and indicators and national accounts data in different breakdowns) and "Annual sector accounts" (nasa_10) (for example non-financial transactions, key indicators and financial flows and stocks).

- The *individual tax return* data for all taxpayers and tax period being studied include:
    - When the estimation is by external analysts, the anonymised taxpayer identification numbers;
    - The tax period;
    - Every line item used for calculation from the financial accounting profits to the tax liabilities;
    - Every line item used to calculate the financial accounting profit/loss, including all income/revenue and all cost/expense items (or separate financial statement data showing these items);
    - Data source: tax returns available at the tax administrations;
    - Note that if individual data is not available (e.g. for privacy reason), some adequately aggregated data could be used instead with little or no loss of relevant information.

- The *registration information* of all individual CIT taxpayers
    - Anonymized taxpayer identification number;
    - Date of registration;
    - Date of deregistration (if applicable);
    - Sector classification of economic activity, ideally consistent with NA classifications;
    - Tax period (starting month/ending month, if different from general convention);
    - Data source: taxpayers' database available from tax administrations.

---

[38] Some of the information listed is available in the Eurostat database for sector accounts for sectors S11 and S12 at annual level.

[39] Regarding conceptual adjustments from accounting to national accounts principles, a good source of information are GNI inventories, which however are not always publicly available and should be requested from National Statistical Institutes.

[40] Information regarding the compilation of the national accounts and about different concepts can be found in the ESA 2010 GNI inventories, These are publicly available in EUROPA/European Commission/CIRCABC/Eurostat/Monitoring GNI for own resource purposes. Moreover, there is, more limited, documentation about methods for sector accounts available in http://ec.europa.eu/eurostat/web/sector-accounts/methodology/sector-accounts-in-countries. Finally, chapter 21 in ESA 2010 describes the links between business accounts and national accounts and the measurement of corporate activity. However, as a general remark, the concepts may vary and therefore the data should be used with caution. It is sometimes necessary to make estimates.

- The **CIT payment data**:
  - The actual CIT collection data for a year, with aggregates and totals, classified into economic activities, including the advance payments, settlements (clearance of underpayments / overpayments), and others such as penalties and fees;
  - The withholding taxes received by non-residents for domestic source income;
  - The taxes on specific sectors levied on corporate income other than CIT (ex. financial sector, extraction sector, etc.);
  - Data source: finance information available from tax administrations.

In terms of data availability, the international standards on SNA define a delay of 36 months between the data reference and its availability. However, provisional figures are usually made available in advance. The tax declarations data is available with shorter delays, although this depends on the timing of tax return submissions and on delays due to validation and data cleaning.

Again, it is critical for the methodology that the macroeconomic data is independent from tax returns data, otherwise there will be no gap.

In principle, the method allows decomposing the gap by sectors. However, in practice, the coverage and possible breakdowns (by region, by sector of economic activity) are strictly dependent on the availability of disaggregate data in the NA sources (since administrative data usually provide detailed disaggregation). However, some difficulties may arise, such as:

- The sector classification in the NA may differ from that of the tax administration;

- The NA systems usually classify the activities of a single company into multiple sectors by using granular business establishment data, whereas single companies cannot be divided into multiple entities for CIT purposes;

- Only institutional unit data (non-financial and financial corporations) is available for property incomes and other transfers in the NA. Therefore, for a detailed sector analysis, survey data or financial statements are required to allocate such transactions into economic activities (sectors).

The treatment of such a set of data from different sources can be achieved with spreadsheet software but statistical software (like SAS, Stata, E-views, and others) can be useful for data analysis and data mining procedures.

e. Description of the results

For the time being, a tax gap based on this methodology was estimated only in Slovakia, presented in chapter 5.4. Further employment of this methodology is planned in Finland.

f. Advantages and disadvantages of the method

One advantage of the method is that it captures, in principle, all forms of non-compliance, except for tax avoidance as national accounts data do not reflect tax avoidance strategy. The method captures the hidden economy and all other forms of non-compliance of corporate income tax only when national accounts capture them (see chapter 4.1.2 on national account adjustments). In addition, even if national accounts do capture hidden economy, it does not necessarily appropriately allocate it into GOS (subject to CIT) and mixed incomes (unincorporated businesses subject to PIT), and provide sufficient information of possible 'true' deductions that would be allowed for corporations.

The methodology gives the opportunity to follow the trends over a certain period. Furthermore, it may allow making comparisons among countries given that NA data are generally computed according to internationally validated standards (see SNA 2008). These comparisons could be performed on both uniformly defined measures (e.g. percentage of undeclared GOS over potential GOS) and on "country-specific" values (e.g. TB and CIT liabilities, which are defined according to local tax legislation). For the latter, the comparison among countries of CIT gap as a percentage of the potential liabilities therefore also reflects the different impact of local legislation on the taxpayers' behaviour.

The computation of "potential" items (such as the CIT base and CIT liabilities) may be influenced by errors, omissions and other failures affecting the NA. Furthermore, the independence between the macroeconomic data and the tax return data is extremely important, but might not be completely ensured. The method does not allow for the same level of disaggregation as bottom-up methods.

Probably the estimation of CIT gaps using this methodology is less resource-intensive and more promptly available than bottom-up methodologies, since the availability of data is timelier and does not require "on field" activity (audits). Nevertheless, it demands skilled human resources. The method is technically demanding and data requirements are considerable. Furthermore, it requires the intervention of several actors inside[41] and outside the Tax Administration (e.g. National Statistical Offices).

g. Accuracy and reliability of estimates

The accuracy and reliability of the estimates depend on several factors, the main ones being:

- The data quality and accuracy;

- The extent and quality of the adjustments;

- The degree of independence of NA data from CIT declarations;

- The assumptions made;

- The degree of conformity of sectorial classification between the NA and the tax administration;

- The number of years available for the estimates. There are several and severe issues potentially affecting the accuracy of the estimates. Therefore, the estimates are better read in terms of "trends" instead of "levels", which requires having several years of estimates.

The quality of the estimates also strongly depends of the accuracy of the NA estimates for the non-observed economy. Hence, the specific methodology adopted in the country should always be mentioned in the tax gap methodology.

Another crucial point is the transformation of the NA figures into the CIT aggregates. It is then necessary to describe accurately all the differences in the definition and classification between the two data sets.

It could be useful to provide indications on the rate of revision of the estimates disseminated in the various years in order to analyse possible errors due to the availability of new information or revision of the methodology.

---

[41] Depending on its structural organization: several types of data, the responsible units for the CIT, declaration, collection, etc.

4.1.3. Macro Model Methods

The macro model methods used to estimate the non-observed economy (including the shadow economy) provide a potential alternative means for calculating tax gaps. These models use macroeconomic indicators like monetary variables or other single indicators such as electricity consumption and labour force indicators.

An example of macro model methods is the electricity consumption method used to estimate the total level of economic activity and the size of the non-observed economy as the difference between the growth of electricity consumption and the growth of official estimates of gross national product. "*The electricity consumption method has been vastly criticised, mainly because of the assumption of relative electricity consumption in the shadow and formal economies since not all shadow economy activities require a considerable amount of electricity; (and because technical progress has made the use of electricity more efficient in both the official and unofficial economy)*" (Risk Management Platform, 2012).

Another example is the use of the relationship between the money (M) in circulation in the economy and that is used at a certain velocity (V) to produce GDP (Y). Any deviation between the observed GDP (Y) and the theoretical GDP ($\hat{Y}=M*\bar{V}$) could be considered as non-observed economy. This method also suffers from criticism. For example, the velocity is probably far from being constant.

A similar approach is used also by Multiple Indicators, Multiple Causes (MIMIC) models, which assume that the non-observed economy (latent variable) is influenced by at least two exogenous causal variables (e.g. tax rates, labour market regulations) and it has effect on two or more macroeconomic indicator variables (e.g. currency and GDP levels) (Medina and Schneider, 2017; Gemmel and Hasseldine, 2012). The advantages of MIMIC models compared to single indicator models are that they enable to use several indicators at the same time to track the non-observed economy and also many potential causal variables can be included (Gemmel and Hasseldine, 2012).

However, the disadvantage of both single indicator and MIMIC models[42] are that they measure the growth of the non-observed economy or tax gap over time by assuming that entire alteration of the variable is due to change in the non-observed economy. Furthermore, these methods measure the change over time but the initial level of tax gap or non-observed economy is assumed to be zero or established by different method (Gemmel and Hasseldine, 2012).

4.1.4. Econometric estimation of the elasticity of reported profit to taxation

Another strand of the literature to estimate CIT gaps relates to econometric estimations of the elasticity of reported profit to taxation.

This strand of the literature clearly focusses on profit shifting of CIT across jurisdictions. The methodology tries to explain differences in the size of reported profit by the level of domestic statutory corporate tax rates and/or by the differences of these rates across jurisdictions.

---

[42] For more detailed assessment see for example Breusch (2005a), Breusch (2005b), Breusch (2005c), Gemmel and Hasseldine (2012). Also the Intersecretariat Working Group on National Accounts (ISWGNA) warned against the use of the MIMIC indicator in 2006. The ISWGNA gathers representatives of the five international organisations (European Commission, IMF, OECD, UN, World Bank) who have co-signed the international manual System of National Accounts, 1993.

The central idea is that the true profit is split between the one generated by the quantity of labour and capital in the economy and the profit shifted in or out of the country for tax reasons. Early examples of this methodology include Hines and Rice (1994) and Grubert and Mutti (1991). With the increased availability of databases, a similar methodology has been applied using firm-level data. These studies are reported under the bottom-up methodologies but they are in essence the same as the ones using aggregate macro data. This strand of the literature has led to econometric studies looking at tax base spillovers estimates where authors try to explain the reported corporate tax base in a country by the domestic tax rate, a weighted average of CIT rates in other countries and additional controls.

One such study "Base Erosion, Profit Shifting and Developing countries"[43] by Crivelli et al. (2015), is reviewed in this chapter. The paper analyses whether base erosion, profit shifting and international tax competition matter for developing countries in the same way as they do in advanced economies. The paper focuses on two types of spillovers: base spillover (i.e. impact of one country's policy on other countries' tax bases) and strategic spillovers (impact of tax changes abroad on one country's policy choices). The paper develops a method to distinguish between base spillovers effects through real investment decisions and through profit shifting, and to quantify the revenue costs of the latter. For this report, we will focus on the results that pertain to base spillover, and to the quantification of the revenues lost through BEPS.

a. Description of the methodology

The paper uses a panel of 173 countries over 1980–2013 to estimate the magnitude and nature of BEPS using regression analysis. The empirical strategy is based on a theoretical model and the main variable of interest is the effect of the tax rates in the rest of the world on a country's tax base.

Base spillovers are explored by estimating the following equation:

$$b_{it} = \lambda b_{it-1} + \varphi \tau_{it} + \gamma W_{-i} \tau_{-it} + \zeta' X_{it} + \alpha_i + \mu_t + \varepsilon_{it}$$

With

- b_{it} : CIT base in country $i=1,..,n$ at time $t=1,..,L$ (with the lag as independent variable),
- τ_{it} : the domestic CIT rate,
- $W_{-i}\tau_{-it}$: some weighted average $\Sigma^n_{j\neq i} \omega_{ij}\tau_{jt}$ of the statutory CIT rates in countries $j\neq i$ (with $\Sigma^n_{j\neq 1} \omega_{ij}=1$),
- X_{it} : vector of controls,
- α_i and μ_t : country and time-specific effects.

φ is the short run marginal impact of a country's own CIT rate on its own CIT base.

The fact that base spillovers can happen through two channels (through real investment decisions and through profit shifting) implies different structures for the weighting matrix. Three scenarios are envisaged: (1) spillover effects depend on the relative size of the country (GDP-weighted rate); (2) spillover effects occur through profit shifting (haven-weighted rates); (3) spillover effects are impacted by the geographical distance between countries (inverse-distance-weighted average). The second scenario is the most relevant for this report. Because there is no direct data on the ease with which profit can be shifted in and out of a country, the weighting is done by reference to 'tax havens', based

---

[43] The paper was presented by Mr Ruud de Mooij (IMF) and discussed during the Fiscalis TGPG meeting of 17 January 2017.

on a commonly used list. The assumption is that shifting profit in and out of a 'tax haven' is equally easy, irrespective of the 'tax haven', but impossible through non havens.

Revenue Cost of BEPS are simulated by eliminating the effects of on tax bases operating through 'tax havens' (by setting the profit shifting cost parameters to infinity) and evaluating the revenue impact by estimating the resulting changes in tax bases and multiplying it by the applicable CIT rate.

b. Tax evasion, tax avoidance or both?

The estimates focus on tax avoidance only.

c. Assumptions, adjustments, bias corrections, common errors

The paper bases its empirical strategy on a theoretical model in which a single representative multinational company has two decisions to take: the allocation of its real capital across countries and the artificial shifting of tax base between them. The allocation of tax bases across countries incurs some cost. In this model, the allocation of real capital with respect to tax rates of other countries depend on the size of the countries, while the amount of profits allocated to another jurisdiction only depends on the cost of artificially shifting it between the two respective countries.

In the regression analysis, the authors estimate the effect of the tax rates in the rest of the world on a country's tax base. They used three different weightings to identify the various channels of profit shifting. For the profit-shifting channel, the authors used "haven-weights", i.e. giving the tax rates of 'tax havens' a weight of one and a weight of zero to all other countries. As the authors acknowledge, this is a limitation the empirical strategy because many forms of BEPS relies on special regimes and arrangements, not simply on low statutory CIT rates.

The authors' aim was to quantify the magnitude and channels of BEPS in less developed countries, where corporate microdata (used in the most recent papers in the literature) is generally unavailable. Average Effective Tax Rates (AETR) for CIT are not generally available either and the main results use statutory rates instead (the authors provided results using AETRs for a smaller sample of countries). The estimation uses the Generalized Method of Moments, and in order to deal with endogeneity problems (when an explanatory variable is correlated with the error term) instrumental variables are used (in this case, the use of the lagged dependent variable as an independent variable, as stated above). There are some missing country-year observations in the dataset which the authors imputed using simple interpolation.

d. Description of the results

The paper finds the following results:

1) **Base spillovers** – The estimation of the equation above implies the short run effect through real capital flows. A one-percentage point decrease in GDP-weighted average CIT rate abroad decreases in the short run the typical country's CIT base by 0.18% of GDP. However, short-run effect is statistically significant only at level of 10%. The long run effect is insignificant. Estimated base spillover effect related to haven-weighted CIT rate is larger and more significant. However, the paper discusses the potential inaccuracies in this estimate. "*The estimated spillover effects when weighting tax rates by inverse distance are similar, but barely significant*" (Crivelli et al. 2015).

2) **Revenue Cost of BEPS.** The paper provides short run estimate of USD 28 billion USD (0.2% of GDP) and USD 95 billion (0.2% of GDP) for Non-OECD and OECD countries respectively. In the long term, these estimates are USD 200 billion (1.3% of GDP) and USD 450 billion (1% of GDP) for Non-OECD and OECD countries respectively. However, these estimates are speculative as stressed in the paper.

e. Data

The paper uses publicly available data on tax rates, revenues and other economic indicators by the IMF[44] and the World Bank.[45] Countries classified as 'tax havens' are taken from Gravelle (2013).

The analysis is based on country-level data. CIT revenues and other indicators required by the methodology are not available at a more detailed level (like industry, or firm size).

The analysis covers all EU Member States. Potentially, the results could be replicated for the EU Members States only (the paper has separate regressions for OECD and non-OECD countries) to obtain an EU level BEPS figures. However, some of the data limitation would still apply, as tax rates have to be calculated for the whole world.

The Crivelli et al. (2016) study was replicated by Cobham and Janský (2017). They used alternative data in three areas: revenue data (from the ICTD-WIDER Government Revenue Database), data on average effective tax rates, and another list of 'tax havens'.[46] The paper also provides country-level estimates of revenue losses.

f. Advantages and disadvantages of the method

The advantage of the method is the use of generally available data and a relatively simple methodology based on estimation of dynamic panel regression model.

The application of the methodology on an individual country basis can be complicated and the accuracy of the results may be even more questionable due to data limitations. The method describes the effects and interactions between tax systems of several countries. However, the methodology does not provide insights for estimating reliable CIT gaps for individual countries. This methodology could be useful to assess the impact of internationally agreed measures by providing estimates before and after the implementation of the measures (allowing for sufficient time).

The proposed methodology is likely to be less resource-intensive or time-consuming than bottom-up methodologies relying on audit activities. However, it demands skilled human resources having knowledge of panel data analysis. In addition, to replicate this methodology, one needs access to econometric software that enables panel analysis.

g. Accuracy and reliability of estimates

The results of the paper are to a large degree tentative. The estimates are based on differences in statutory CIT rates only and not on specific 'tax haven' rules or tax incentives. The spillover estimates

---

[44] IMF Fiscal Affairs Department, World Revenue Longitudinal Data: http://data.imf.org/?sk=77413F1D-1525-450A-A23A-47AEED40FE78 and International Financial Statistics (IFS): http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B.

[45] World Development Indicators (WDI): https://data.worldbank.org/data-catalog/world-development-indicators

[46] Instead of relying on Gravelle (2013), the paper relies on an alternative list of countries identified by Cobham and Janský (2015).

might also be biased due to endogeneity problem. Moreover, the estimated revenue cost of BEPS should be considered as "illustrative" according to the authors, due to given assumptions and simple methodology.

4.1.5. CIT Efficiency Estimates

Another strand of the literature develops the CIT efficiency concept.

CIT efficiency is defined as the ratio of actual tax revenue to theoretically collectable revenue, a concept very close in its aims from the CIT gap. It provides for a benchmark. Several papers (Keen et al. 2014, Dover et al. 2015, Candau and Le Cacheux, 2017) have used this concept. This chapter presents and reviews the IMF Policy Paper "Spillovers in International Corporate Taxation" by Keen et al. (2014). [47]

The paper makes an analysis of 'spillovers' in an international corporate tax system. National tax systems are not closed circuits. One country's tax rules and practices affect others. The paper focuses on two broad types of spillovers: base spillovers and strategic spillovers. For this report, we will focus mostly on base spillovers and how to quantify them.

a. Description of the method

In order to gauge to which extent cross-border tax effects may influence a country's CIT tax revenues, the IMF paper relies on the concept of CIT-efficiency, using the gross operating surplus as a reference tax base.[48] More specifically:

The **CIT-efficiency** in country i (E_i) can be defined as the ratio of actual CIT revenue (R_i) to a reference level of CIT revenue, which is computed by multiplying the standard CIT rate (t_i) by a reference tax base (G_i).

$$E_i = R_i/(t_i * G_i)$$

A CIT efficiency below 1 indicates that the CIT system is less effective in raising revenue compared to the benchmark. Cross-country variation in CIT efficiency can reflect differences in policies (tax deductions and tax incentives) but also behavioural responses (such as profit shifting).

The paper uses as the reference tax base the GOS of corporations.[49] It provides for a proxy of "*what the base would be if profits were allocated on something similar to a 'source' basis*" (Keen et al., 2014). The paper mentions that it is close to the accounting concept of Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA). Compared to the standard CIT base, this reference tax base is broader, as no adjustment has been made for depreciation allowances, interest and other specific provisions. Loss carry-overs can also create differences.[50] Therefore, it is expected that CIT efficiency calculated with the GOS, as the reference base would be lower than unity.

---

[47] The paper was presented by Mr Ruud de Mooij (IMF) and discussed during the Fiscalis TGPG meeting of 17 January 2017.
[48] Particularly Appendix IV of the paper (Keen et al. 2014)
[49] Data on GOS are based on the national accounts and computed as value added by corporations, minus compensation of employees. Some other papers use the Net Operating Surplus.
[50] For more details on the differences between the GOS and a standard CIT base, please refer to chapter 4.1.2.

The IMF paper regresses the CIT efficiency (E_i) as the dependent variable on the tax rate (t_i) controlling for time and country fixed effects. The results point to a "strong negative relationship" (Keen et al., 2014) between the two, which can be indicative of profit shifting.

Revenue implication

Profit shifting leads to an overall loss of tax revenue, on top of a reallocation of tax revenues. The GOS data can be used to indicate the size and countries where the losses and gains occur, subject to a number of limitations. The loss is estimated by comparing the actual CIT revenues (R_i) with (simulated) CIT revenues without profit shifting.

Revenue without profit shifting (R_i^*) for country i is estimated by multiplying its CIT rate (t_i), its reference tax base (G_i or GOS) and an average CIT efficiency of ($\bar{E}$) (with the countries' efficiency weighted by GOS)[51]:

$$R_i^* = t_i * G_i * \bar{E}$$

The difference between the revenue without profit shifting and the actual CIT revenue for each country is then considered as an approximate estimate of the revenue gain (if positive) or loss (if negative) from the profit shifting:

$$\Delta_i^* = R_i - R_i^* = t_i * G_i * (E_i - \bar{E})$$

b. Tax evasion, tax avoidance or both?

The method estimates spillovers from international corporate taxation and the effects of CIT efficiency - intended or not - and tax incentives.

The method gives insight into the phenomena leading to tax avoidance (profit shifting) and tax evasion. If high CIT rates come along with lower CIT efficiency, this might be an indicator of spillovers and of BEPS. The GOS approach gives a rough proxy for the CIT revenue a country would receive in the absence of profit shifting, or more precisely: if CIT were levied on a source basis.

c. Assumptions, adjustments, bias corrections, common errors

The GOS of corporations is here assumed to correspond to the reference tax base. As was extensively discussed under chapter 4.1.2, there are differences between the GOS and a potential CIT base, which stem from depreciation and amortization, interest payments, tax incentives, reductions and exemptions but also inefficiencies in enforcement.

Secondly, the GOS is computed from the national accounts and can be biased because of different outcomes in the field of transfer prices, as a result of deliberate actions (manipulation), differences in interpretation or errors.

Finally, in the revenues estimates made by the paper, one of the main assumptions is that any cross-country variation in CIT-efficiency is assumed to be caused by profit shifting only. By attributing all cross-country differences to profit shifting, the method does not take into account cross-country differences of treatment in those items. The authors warn against the assumptions of this methodology.

---

[51] $\bar{E} = \Sigma\, \omega_i\, E_i$, with $\omega_i = G_i / (\Sigma\, G_s)$

d. Description of the results

The paper finds significant and sizable spillover effects on corporate tax base and rates. This reflects both the impact of taxation on real economic activities and on avoidance behaviours. The latter is of particular relevance for a tax gap measure.

The paper estimates that the (unweighted) average revenues loss across all countries in the sample is about 5% of current CIT revenue.

A similar methodology was used by Dover et al. (2015) and the revenue losses at EU level due to corporate tax avoidance are estimated to EUR 50-70 billion.[52]

e. Data

The GOS of corporations is based on the NA data (SNA). The paper relies on data for 93 countries from the UN Statistics division. Data on tax rates and CIT revenues come from the IMF's Fiscal Affairs Department tax and revenue database.

f. Advantages and disadvantages of the method

The method is useful as it enables to set a benchmark of CIT efficiency. It also provides for an indication of the revenue impact of profit shifting on a regional or global level.

The disadvantage of the method is that differences in CIT efficiency may be due to other issues than profit shifting spillovers. The method indeed attributes all cross-country variation in CIT-efficiency to profit shifting. Variations in CIT efficiency may in fact reflect unrelated features such as e.g. differences in compliance and enforcement.

While the proposed approach can lead to estimates per country, one must interpret such results with caution. GOS data are only a distant approximation of the standard CIT base. In addition, the national accounts, based on which the GOS is computed, can be biased because of different outcomes in transfer prices. While it provides for interesting results at an aggregate level, it is less so at a country-specific level.

Furthermore, the approach only captures profit shifting between countries in the sample and excludes several 'tax haven' countries, which are an important source of spillovers.

Therefore, strong assumptions raise caveats on the results based on this method.

This methodology relies on publicly available information, that is made available in a relatively manner and for long time series. While it is likely to be less resource-intensive than bottom-up methodologies relying on "on field" activity (audits), it still demands skilled human resources.

---

[52] However, Dover et al. (2015) uses for the reference tax base Net Operating Surplus (NOS), which subtracts depreciation from Gross Operating Surplus (GOS) data. The IMF paper referred to the possibility of using the NOS, as a possibly better reference tax base. However, for emerging and developing economies, it is more difficult to have access to NOS data. In addition, the Dover et al. paper uses data adjusted for the compensation to self-employed. In an alternative, they compute the theoretical amount that would be collected if the NOS would be taxed at the standard rate and compare it to actual CIT collection. Clearly, standard CIT systems do not actually tax NOS.

g. Accuracy and reliability of estimates

The GOS approach gives insights in effects but only leads to very rough estimates of profit shifting based on a number of assumptions. The paper uses the strong assumption that profit shifting is the only source of cross-country variation in CIT-efficiency.

4.1.6. Advantages and disadvantages of top-down approaches

The above-mentioned methodologies show a number of advantages and disadvantages. While some are specific to a given methodology, several of them are hold true for all or most methodologies.

In particular, the main advantages are the following:

- The top-down method is very comprehensive. It is supposed to capture potentially all types of reasons for non-compliance;
- It provides a single estimate;
- It gives the possibility to monitor trends over a period;
- It produces timely estimates;
- It uses data that are – to an extent – publicly available;
- It requires few resources (financial and human resources).

However, it has the following disadvantages or limits:

- It requires adequate data, notably the independence of macro-data from fiscal and administrative data, what may not happen, as explained above;
- The complexity of CIT system (e.g. allowances dependent on individual circumstances, etc.) makes the application of top-down method more difficult than for other taxes.
- It does not explain the reasons of non-compliant behaviour;
- Given the complexity of tax systems, an error at one point may lead to consequences in other places in terms of taxation. However these are not always captured by top-down method.;
- It captures only areas/activities, which are recorded in macroeconomic data and disregards unrecorded areas;
- International differences between tax systems and the effects of movement of capital and business activities (e.g. BEPS) can be measured only to the extent that national accounts are adjusted to reflect these effects, in case of single-country estimates. This is specific to the CIT gap.

4.2. Bottom-up approaches and data

4.2.1. Introduction

Bottom-up methods – also called "micro" or "direct" methods – are characterized by determining the magnitude of non-compliance from data obtained directly from the observation (Swedish Tax Agency, 2008) of specific components of the tax (Rubin, 2011), either taxpayers groups or non-compliance forms.[53]

The results and conclusions reached this way are then grossed-up to the whole population by applying several methods and statistical and econometric techniques. This is an important feature of these approaches: they cover only components of the population subject to that particular tax, whereupon the estimation of total tax gap has to be done by aggregating the several components that form that tax. Therefore, it is necessary to make several estimates for each specific tax gap, possibly using different data sources and methodologies.

This approach can be implemented through different kinds of methods, which we can classify on a double dimension based on information source and data treatment.

Various *information sources* can be identified, such as taxpayer information, enquiries, risk registers, data matching, audits (on randomly selected samples or resulting of the operational activity of the Tax Administration), compliance controls and checks, questionnaires, and surveys.[54] All these methods have in common the fact that the data obtained this way and that pertain to a specific component of the tax gap or group of taxpayers, could be used to reach conclusions about the whole population (Swedish Tax Agency, 2008). Being able to do so depends on the sample representativeness, which in turn largely depends on its randomness. If the sample is representative, the extrapolation exercise will allow the valid application of the conclusions to the entire population it represents. Otherwise, the sample will be biased, representing only the taxpayers or tax gap component with the same characteristics as the analysed group. When that happens, it is however still possible to use statistic and econometric methods and techniques to correct the sample bias, like regression, statistical matching and sample selection models (Fiscalis TGPG, 2016).

The *data treatment* relies on statistic and econometric methods. Examples of the statistical methods are the indicators used by Internal Revenue Service (IRS) to measure the "payment gap", namely the "Voluntary Payment Compliance Rate". It is calculated directly and exclusively from data on individual taxpayers – internal to IRS – and defined as "*the percentage of the total tax paid timely on timely filed returns relative to the total tax reported on timely filed returns*" (Brown and Mazur, 2003). An example of the econometric method is the one proposed by Feinstein (1999), called "Detection Controlled Estimation", and which tries to account for undeclared income by taxpayers that is undetected by the tax inspector.[55, 56]

---

[53] Depending on the tax gap we want to estimate, it can concern a tax, a group of taxpayers, a type of non-compliance. For example, the IRS calculates the tax gap to three different types of compliance: "payment", "filing", "reporting", from which results, respectively, the "underpayment gap", "non-filling gap" and "underreporting gap" (Mazur and Plumley, 2007; Brown and Mazur, 2003).

[54] Gemmel and Hasseldine, 2012; Fiscalis TGPG, 2016; Rubin, 2011; Swedish Tax Agency, 2008.

[55] It was applied, for example, by the IRS on estimating the "individual underreporting gap for tax year 2006", beginning on the National Research Program (NRP) of 2006 (United States Government Accountability Office (2012)). See Brown and Mazur, 2003; Gemmel and Hasseldine, 2012.

In the context of the analysis of the tax gap by tax administrations, the use of data obtained from risk-based audits assumes special relevance. As these audits are directed at taxpayers who were selected according to risk analysis criteria, one would expect these taxpayers to have a higher probability of incurring irregularities than the whole population subject to that tax. Consequently, the results cannot be generalized to the whole population unless the selection bias is taken into account (see chapter 4.2.2.2. on risk-based audits below and Annex III).

4.2.2. Audit-based approaches

Given their significance in the literature and their application over many years in several countries, this chapter focuses on audit-based approaches, and more particularly on two ways of implementing them: random audits and risk-based audits.

4.2.2.1. Random audits

Random audit programmes cover randomly selected samples of taxpayers in order to be representative of the wider population the sample intends to represent. Because they aim at representativeness, they are usually developed over the whole spectrum of the analysed component (a tax or a taxpayers group). However, without having additional and independent sources of information, it is difficult to know how actually representative is the selected sample (Gemmel and Hasseldine, 2012).

The main disadvantage of random audits is their high costs, both to tax administrations and taxpayers, especially the compliant ones (Feinstein, 1999). The time lag between the moment the data refer to and the moment when the results are obtained is another disadvantage of this method (see chapter 5 for country experiences). The average monetary return is likely lower than that of risk-based audits, because a random audit focuses on both compliant and non-compliant taxpayers, while a risk-based audit focuses exclusively on taxpayers with higher risk of non-compliance (Feinstein, 1999).

These programmes also tend to be unpopular among taxpayers – who are being subject to an intrusive action without signs of irregularities – and among tax auditors – who perceive their career progress to be linked with the results of the audits they conduct (Feinstein, 1999). They may also face resistance from auditors who prefer to audit high risk cases where they expect significant additional revenue.

Furthermore, random audits start from the population of known taxpayers. For example, it cannot detect activities carried out by taxpayers who are not registered and it thus biases downwards the estimates of (certain parts of) the tax gap (Feinstein, 1999). Besides, auditors may not detect all under or misreported activities. For parts of the population, more specifically the largest taxpayers, random audits are in practice often not feasible. These audits require too much time, too many resources, because of the size and complexity of these organisations.

Finally, random audit may present possible biases due to the different abilities of tax auditors as audits conducted by more expert auditors result in higher outcomes (Feinstein, 1990).

One of the main advantages of bottom-up approaches is to allow the extrapolation of the conclusions to the population it represents. In addition, because they focus deeply on a specific component of the tax, they allow a better knowledge about the causes of the non-compliance, thus helping to develop audit selection and analysis methods (Feinstein, 1999).

---

[56] Erard et al. (2002) propose another method for the application to data obtained from risk-based audits. Their proposed model is characterized by addressing simultaneously two essential questions: the probability of a tax return to be audited, together with the estimation of the magnitude of irregularities contained on it.

4.2.2.2. Risk-based audits

Risk-based audits[57] focus on specific taxpayers selected with criteria that generally obey to fiscal policy guidelines and with specific risk analysis criteria. They can focus on one or several taxes and, within each tax, they can cover the full spectrum of the tax or be limited to a part of it.

Tax administrations can develop bottom-up estimates based on their routine risk-based audits, thereby using the results of the controls already performed on taxpayers in their current activities. The use of these data may be appealing because they are already available at (virtually) no additional cost. Also the number of available observations and the frequency of data collection are usually much larger than in case of random audits, being available on a tendentiously continuous basis throughout the year (Erard et al, 2002). Risk-based audits tend to generate less resistance also from taxpayers as they expect the most likely offenders to be targeted (Gemmel and Hasseldine, 2012). However, some caution must be used because the available sample is not to be considered representative of the whole population (*selection bias*), since the selection of taxpayers is based on a risk assessment, contrary to random audits. The results cannot be directly extended to non-selected taxpayers in order to produce an overall estimate.

The risk-based audit data can be used if the selection bias is treated with the help of statistical approaches, such as post stratification approach or Heckman approach (Heckman, 1979). The *post stratification approach* suggests that when taxpayers (both audited and non-audited) can be divided into subgroups (strata) using variables that are relevant in the selection process (e.g. dimension of firms, region, sector of economic activity) one can assume that there is no selection bias within each stratum. The sum of strata estimates, obtained by grossing-up audited figures using an appropriate coefficient, provides the total tax gap. The *Heckman* two-step estimator corrects for sample selection bias by estimating both the selection process and the outcome variable in the same model. The model hence consists of two equations: the selection equation and the outcome equation. The selection equation specifies the probability that an observation will be included in the sample. (See Annex III for further details).

4.2.3. Matching techniques for the comparison of companies

Another method consists in the propensity score matching approach to estimate profit shifting by multinational companies (MNE). Several academic papers (Egger et al. 2010 and Finke 2013) have used this approach. To exemplify, this chapter describes the methodology used in the research paper "Tax Avoidance of German Multinationals and Implications for Tax Revenue Evidence from a Propensity Score Matching Approach" (Finke, 2013).[58]

The paper provides a method to estimate profit shifting of MNE in Germany through micro-econometrics tools. Specifically, it uses a propensity score matching approach between MNE and domestics firms to get an estimation of the profit shifting and to make a correction of the self-selection bias. It uses a probit model with firm characteristics as exogenous variables, to obtain the probability to incur tax avoidance, a necessary step to make the matching between firms. This work closely relates to the paper of Egger et al. (2010), which uses the same tools but to estimate BEPS of MNE in all

---

[57] The economic literature also uses the expression "Operational audits", which can be considered as a synonym.
[58] The paper was presented by the author Ms Katharina Nicolay (University of Mannheim) and discussed during the Fiscalis TGPG meeting of 10 May 2017.

Europe (with the AMADEUS database) and uses regional characteristics instead of firm characteristics.

a. Description of the method

MNEs can use controlled intra-group transactions to reallocate income to low-tax countries. Consequently, this study investigates how these opportunities translate into differences in tax payments of MNEs vis-a-vis purely domestic firms through propensity score matching method.

The study aims at capturing what the correct profit would be in the absence of profit shifting, and does so by comparing profits/payments of MNEs with those of domestic companies.

Controlling for the other characteristics of the firms, the method calculates profit shifting as the difference in tax payments of a firm if it is an MNE (MNE=1) or not (MNE=0). This comparison gives an estimation of BEPS because, unlike MNEs, domestic firms are by definition unable to shift profits to low-tax countries as they do not have foreign affiliates. The group of MNEs is directly observed, but the counterfactual (the group of similar domestic firms) is unobserved. Therefore, the researchers construct a control group with domestic firms. The difference between the groups gives the amount of shifted profits.

This comparison between the two groups may lead to a biased result because the sample of all firms is not random (self-selection bias). In order to avoid this self-selection bias, the researchers can use a propensity score matching approach. The main idea behind the propensity score matching "*is to determine a control group which is similar to the treatment group with respect to as many criteria as possible, and which allows for a meaningful comparison of the outcome variable for these two groups*" (Finke, 2013). To apply this method, the selection of units between groups (control versus treatment group) is done using observable characteristics.[59] In particular, a probit model[60] gives the probability of a firm to be an MNE through exogenous variables of firm characteristics.

Finally, the approach uses different matching algorithms (nearest neighbour and kernel) to assign the units between groups. Moreover, as each unit from the treatment is assigned to one or more domestic firms (from the control group) the propensity score-matching approach weights each unit from the control group.

Formulas:

$$ATT_i = E[T_i|MNE_i = 1] = E[T_i(1)|MNE_i = 1] - E[T_i(0)|MNE_i = 1] \; \forall i \in I$$

Where

$E[T_i(0)|MNE_i = 1]$ *is the unobserved counterfactual*

The reduction in tax payments due to profit-shifting strategies is the Average Treatment effect on the Treated (ATT). It is the difference between the tax payments $T_i(1)$ of a firm *i*, part of a multinational group ($MNE_i = 1$) that can shift profits and the tax payments of the same firm *i* in the hypothetical case of being a domestic firm unable to shift profits $T_i(0)$.

---

[59] To comply with the Conditional Independence Assumption (CIA).
[60] Alternatively a logit model.

This is equivalent to the mean of the differences of tax payments between MNEs and the corresponding domestic firms assigned with propensity score matching. Formally,

$$ATT = \frac{\sum_{i=1}^{NT}(T_{1,j} - \sum_{j=1}^{NC} w(i,j)T_{0,j})}{NT}$$

$Where$

$T_{1,i}$: $tax\ payment\ of\ the\ MNE\ i\ of\ the\ treatment\ group$

$T_{0,j}$: $tax\ payment\ of\ the\ domestic\ firm\ j\ of\ the\ control\ group$

$w(i,j)$: $weights\ between\ the\ MNE\ i\ and\ the\ domestics\ firms\ j\ (assigned\ with$

$\qquad propensity\ score)$

NT: $number\ of\ MNE$
NC: $number\ of\ domestic\ control\ firms$

Different matching algorithms exist that differ with respect to the number of control entities chosen and the weighting $w(i,j) \in [0,1]$ of each control observation.

b. Tax evasion, tax avoidance or both?

The method estimates tax avoidance. More specifically the paper refers to profit shifting.[61]

c. Assumptions, adjustments, bias corrections, common errors

The main assumption is that an MNE and a group of matched (i.e. with the same characteristics) domestic firms would pay the same amount of taxes if they were both unable to shift profits.

The validity of the results of the matching procedure requires the Conditional Independence Assumption (CIA) – the selection into the group of multinational firms or domestic firms is only driven by observable characteristics and is not driven by the outcome (the payment of taxes). In other words, the selection into groups is only driven by exogenous variables.[62] Moreover, the method also needs to satisfy the Common Support Condition (CSC), i.e. firms with same characteristics have the same probability to be MNE. The method makes a self-selection bias correction through propensity score matching algorithm as long as this latter satisfies the hypothesis of CIA and the CSC.

There are also adjustments in the probit estimations. Those use productivity instead of profitability because the latter is affected by profit-shifting activity, which is precisely what we try to assess. Similarly, the debt to equity ratio is affected by the intra group profit/debt shifting strategies. Therefore, an adjusted debt ratio is calculated, which excludes related party debt and is therefore not affected by profit shifting. Besides, to avoid simultaneity between variables (for example, international integration and productivity), the method needs to make additional restrictions in the sample of firms by selecting only those MNE in 2007, which were purely domestic in 2006. Therefore, many observations are lost.

---

[61] Profit shifting can occur through various channels; transfer mispricing, strategic location of intangibles, debt shifting or treaty abuse.
[62] I.e. In the present case, the MNE status is supposed to be exogenous.

Turning to the construction of the sample, the method classifies a firm as MNE if the firm owns more than 50%, or is more than 50% owned by a foreign firm, either directly or indirectly. The sectors covered in the analysis are manufacturing, mining, construction, energy and water supply. The analysis does not completely exclude loss-making firms. The study focusses on German firms but due to a lack of full coverage of all multinationals in Germany in the database, the estimation of the loss of tax revenues from profit-shifting activity needs to be corrected. The ATT is multiplied by the sum of domestic investors with foreign direct investment (FDI) and foreign investors with domestic FDI.

d. Description of the results

The main results in the study come from different matching algorithms (nearest neighbour and kernel). Tax avoidance is estimated in the range of EUR 600,000 and 670,000 (for a sample size of 1,500 MNE and 2,920 domestic firms), which corresponds to 27 % of the tax payments of domestic firms. Extrapolating this effect to the total number of firms with FDI yields an overall revenue loss of 10.2 billion EUR for Germany.

Looking at firm characteristics, profit shifting is concentrated in new MNEs (firms that were domestic firms in 2006 and MNE in 2007), in large firms, in MNE with high debt ratio, and in those with high R&D investment. The empirical evidence suggests that multinational firms reallocate profits across group entities according to international tax rate differentials in a way that minimizes the overall tax burden.

e. Data

The paper uses microdata (financial statements) of German enterprises from the DAFNE database of Bureau Van Dijk. According to the paper, this database covers a huge share of corporations in Germany and the reported balance sheet positions it contains are detailed. It also includes ownership information, which enables a classification of each firm as MNE or domestic. Finally, it provides interesting firm characteristics to estimate the probit model.

DAFNE is a private database and it contains only information for German companies. Therefore, it is not an adequate source to estimate tax avoidance in other countries. Tax return data would be a first alternative and a better source because it would overcome some drawbacks of the paper (extrapolation to the national level, randomized samples, etc.). Another alternative would be AMADEUS database but, similarly to DAFNE, it is a private source and there are costs to access the database.

Coverage and possible breakdowns by region, sector: The approach gives an estimation of tax avoidance for a sample, which is then extrapolated to the overall population. The breakdowns in the paper are related to firm characteristics such as high/low debt, large/small firms, level of R&D investment, etc. Regional and sectoral breakdowns would require a large enough sample of enterprises classified by activity (at NACE level for example) and by region.

Software: Most of the needed algorithms (probit/logit, matching procedures, kernel density, etc.) are included in most statistical/econometric software (accessible in most tax administrations). In general, these software provide the relevant matching algorithms (according to the designs[63] of the matching)

---

[63] Matching designs can be bipartite, or non-bipartite. Bipartite is equivalent to sampling without replacement, while non-bipartite designs are equivalent to sampling with replacement. Bipartite designs are more common, but non-bipartite designs are available for the rare case when you want to reuse a member, for example, if you use the same control as a match for two or more treatment group participants. http://www.statisticshowto.com/propensity-score-matching

f. Advantages and disadvantages of the method

The main advantages of the matching method are:

- In general, bottom-up/micro approaches lead to the traceability of tax avoidance, i.e. it enables to draw how firms shift profits to other countries;
- A detailed and sophisticated analysis based on firm-level data.
- A flexible approach that could be done with different characteristic to obtain different analysis;
- Crucially, it overcomes the observed differences between treatment and comparison;
- The propensity score matching method - as used in the study - provides for a statistically unbiased, tested and checked estimate of tax-avoidance;
- Propensity score matching has a number of applications in the bottom-up approaches, beyond its use in the aforementioned study (for example for grossing up of audit results).[64]

The main disadvantages of the method are:

- The difficulty to obtain an adequate sample to apply the matching procedure. For example, the approach only works if there are more control group firms (domestic) than MNEs.
- Complex and data-demanding pre-calculations of variables;
- If tax returns data (or other public sources) are not available, it is necessary to use a private database of firm-level financial statements, which implies acquisition costs.
- The paper relies on accounting data which may differ from tax data;
- The method requires restrictions in firms sample to avoid simultaneity (i.e. sample is restricted to firms that became MNEs in 2007);
- The risks of unobserved heterogeneity, simultaneity, significance, etc. Although the majority of these problems can be solved;
- Some methodological disadvantage can appear in process of comparison between MNE and non-MNE companies. The fact that some of companies do not exploit international tax planning methods does not mean that they are compliant with all their tax obligations. We can therefore conclude that the accuracy of tax gap estimation is impacted if this is the case.
- There are by assumption no unobserved differences (which is often implausible) between treatment and comparison groups;
- The difficulty to extrapolate the results to the overall population in an accurate way;
- The model is time consuming.

g. Accuracy and reliability of estimates.

- Many assumptions, adjustments and restrictions harm the accuracy and reliability of the estimates. However, the results are complemented with robustness tests with respect to unobserved heterogeneity. These tests seem to confirm that propensity score matching, as used in the study, provides unbiased results.

---

[64] Examples of application of the propensity score method to tax gap related issues are contained in Alm et al. (2015), Beer et al. (2015) and Katz et al. (2013).

- To get reliable results, it is also necessary to have high quality data: it includes not only accuracy, reliability, data completeness, etc., but also respecting the Common Support Condition can be a problem if groups (control group and treatment group) are very different.
- The propensity score matching method only helps monitoring observable differences, not unobservable differences.
- Finally, it would be beneficial to use other matching methods (i.e. not only propensity score matching), in order to compare the results of the research and to ensure the appropriateness of the used method.

4.2.4. Econometric estimations based on firm level data

As mentioned above in the top-down section, the computation of the tax elasticity of reported income has led to several studies using firm-level data. Examples include Huizinga and Laeven (2008), Weichenrieder (2009), the OECD (2015), Gumpert, Hines and Schnitzer (2016) and Dowd, Landefeld and Moore (2017). The methodology is identical to the one described above, but that the data is now at firm level.

In this chapter, we analyse three methods. Johansson et al. (2017) use firm level data from ORBIS to estimate profit shifting. Next, Huizinga et al. (2008) use firm level accounting and ownership data from AMADEUS to estimate part of tax avoidance that occurs due to the specific debt-shifting channel. Finally, Heckemeyer and Overesch (2013) provide a meta-analysis to derive a consensus estimate on 27 previously conducted studies on profit responsiveness to international differences in corporate tax rates.

4.2.4.1. Tax planning by multinational firms: Firm-level evidence from a cross-country database

This chapter describes the methodology used in the OECD Working Paper by Johansson et al. (2017),[65] which analysis the profit shifting, mismatches between tax systems and preferential tax treatment. Firstly, the authors assess profit shifting in OECD and G20 countries by using a large sample of multinational and domestic corporations' financial accounts data from the ORBIS database. Compared to earlier studies that focussed on profit shifting between parents and their subsidiary(ies), this study tries to capture profit shifting between all the members of multinational groups. Secondly, the paper conducts a joint assessment of the effect of mismatches between tax systems and preferential tax treatment.

a. Description of the method

The method uses a detailed international firm-level dataset to measure the effects of BEPS on firms' profitability and effective tax rates. To analyse profit shifting, the paper uses the tax rates differentials within the group, while the effects of mismatches between tax jurisdictions and preferential tax treatment is assessed by comparing the effective tax rate (ETR) of multinational group with the ETR of a domestic entity on its reported profit. The results provide regression coefficients.

---

[65] The paper was presented by Mr Christian Kastrop (OECD) and discussed during the Fiscalis TGPG meeting of 20 June 2017.

To estimate the profit shifting, the effects on firm profitability are estimated using an equation that defines the "observed" profit as sum of the "true" profit (the potential one) and the shifted profit (as consequence of tax planning strategies). With this information, the procedure uses a panel data model with the profitability as dependent variable and the "true" and shifted profit as regressors.

Yet, the "true" (potential) profit is not observed directly, so it is necessary to estimate it through a vector of firm characteristics that determine the profitability of an enterprise. The shifted profit is introduced in the model as the difference between the statutory rate of a multinational enterprise (MNE) and the unweighted average of the statutory tax rates in the countries where this MNE is registered. The coefficient of the statutory tax rate differential is the semi-elasticity that explains the profit shifting as consequence of tax differentials.

The method to estimate BEPS effects on firm profitability[66] starts with the following equation:

$$Observed\ profit = \text{true}\ profit + \text{shifted}\ profit$$

The panel data model is defined as:

$$Profitability_{f,g,c,i,t} = \alpha X_{f,g,c,i,t} + \beta\left(STAT_{c,t} - STAT\_group\_avg_{g,c,i,t}\right) + \delta_t + \delta_i + \varepsilon_{f,g,c,i,t}$$

$Where$:

- $Profitability_{f,g,c,i,t}$: is a measure of profitability of the MNE f that belongs to a group g in country c and industry i in year t.
- $X_{f,g,c,i,t}$: is the vector of characteristics of a MNE f that belongs to a group g in country c and industry i in the year t.
- $STAT_{c,t} - STAT\_group\_avg_{g,c,i,t}$: is the difference between the statutory tax rate of a MNE g that belongs to a country c in the year t and the unweighted average rate of the statutory rates of the countries where MNE g is present in year t.
- δ_t, δ_i: are binary variables that take into account time and country fixed effects.

To estimate mismatches and preferential tax treatment, the method estimates the effects on the ETR by comparison of the ETR of a multinational entity with the ETR of a domestic one. The comparison is based on a panel data model that relates the ETR of a MNE (the dependent variable) with a vector of firm characteristic and a set of dummies to take into account firm size and if the entity belongs to a MNE or not.

The ETR[67] is estimated as:

$$ETR_{f,c,i,t} = \gamma_1 Large\_firm_{f,c,i,t} + \gamma_2 Small\_firm_{f,c,i,t} \cdot MNE_{f,c,i} + \gamma_3 Large\_firm_{f,c,i,t} \cdot MNE_{f,c,i} + \gamma_4 X_{f,c,i,t} + \delta_i + \delta_{c,t} + \varepsilon_{f,c,i,t}$$

---

[66] The profitability is defined here as the ratio of the pre-tax profit over total assets.
[67] The ETR is measured as the corporate tax expense.

$Where$:

- $ETR_{f,c,i,t}$: is the effective tax rate of an entity f that operates in country c, in industry i at year t.
- $MNE_{f,c,i}$: is a dummy variable equal to one if the entity f belongs to a multinational group and zero otherwise.
- $Large\_firm_{f,c,i,t}$: dummy variable to take into account large enterprises (more than 250 employees).
- $Small\_firm_{f,c,i,t}$: dummy variable to take into account small enterprises (less than 250 employees).
- $X_{f,c,i,t}$: vector of firm characteristics.
- $\delta_i, \delta_{c,t}$: time and country fixed effects.

b. Tax evasion, tax avoidance or both?

This method enables to estimate avoidance, and specifically cross-border avoidance.

c. Assumptions, adjustments, bias corrections, common errors

The method treats all the tax rate differentials in the same way. That is, the incentive to shift profits when the difference in statutory rates between 40% and 30% is considered to be the same as when the difference is between 30% and 20%.

The authors tried to separate real economic activities from profit shifting. The approach is mostly empirical, with no specified theoretical model.

The paper used data from ORBIS, which provides financial accounts (see description in the next section). Therefore, some information relevant to cross-border tax avoidance (e.g. intangible goods) are not available. The coverage of the database is limited for some countries where the firms in the database are not completely representative. Therefore, the data is best used for global estimates of tax avoidance rather than for country-specific ones.

The computation of the tax revenue loss relies on heavy assumptions. They are dependent from the average effects of the sample of firms used in the analysis, and use extrapolated data for the firms not covered in ORBIS.

It appears that the method does not take into account any specific bias corrections. On the other hand, there are many assumptions to avoid various sources of bias.

d. Description of the results

According to the headline result of the paper, for the average multinational entity, a 1 percentage point lower tax rate differential between the home and partner counties is associated with 1 percent lower group level profitability. However, strong anti-avoidance rules, such as transfer pricing, interest deductibility, general anti-avoidance rules (GAARs) and controlled foreign-company (CFC) rules can limit profit shifting. Due to mismatches between tax jurisdictions, the effective tax rate of multinational corporations is 3.3 percentage points lower compared to similar domestic entities. The authors found no significant difference between the effective tax rates of domestic and multinational small firms. This is likely due to the high fixed costs of international tax planning.

Based on these results, the authors did an illustrative exercise to calculate the revenue loss of profit shifting and the international tax systems mismatches. This could amount to 4-10 percent of global CIT revenues, which corresponds globally to about USD 100-240 billion in 2014. However, the estimate contains high uncertainty. The largest part of the revenue loss comes from profit shifting.

e. Data

Extensive, worldwide, firm level data is required. The method used ORBIS, a commercial database for corporate entities in the OECD and G20 countries.[68] As the ORBIS database is not publicly available, tax authorities could use their own tax return database to replicate the results. However, tax return data do not include information concerning companies (entities) in other countries. Therefore, it could be very difficult to replicate the results based only on tax return data. In addition, it is possible that data were too small in countries with few multinational companies. Of course, tax authorities could supplement information from tax returns with other corporate dataset, which requires data matching (Habu, 2016).

Regarding possible breakdowns, the authors report global results from the main regressions and present breakdowns by firm size and country type (based on strength of anti-avoidance rules) for the tax revenue effects. Although the firm level data could be used for further breakdowns, insufficient coverage would make results that are more detailed highly uncertain.

f. Advantages and disadvantages of the method

The advantage of the method is that it can distinguish between two forms of BEPS: profit shifting to low tax countries and exploiting the mismatches between tax systems without making assumptions about the specific channels of BEPS-related behaviour.

The disadvantages of the method are following:

- The method is data intensive
- Only global estimates are available;
- The data source contains information only from financial accounts;
- Costly access to a commercial database
- The tax rate differential is calculated using the unweighted average tax rate between countries. This is a potential bias source because all differentials are treated in the same way;
- Results cannot be attributed to specific countries.

g. Accuracy and reliability of estimates

The study is based on the most detailed, largest available dataset. The results are robust to a variety of model specifications. The main results on the semi-elasticity of profitability with respect to the intra-group tax rate differences is 0.2 percentage points higher the estimate from the meta-analysis in Heckemeyer and Overesch (2013) (see chapter 4.2.4.3 below). The specification using country-fixed effects lead to lower estimates (by around 30% for profit shifting).

The uncertainty from the statistical estimations is reflected in the tax loss calculations. However, due to the data and methodology limitations, the tax revenue estimates should be interpreted with caution.

---

[68] Bureau van Dijk compiles ORBIS, see https://www.bvdinfo.com/en-us/our-products/company-information/international-products/orbis. The authors did an extensive data cleaning process to prepare the database for analysis (identifying MNE groups, dropping implausible, suspect, outlier values) which is described in appendices 2-4 of the OECD working paper.

4.2.4.2. Capital structure and international debt shifting

This chapter describes the methodology used in the research paper "Capital Structure and International Debt Shifting",[69] which analyses how much a multinational company's capital structure in a country depends on a weighted average of the national tax rate and differences between national and foreign tax rates. Many corporate income tax systems give a preferential tax treatment to debt financing as interests can be deducted while in case of equity financing the dividends cannot be deducted from the pre-tax profit.[70] The study finds that the capital structure of a company depends on the national tax rates and debt shifting occurs towards high tax rate countries. It does however not provide for a direct estimation of the tax gap as such.

a. Description of the method

The paper presents a regression model of the optimal overall capital structure of multinational firm reflecting tax and non-tax factors and the evidence on the impact of taxation on firm indebtedness for a sample of 32 European countries over the period 1994 through 2003 using a firm-level data.

The prediction of the model: a multinational firm's indebtedness in a country depends on weighted average of national tax rates and differences between national and foreign tax rates. These differences matter as multinationals have an incentive to shift debt to high-tax countries.

An equation of the regression model:

$$\lambda_i = \alpha_i + \beta_1 \tau_i + \beta_2 \sum_{j \neq i}^{n} (\tau_i - \tau_j) \rho_j + \varepsilon_i, \quad i = 1, \ldots, n,$$

Where:

λ_i is the financial leverage of subsidiaries of a multinational firm;

α_i is a country-specific fixed effect;

$\beta_1 \tau_i$ is a 'domestic' effect of taxation on leverage;

$\beta_2 \sum_{j \neq i}^{n} (\tau_i - \tau_j) \rho_j$ is 'international' or 'debt-shifting' effect on taxation, ρ_j is the asset shares;

ε_i is an error term.

b. Tax evasion, tax avoidance or both?

The method focuses on tax avoidance, which occurs due to debt shifting.

c. Assumptions, adjustments, bias corrections, common errors

- A firm is defined to be a subsidiary if at least 50% of the shares are owned by another single firm.
- Multinationals do not take into account the taxation of dividends, interests, and capital gains at the investor level.

---

[69] Huizinga H., L. Laeven and G. Nicodème (2008). The paper was presented by Mr Gaëtan Nicodème (European Commission, DG TAXUD) and discussed during the Fiscalis TGPG meeting of 17 January 2017.
[70] With the exception of Notional Interest Deduction systems.

- There are other significant factors affecting the financial leverage of subsidiaries of multinational firms.

d. Description of the results

The model shows that there is statistically significant effect that the foreign subsidiary's capital structure reflects local corporate tax rates as well as tax rate differences between the parent firm and other foreign subsidiaries. Nevertheless, the economic effect is rather small.

e. Data

The method uses firm-level data from external database AMADEUS, which contains accounting data on private and publicly owned European firms and their ownership relationships. Information on statutory tax rates are coming from International Bureau of Fiscal Documentation (IBFD) and various ministries.

Needs:

- firm-level databases;
- information on statutory tax rates;
- pre-calculations of variables; suitable statistical software.

f. Advantages and disadvantages of the method

- This method provides a detailed and sophisticated analysis, which considers more aspects and not only tax issues;
- The model can be applied on an EU or worldwide level;
- It is possible to calculate it for sectors (but only in case the data covers enough firms from a particular industry).

However, it has the following disadvantages and limits:

- The model cannot be calculated separately for one country;
- It is data and time-consuming: in particular, with regard to the pre-calculations of variables which can be relatively data-demanding and complicated are needed for model estimates;
- An access to all needed databases can be costly. However, research institutions usually have an access to these databases. Limitations regarding firm-level information, as the AMADEUS database (used in this method) does not include the banking sector, has limited coverage for some countries and it provides accounting data (which may differ from tax data);
- The model does not include interest limitation rules.

g. Accuracy and reliability of estimates

While the results of the model are statistically significant both the domestic and international economic effect of taxation on leverage are rather small.

4.2.4.3. Meta-regression analysis to establish consensus estimate on profit response

This chapter describes the methodology used in the research paper "Multinationals' Profit Response to Tax Differentials: Effect Size and Shifting Channels",[71] which establishes a consensus estimate for the scale of profit shifting activity by analysing the existing evidence on tax elasticity of reported parent or subsidiary profits. The authors offer a meta-analysis of the empirical literature on the reported profit responsiveness to international differences in corporate tax rates, as the literature does not provide consensus estimate for the magnitude of this elasticity. The study does however not provide for a direct estimation of the tax gap as such.

a. Description of the method

Heckemeyer and Overesch (2013) use a meta-regression method to analyse 27 previous studies, which include 203 estimates of MNEs' profit response to international tax rate differentials. The studies selected for this meta-analysis exclusively estimate the empirical relationship between the reported profitability of parent or subsidiary entity and profit-shifting incentives. The study aims at explaining the heterogeneity in empirical findings. The dependent variable is the tax semi-elasticity[72] of reported profits as estimated by previous studies. The independent variables reflect the various study characteristics (data sample characteristics, econometric specification etc.).

b. Tax evasion, tax avoidance or both?

This method enables to estimate only tax avoidance.

c. Assumptions, adjustments, bias correction, common errors

The authors found more than fifty studies on "income shifting" but the selection of studies for meta-analysis was adjusted to include only the studies that use "*a profit measure as their dependent variable", "directly provide tax semi-elasticities or allow for the transformation of reported effects at sample means"*. While the meta-analysis attempts to sample all tax effect estimates from the sampled studies, some highly selective estimates with specific characteristics from a subsample of specific industries are excluded.

d. Description of the results

The main finding of the study is that tax semi-elasticity of pre-tax profits is about 0.8. If the international tax rate differential increases by 1 percentage point, then reported profits decrease by 0.8 percentages. This 0.8 is a cross-country long-run estimate. At the country-level, it could be higher or lower.

The paper also estimated the main route for shifting strategies. Non-financial shifting (for example transfer prices and IP royalty payments) strategies explain about 82% of profit shifting. Financial strategies (for example debt shifting via thin capitalization) explain about 18%.[73]

---

[71] Heckemeyer, J. and M. Overesch (2013). The paper was presented by Prof. Michael Overesch (University of Cologne) and discussed during the Fiscalis TGPG meeting of 17 January 2017.

[72] The semi-elasticity shows the percentage change of reported profits as reaction to a one-percentage change in the tax differential compared to international locations.

[73] In their revised (published) version, these shares are respectively 67% and 33%. See Heckemeyer, J. and M. Overesch (2017)

e. Data

The authors use meta-analysis of 27 studies, which includes 203 estimates of MNEs' profit response to international tax rate differentials. The 27 studies used six different databases, which cover different geographical locations and types for firms. The earlier studies are from the 1990s and the latest from 2008. The estimated semi-elasticities tend to decrease (Semi-elasticities are higher in the early studies). It is not clear why estimates decrease but possibly reasons are following:

- tax elasticity of income has decreased;
- empirical approach might have changed or methods have developed;
- firm-level data may produce accurate estimates. Latest studies use mainly firm-level data;
- effective anti-avoidance legislation and enforcement.

The variation of the tax effects depends also on the profit variables used by the initial studies: after-financing profit, measures excluding the tax effect originating from intercompany financing like Earnings Before Interest and Taxes (EBIT), value added or total factor productivity. The tax effect on EBIT, value added or total factor productivity does not capture the full profit response to taxes. The EBIT reflects only non-financing shifting techniques like transfer pricing and royalty payments but profit shifting based on interest income and interest from debt financing is not included. All types of profit shifting is captured by the after-financing profit of a subsidiary.

f. Advantages and disadvantages of the method

The main result 0.8 is the overall estimated tax elasticity. It includes strategies that are legal and illegal. The meta-study includes a considerable number of studies from different regions of the world and provides a consensus estimate.
The methodology allows explaining the importance of different strategies. Hence, we can concentrate on the most important strategies and try to estimate how big the tax gap is in these shifting strategies. Disadvantage is that the method is not suitable to estimate a gap at country level because lack of sufficient number of country level studies.

g. Accuracy and reliability of estimates

The meta-dataset includes studies over a period of 20 years. Over this period, the size of estimated semi-elasticities decreases. The authors point out that one of the possible reasons for this pattern can be that the accuracy of the estimates over time has increased due to increased use of firm-level data which made possible to use more accurate microeconometric approaches.

4.2.5. Advantages and disadvantages of bottom-up approaches

For the above-mentioned bottom-up methodologies, we can identify a number of advantages and disadvantages. While some are specific to a given methodology, several of them hold true for all or most methodologies.
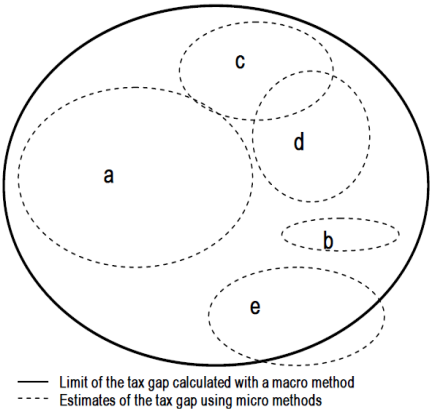
Advantages

Bottom-up approaches have some important advantages over top-down ones. First, bottom-up approach can provide guidance and orientation to identify the gap's causes given that it focuses on a specific component, with uniform and well-defined features among its constituents (Swedish Tax

Agency, 2008). Second, they provide for greater certainty and precision of the estimates because of the higher granularity demanded by these approaches (breakdown of the gap into partial gaps) as well as because they present a direct relation between the resulting estimates and the behaviour of the taxpayers that generate them (namely, because they measure the gap directly[74]). When less uncertain estimates are necessary, i.e. for smaller gaps, this will be more accurate than top-down methods. Finally, being direct, it is easier to solve the problem of top-down approaches of determining the rate to apply to the missing tax base. Besides, such detail provides useful operational information, improving the quality of the risk analysis and allowing a better prioritization of the compliance resources (Rubin, 2011; Feinstein, 1999). The propensity score matching technique, as discussed above, provides a useful method to estimate tax avoidance, without relying on audit-based data. It could be used also for grossing up of audit results in bottom-up estimates. Finally, the econometric estimations are likely to be less resource –intensive and time consuming compared to bottom-up methodologies relying on audit activities.

Disadvantages

One of the major disadvantages of bottom-up approaches is that they do not estimate the total gap, but only components of it (i.e. partial gaps) (Swedish Tax Agency, 2008). The estimation of the total gap has to be done by aggregating all the partial gaps. While there may be complementarities in using various approaches, there may be also overlaps between some gaps ('c' and 'd'), as illustrated on the figure below. There is a risk that by aggregating partial gaps 'a', 'b', 'c', 'd', 'e', we double-count and therefore overestimate the total gap.

— Limit of the tax gap calculated with a macro method
---- Estimates of the tax gap using micro methods

Source: Swedish Tax Agency (2008), p. 37

Another important disadvantage of bottom-up approaches is that they do not capture forms of non-compliance that are not detected by the methods of information collection they are based on. Bottom-up approaches based on audits can only explain the gaps we know about or suspect, based on compliance controls and other surveys (Swedish Tax Agency, 2008). For instance, bottom-up approach do not cover completely hidden economy as only registered taxpayers are usually selected for an audit. Even if the hidden taxpayers are selected for an audit, there is lack of information on the target population to gross-up the observed data. Also the estimates with a bottom-up approach depend heavily on audit scope and quality and it is difficult to assess the reliability and confidence intervals.

---

[74] This is why they are called "direct".

As bottom-up approaches are based on specific information about specific components of the gap, they do not capture particular forms of non-compliance and therefore they may underestimate the non-compliance.[75]

Perhaps the most important disadvantage of bottom-up approach is that it requires significant resources, in case it is based on random-audits or enquiries (Rubin, 2011). In spite of this disadvantage, some authors argue that "*The useful information provided by the bottom-up approach can justify much of the required resources even without a tax gap estimate*" (Rubin, 2011). Also the propensity score matching method requires complex and data-demanding pre-calculations of variables, which might be time consuming. A disadvantage for a random-audit approach is that (all) tax returns will have to be filed before a random sample can be checked and this filing may take a couple of years. For parts of the population, more specifically the largest taxpayers, full comprehensive audits are in practice often not feasible. These audits require too much time, too many resources, because of the size and complexity of these organisations. Another disadvantage is that it requires sufficiently large samples in order for the grossing-up exercise to the population not to be biased. Working with large samples makes it expensive. Furthermore, it is difficult to determine its appropriate size and representativeness when additional and independent sources of information about that component are not available (Gemmel and Hasseldine, 2012). Although the risk-based audit data are available for tax administrations, additional resources are needed to record them in a way that they could be used for later tax gap analysis. This means correctly classifying the type of non-compliance, divvying up the amount of fraud uncovered between various taxes. These additional tasks might not be relevant for the tax authorities' work or not required by law but they are important for the tax gap work. Econometric estimations based on firm level data require access to public authorities' databases with sensitive data, which may be problematic when estimates are outsourced, or to commercial databases, which can be costly.

---

[75] The IRS recognized this problem on its TCMP approach (Gemmel and Hasseldine, 2012) and tried to overcome it by applying multipliers to the obtained values of non-compliance, in order to estimate the whole gap of that component (Feinstein, 1999).

4.3. Alternative approach

The following chapter focuses on an alternative methodology that cannot be classified as either top-down or bottom-up approaches. Nevertheless, this approach is interesting to assess the possible revenue loss via treaty shopping by multinational companies. This chapter describes the methodology used in the research paper "Optimal Tax Routing: Network Analysis of FDI Diversion",[76] which analyses the network of bilateral tax treaties to identify the route with the lowest tax cost. These routes are used by the multinational companies to treaty shopping and aggressive tax planning with the objective to reduce the tax burden.

a. Description of the method

The paper uses the data of 108 jurisdictions in 2013 to estimate the "shortest paths" that can be used by multinational enterprises that seek to minimise tax payments, through treaty shopping, when repatriating profits. Treaty shopping is in the paper considered as practice of MNE's which funnel the investment through a third country to take advantage of treaty provision not found between the host and the home country, rather than investing directly in a host country (Davies, 2004). The empirical strategy constructs the indicator based on the network approach to international taxation where the links of the network are given as the cost of channelling corporate income from one country to another in terms of the lowest taxes to be paid (van't Riet and Lejour, 2017). In particular, the tax payments are constructed from the corporate statutory rates, withholding taxes on dividends and the double tax relief methods. The shortest paths (lowest tax payments) within the network are derived by Floyd-Warshall algorithm described in detail in Annex C1 of the van 't Riet and Lejour (2017) paper. The results of the network analysis (the bilateral tax rates minimizing the tax costs and centrality measures for host and home country) and other explanatory variables (that control for FDI behaviour) are regressed with bilateral FDI stocks given as dependent variable.

In particular, three main results are achieved by applying a network approach and graph theory tools to the international tax system (that similar to Barrios et al., 2012 includes the application of the provisions of Treaties) and using cross-section econometric techniques. First, the authors are able to identify the shortest paths among countries that MNEs can use for minimizing tax payments when repatriating profits. In other words, it is found that MNEs can decide to combine different strategies in host and conduit countries in order to reduce the tax burden on profits. Second, different centrality measures are constructed for identifying the countries that operate as central points in the international tax network by facilitating the MNEs' operations. Third, the indicators of treaty shopping and network centrality are used as explanatory variables for explaining FDI diversion and bilateral FDI stocks.

The empirical strategy can be decomposed in the following steps:

- First step: Definition and calculation (by using the Floy-Warshall algorithm) of the total tax distance matrix for describing the tax costs for (incoming/outgoing) dividends between pairs of countries. This is helpful for estimating the tax reduction due to treaty shopping;
- Second step: Definition of treaty shopping and tax network centrality's measures; ranking of countries;

---

[76] van 't Riet, M., and A. Lejour (2017). The paper was presented by Mr Maarten van't Riet (CPB Netherlands) and discussed during the Fiscalis TGPG meeting of 20 June 2017.

- Third step: Estimation of a FDI gravity model with the inclusion of variables derived from network analysis for explaining FDI diversion and bilateral FDI stocks.

b. Tax evasion, tax avoidance or both

The method estimates tax avoidance due to treaty shopping, with a focus on dividend repatriation.

c. Assumptions, adjustments, bias corrections, common errors;

The paper's empirical strategy assumes the investment decision between parent and subsidiary within the network as given with focus to taxation of dividends. Withholding taxes on royalties are not considered. However, they figure within the OLS regression as one of the explanatory variables. Statutory rates are used instead of effective rates.

d. Description of the results

The paper finds that treaty shopping potentially leads to reduction of the tax burden on repatriated dividends at the level of MNE's of about 6 percentage points on average. This reduction is on top of the 9 percentage points reduction realized through double tax treaties. The paper shows that some countries play a central role in the international tax network. However, being a conduit country does not lead to major additional tax revenues as it hardly taxes incoming or outgoing dividends.

More generally, the paper makes three main contributions to the renewed interest in studying the impact of regulations on international taxation (Bräutigam et al., 2016). First, the separation of direct and indirect tax routes that can be pursued by MNE. Second, the construction of measures (e.g. tax distance, tax network centrality) that can be used in two-steps analyses. Third, the treaty shopping (network centrality) plays a positive (negative) role on FDI.

e. Data

The paper used publicly available data on tax rates, especially the Worldwide Corporate Tax Guide 2013 from Ernst and Young. Explanatory variables used in OLS regression can be found at IMF and the World Bank databases. Countries are classified as 'tax havens' following Gravelle (2013) which is also publicly available.

The paper attempts to cover whole world. In particular, the data for 108 jurisdictions covers 95% of worldwide GDP in 2013. Breakdowns are possible however, without the benefit in terms of delivered results.

The paper seems demanding in data preparation as it consists of data for 108 jurisdictions. Furthermore, the network analysis is very time consuming which reflects the performance of analysis only for one year. The network analysis is performed via Floyd-Warshall algorithm that requires basic programming skills. However, the basic description of algorithm functioning in various programming languages can be found online.

f. Advantages and disadvantages of the method

The paper proposes a unique methodology, providing the opportunity to quantify treaty shopping, while there was no readily available measure of its magnitude or on the size of the subsequent reduction of the effective tax burden for MNEs. If re-estimated for several years, it can provide

valuable insights about development of Treaty shopping that can be a significant source of tax avoidance.

A major disadvantage of the method is that it is a time consuming process, in terms of data preparation and performance of the Floyd-Warshall algorithm to derive the shortest path between countries in terms of the lowest tax payments. A further limitation is the focus on dividends only. Finally, the measure reflects the potential use of a country for tax treaty shopping purposes (based on country-specific information), but not its actual use.

g. Accuracy and reliability of estimates.

The results can be considered as accurate and reliable. The contribution of van 't Riet and Lejour throws new light into the study of tax avoidance activities of MNEs in the international tax system. The empirical analysis is both innovative and robust to different specifications. The analysis has been conducted for one year (2013) given the time-consuming procedure. Yet, performing the same analysis for a different year can prove useful for checking the robustness of the proposed approach and providing additional insights on the evolution of the international tax system. A more detailed discussion on the algorithm adopted for the identification of the tax distance matrix and on the presence of different procedures can prove useful for non-technical readers (Magzhan and Jani, 2013).

4.4. Conclusions

Estimating the CIT gap is difficult, both in terms of methodological consideration and in terms of data needs.

The two main approaches to estimating the tax gap – the top-down and bottom-up methods – have both advantages and disadvantages, as discussed in chapters 4.1.6 and 4.2.5 above. The choice of the estimation method depends on the availability of data, on resources and on the purposes of the estimation.

While the top-down methods start from macroeconomic indicators or national accounts data to estimate the CIT gap, bottom-up methods start from data obtained from individual taxpayers to extrapolate them to a wider population.

Top-down methods allow for a single overall estimate of tax gap and have therefore a wider coverage. Bottom-up approaches generally do not estimate the total CIT gap but parts of it. Generally, they only cover the gaps that are known or suspected. It is therefore not guaranteed that tax evasion is fully captured. Some bottom-up approaches (such as matching techniques and econometric estimations based on firm level data) can be used to cover tax avoidance. However, the estimates obtained with bottom-up approaches may be more precise and, more importantly, they allow for a better understanding of what causes a tax gap. Several authors report that tax administrations use bottom-up approaches preferentially in the process of estimating the tax gap, whether as exclusive approach (e.g. USA) or complemented with top-down approaches (e.g. Italy).

In terms of data requirements, the quality of the data and their treatment is obviously essential to the quality of the estimates in both cases. For the top-down approach, having data that are independent from tax administration and the ability to transform those into theoretical CIT liabilities is essential. For bottom-up approaches, the representativeness of the individual data collected and their quality (e.g. quality of the audit) as well as the extrapolation to a bigger population are key elements.

There are clear complementarities between both approaches. The bottom-up and top-down approaches can be combined either (1) by using each methods for different components of the tax gap, or (2) by using both approaches to estimate roughly the same gap. This type of analysis provides more detailed information about the CIT gap and enables to increase the reliability of the results. It also helps to make improvements of the methodologies used.

5. Country experiences

This chapter focuses on tax gap estimates that have been carried out or are envisaged at national level. The chapter draws on the survey of CIT gap estimates carried out for this report, national experiences as they have been presented at the TGPG meetings (from Denmark, Italy and Sweden,) but also on desk-based research. It also provides for a short overview of tax gap estimates in other countries (in and outside of the EU) based on publicly available information. The studies presented in this chapter are using bottom-up and/or top-down approaches.

5.1. Survey of CIT gap estimation practices in Member States

A survey on current practices of CIT gap estimations was drawn up by the TGPG. The survey questionnaire was sent to Member States (see Annex IV) and a reply has been received from all but three (Ireland, France and United Kingdom). The below chapter reflects information as of June 2017.

The result shows that out of the 25 Member States for which the information is available, nine are performing or have taken steps to carry out specific national estimates of the CIT gap (Belgium, Bulgaria, Denmark, Greece, Italy, Romania, Slovakia, Finland and Sweden).[77] Countries are at different stages in the application and development of estimation methodologies. For example, Belgium is exploring the possibilities to apply such methodologies in the near future. Four Member States (Czech Republic, Portugal, Latvia and Lithuania) have indicated that they are planning to undertake CIT gap estimates in the future.

Six Member States that estimate the CIT gap use or intend to use **bottom-up methods** (Belgium, Bulgaria, Denmark, Italy[78], Finland and Sweden), either based on risk-based audits or on random audits. Three Member States use top-down methods (Italy, Romania and Slovakia) with National Accounting Methods as a basis for the calculation. The Netherlands also uses a bottom-up approach on its programme for SMEs.[79]

Regarding **bottom-up methods**: three out of the six countries that apply or intend to apply this method (Belgium, Bulgaria and Italy) use risk-based audits data as a sole source of information; Denmark uses both risk-based and random audits data, and Finland and Sweden use only data from random audits. For its SMEs programme, the Netherlands also uses random audits. Three of the countries that (intend to) use risk-based audit data, selected Heckman's method to correct for sample selection bias (Belgium, Denmark, and Italy).[80]

The methods used (or planned) capture **tax evasion** in six Member States: Belgium, Denmark, Italy, Slovakia, Finland and Sweden. Three other Member States (Bulgaria, Greece and Romania) use methods that capture both **tax evasion and tax avoidance** and none of them captures **tax avoidance**

---

[77] Germany has indicated that it does not carry out specific CIT gap study on its own but relies on external academic studies on the topic. The outcomes of these studies are then used in-house to assess the likely effects of reforms options.

[78] Italy also uses top-down methods in addition (see chapter 5.3).

[79] Greece did not provide details on which approach is envisaged.

[80] Bulgaria did not specify if it also uses it.

solely. It seems there is no direct relationship between the method used (top-down or bottom-up) and the form of tax revenue loss measured (tax evasion or tax avoidance).

More generally, **data** used to estimate CIT gap include audits results, tax returns, financial data, tax liabilities, surveys, risk registers, data extracted from accounting systems and other databases / systems and National Accounts.

The **scope of the estimates** also varies: the methods selected by five countries (Bulgaria, Denmark, Greece, Italy and Romania) cover all types of companies whereas it covers only a subset of it in five Member States (Belgium, Netherlands, Slovakia, Finland and Sweden). Again, there is no one-to-one relationship between the method used by Member State and the scope.

In eight countries (Bulgaria, Denmark, Greece, Italy, Netherlands, Romania, Finland and Sweden), the National Tax Authority is responsible for the estimates, and in two countries (Belgium and Slovakia) the responsible body is the Ministry of Finance.

Only three countries **publish** their results (Denmark[81], Italy[82] and Slovakia[83]). As a result of the Open Government Act, the Netherlands has published reports on the random audit program on SMEs. The tax gap (or 'compliance deficit') for this population is estimated as a total figure, that includes not only CIT but also other taxes.[84] Other countries prefer not to publish their results. Belgium signalled concerns about the robustness of (initial) results.

Performing CIT gap estimates consumes **resources**: time, staff, and software. The personnel needed to this exercise vary significantly with the method used: bottom-up methods using random audits are the most time and staff consuming measured in full-time equivalent (FTE): Denmark uses 150 FTEs[85] in the year the survey is conducted, Finland uses 50 and Sweden 100. The Netherlands consumes 240,000 hours only in the planning of the field audits of its SMEs programme. Although these resources are indirect, in the sense that they are not used directly to estimate the gap, they are necessary to collect the data needed to perform the calculations. When the resulting data is available, the resources are much less demanding: Finland uses one analyst for one month and Sweden 2 analysts. Bottom-up methods using risk-based audits data and top-down methods are less resource-demanding: Belgium (bottom-up, further exploiting existing risk-based audit data) dedicated one FTE combined with some outsourced assistance, Italy (top-down and bottom-up with risk-based audit data) uses 3.5 FTE on each method, and Romania and Slovakia, both using top-down methods, use four and one FTE, respectively. Data is treated both using general spreadsheet software (MS Excel) and/or statistical and econometric software (SPSS, EViews, Stata, SAS, R, etc.). These softwares are used on bottom-up and top-down methods, or with risk-based or random data.

---

[81] http://www.skat.dk/SKAT.aspx?oId=2619&vId=0
[82] http://www.mef.gov.it/ministero/commissioni/rel_ev/index.html
[83] Preliminary estimates are provided in chapter 5.4.
[84] https://www.rijksoverheid.nl/documenten/wob-verzoeken/2017/11/23/wob-verzoek-over-correctiepotentieel-belastingdienst
[85] 150 FTEs are employed for the complete survey. The number of FTEs working on companies paying corporate takes is 50-60.

Most countries (plan to) **update** their estimates annually (Belgium, Italy, Netherlands, Romania, Slovakia and Sweden) and triennially (Denmark and Sweden[86] – in this case, the major report). Bulgaria and Greece do not make regular updates.

At the survey date (mid-2017), the most recent **reference year**[87] was 2014 for most of the available estimates (Italy on its top-down estimates, Netherlands on its SMEs programme, Romania, and Sweden). Other countries had older estimates (Bulgaria 2008 – 2010; Denmark 2012; Italy on its bottom-up estimates 2009) while Finland and Slovakia had more recent estimates (2015 – 2016). The time difference between the release of estimates and the reference year to which the underlying data refer, is in most cases 2 or 3 years (Bulgaria, Denmark, Italy on top-down estimates, Netherlands on its SMEs programme, Romania and Slovakia).

The **issue** most commonly identified by Member States about the methodologies used, is the fact that they do not capture all forms of non-compliance:[88] five countries referred to this issue; these include countries that (intend to) apply bottom-up methods (Belgium, Finland, Italy, Sweden) as well as those using top-down methods (Slovakia). Concerning bottom-up methods with risk-based audits data, the sample bias resulting from the fact the sample is selected on a risk basis and thus not representative of the population is referred by three countries (Belgium, Bulgaria and Italy). Three countries using bottom-up methods (Bulgaria, Denmark and Finland, with the last two using random-audit data) refer to the resource intensiveness as a disadvantage of the method. Italy refers to conceptual differences between national accounts and tax data as an issue concerning the use of top-down method. Belgium, Finland and Italy refer to the absence of complete audits, as they are limited in scope (e.g. targeted at SME's, limited to audit of the turnover of certain amount). This results in fragmented estimates as only a small portion of the tax gap for companies is measured and it is unknown how that portion relates to the total gap. On the advantages side, the Netherlands also referred to the fact that its programme allows for a reflection of the quality of the overall tax system: the quality (complexity) of tax legislation, the willingness of taxpayers to be compliant, quality of tax service providers, available software, quality and resources of the tax administration.

Most countries indicated that the selected methods are based on some **assumptions** and subject to **bias corrections**. Generally, these include sample representativeness (Belgium, Denmark and Italy), (un)cover of all relevant issues (Denmark), differences between National Accounts and tax concepts (Italy, Romania and Slovakia).

Most of the methods allow in some way to **breakdown the results**, whether by sectors, regions, forms of non-compliance, error types, taxpayer sizes, risk areas, customer groups or behaviours. Five countries (Bulgaria, Denmark, Netherlands, Romania and Slovakia) have indicated that they are able to break down the results by sectors, regions and other items (forms of non-compliance, error type, taxpayer size). Sweden's tax gap can be broken down by risk areas.

---

[86] Triennial results are published in a major report (different from the annual updates).
[87] Reference year is the income year to which the estimates refer.
[88] We include here tax avoidance.

Table 5.1 - Survey of CIT gap estimation practices

Member States	In-house CIT gap estimates (planned, initiated or ongoing)	Method	Audits	Heckman sample selection correction for operational audits	Top-down method	Scope of gap	Scope of companies	Public	Periodicity (last update)
Belgium	Initiated	BU	Risk-based	Yes		Evasion	Subset	No	Annual (planned)
Bulgaria	Yes	BU	Risk-based	n.a.		Evasion - Avoidance	All	No	No fixed periodicity (2010)
Czech Republic	Planned								
Denmark	Yes	BU	Risk-based and Random	Yes		Evasion	All	Yes	Triennial (2012)
Germany	No								
Estonia	No								
Ireland	n.a.								
Greece	Yes	n.a.				Evasion - Avoidance	All	No	No fixed periodicity (n.a.)
Spain	No								
France	n.a.								
Croatia	No								
Italy	Yes	BU / TD	Risk-based	Yes	National Accounting	Evasion	All	Yes	Annual (2014)
Cyprus	No								
Latvia	Planned								
Lithuania	Planned								

Member States	In-house CIT gap estimates (planned, initiated or ongoing)	Method	Audits	Heckman sample selection correction for operational audits	Top-down method	Scope of gap	Scope of companies	Public	Periodicity (last update)
Luxembourg	No								
Hungary	No								
Malta	No								
Netherlands	No (only SMEs)	BU	Random			n.a.	Subset	Yes	Annual (2014)
Austria	No								
Poland	No								
Portugal	Planned								
Romania	Yes	TD			National Accounting	Evasion - Avoidance	All	No	Annual (2016)
Slovenia	No								
Slovakia	Yes	TD			National Accounting	Evasion	Subset	Yes	Annual (2016)
Finland	Yes	BU	Random			Evasion	Subset	No	n.a. (2016)
Sweden	Yes	BU	Random			Evasion	Subset	No	Annual (2014)
United Kingdom	n.a.								

Source: questionnaire to Member States. Note: n.a. - not available. Situation in June 2017. BU: Bottom-up; TD: Top-down.

5.2. Denmark

The CIT gap estimation in Denmark is conducted using two different methods, which are both bottom-up:

1) **A Random Audits Survey** on small and medium sized companies (up to 250 employees), which has been conducted on income years every second year since 2006 (2006-2014);

2) A **Model Approach** based on risk-based audits using Heckman style bias correction. This method is used for large companies (more than 250 employees). The model-based approach is still under development and therefore the results are not available.

5.2.1. A Random Audits Survey (RAS)

a. Description of the method

The RAS is based on drawing a representative random sample within the target population of approximately 220.000 companies. The sample size is 1000. A mechanism is used to ensure that companies recently audited will not be re-audited. The sample therefore consists of 1000 companies, which have not been previously audited in the relevant income year. In order to calculate the tax gap, the sample is scaled to the whole population, such that each company in the sample has a weight of approximately 220.

b. Tax evasion, tax avoidance or both?

The method estimates tax evasion. The method does in addition cover errors, omissions etc.

c. Assumptions, adjustments, bias corrections, common errors

It is assumed that when a company is audited, the auditor identifies all issues in the company. However, if the auditors do not detect some issues, the possible alteration in the reported taxable income may be understated.

d. Description of the results

The CIT gap for small and medium sized companies is estimated to 4.4 bill. DKR in 2012 (the gap estimation for 2014 is currently under preparation). The estimate of 4.4 bill. DKR corresponds to 20 percent of the potential CIT liabilities. The number of companies that made errors (i.e. the error rate) is 56 percent. It covers both intentional and unintentional errors. Half of the gap concerns companies intentionally trying to evade paying taxes, these companies however only represent 10 percent of the total population. Most of the errors can be attributed to sectors such as *hotels and restaurants*, *transport*, *community, and social* and *personal service* sector while *finance and insurance* is the sector with least errors.

e. Data

The necessary data are collected from the random audits. In order to describe the gap and error rates for sectors and company types, the sample of audits are combined with company specific characteristics. In order to calculate the overall CIT gap, only the results from the randomized audits are necessary. It is ensured that the audits are homogeneous, by carefully designing what should be audited and in what way, just as the registration is carried out in a homogeneous way.

The RAS covers all companies up to 250 employees. It is possible to break down the gap to sectors, regions and error-types.

Resources, time, HR, Software

The RAS method requires approximately 150 FTE's (with 50-60 working on companies paying corporate income tax) in the year when the survey is conducted. The audits are conducted over approximately three-quarters of a year, and the analysis requires three to four months. No specific programs are needed. Currently the statistical software used is SAS.

f. Advantages and disadvantages of the method

Advantages

Apart from the ability to measure the tax gap, it allows measuring the degree of compliance in the population, and comparing it to previous compliance degrees. Furthermore, the error types are being described. It is therefore possible to some degree (if there are enough observations) to divide the tax gap into different error types. Since everything is done by the tax administration itself, it is easy to control how and when the survey should take place. It is also possible to make it consistent with previous surveys. We are not dependent on external entities.

Disadvantages

The RAS method is relatively expensive. As already mentioned, the method requires approximately 150 FTE's in the year when the survey is conducted.

g. Accuracy and reliability of estimates

For the RAS method, the sample size of 1000 companies has been found to be appropriate given a relatively high error rate (56 percent in 2012 and it was also above 50 percent in 2008 and 2010). The resulting gaps are assumed to be both reliable and quite precise, as the gaps have been estimated independently over several years with consistent results. Since the auditors most likely cannot uncover all the issues in a company, the gap can be seen as a lower bound estimation.

5.2.2. Model approach (MA)

a. Description of the method

The MA currently applied for the large companies use existing results of risk-based audits. The model uses a two steps estimator method to correct sample selection bias, which is based on the Heckman approach. The model can be presented using the following equations:

Probability of non-compliance:

$$P^* = \beta_P' X + \beta_\lambda \lambda_P + \epsilon_P \ (1)$$

Magnitude of non-compliance (only when $P^* > 0$):

$$\ln N = \beta_N' X + \beta_\lambda \lambda_N + \epsilon_N \qquad (2)$$

Risk-based audit selection:

$$A^* = \beta'_A X_A + \epsilon_A \qquad (3)$$

N is only observed when $A^* > 0$.

Equation (1) above, states the probability whether an enterprise will not comply. Equation (2), conditional on non-compliance, measures the magnitude of the non-compliance. Equation (3) states the probability of being selected for an audit. Lambda, the bias correction term estimated in equation (3) is applied both to equation (1) and equation (2).

b. Tax evasion, tax avoidance or both?

The method estimates tax evasion as well as errors, omissions, etc.

c. Assumptions, adjustments, bias corrections, common errors

The literature on the application of the MA, including assumptions and pitfalls is voluminous.[89] However, only the assumptions regarding this specific application are presented. It is assumed that it is possible to identify measurable characteristics relevant for companies that are chosen for audit. It is also assumed that audits are conducted in a homogeneous way, or if not, that it is possible to correct for it. Furthermore, it is assumed that the risk-based audits are capturing all non-compliance in the company.

When applying the method one should be careful with the data transformation, since the distribution of audit results are usually highly non-normal. For data transformation, one might use a log transformation, since most monetary values have been found to be approximately log-normally distributed. It is recommended that all individuals in the target population have a positive probability of being audited. Therefore, including random audits in the sample supposedly improves the quality of the estimations.

d. Description of the results

No result is currently ready to be reported.

e. Data

The data requirements for the MA are risk-based audits on the target population. Random audits are helpful, but not strictly necessary. Furthermore, the method requires data on the complete population. It is not a priori possible to state what data is needed, however company specific data such as financial statements, the size of the company, its tax reports and sector are examples of useful data in order to build the matrices of explanatory variables. There is also a requirement to have audit results on companies that did not make any errors in order to estimate both equation (1) and (3) above.

Coverage and possible break downs by region, sector

In theory, the MA enables to break down tax gap estimates per sector/region/error types etc. However, it requires enough risk-based audits in the target population. If the population and/or the sample are too small, it will not be possible.

---

[89] There is a useful survey about the general assumptions and pitfalls with applications to criminology in Bushway et al. (2007).

Resources, time, HR, Software

This MA requires analysis of similar length as the RAS, however it only requires few resources from auditors, compared to the RAS. These resources are needed for technical assistance regarding the risk-based audits. Model estimation is conducted in the programming language R, using the package 'sampleSelection'.

f. Advantages and disadvantages of the method

Advantages

The MA is cheap to apply compared to random audit surveys. It can be applied to any population large enough and with enough data. Since it can be applied on various populations the tax gap, these populations can more easily be compared since they are estimated using the same method.

Disadvantages

If the risk-based audits are not able to target the correct/relevant companies, the model results will be misleading. It is not able to "predict" the behaviour of the companies, the resulting gaps are historical and may be outdated. It does not give new insights about where the non-compliant behaviour is taking place.

g. Accuracy and reliability of estimates.

If there are enough data i.e. a large enough sample and with sufficient background data, the model is assumed to yield reliable estimates. However, as the implementation of the MA is in an early stage, more experience and time is needed to draw conclusions on how precise and reliable the estimates are.

5.3. Italy

This chapter presents the methods used in Italy to estimate the CIT gap, as presented during the TGPG.[90]

The law[91] requires that an annual report is produced on non-observed economy and tax and social security contribution evasion. A committee of experts has been set up[92] for that purpose. Tax gap estimation methodologies have therefore been proposed or refined for several taxes. As for CIT gap, the Italian Revenue Agency (IRA) currently adopts two methodologies, but they are still under development:

1) a top-down method, which is the main approach for tax gap estimation;

2) a bottom-up method, which is used in order to check and enrich top-down results by allowing to breakdown figures and derive specific information non obtainable using the top-down approach.

As explained in the following, the first methodology focuses on tax evasion arising from the operating activity of the enterprises, while the second may also capture tax avoidance.

5.3.1. Top-down method

The top-down approach is based on a comparison between national accounts data and tax returns data.

Definitions and Classifications

In order to ensure consistency in the treatment of data, the following needs to be taken into account:

- Target population

The Italian tax system, like others, provides that the tax to be paid (CIT or PIT) depends on the legal status of the taxpayer. The National Accounts identifies various institutional sectors and divides the national income between them. However, the classifications and definitions adopted for fiscal and statistical purposes do not coincide. A correspondence must therefore be established. Table 5.2 shows a framework that connects the legal form, relevant for tax purposes, and the classification by institutional sectors adopted in National Accounts. The CIT applies to corporations (SC) and public and private bodies, such as non-profit institutions (ENC), while PIT[93] is paid by individuals (PF) and, by means of their members, by partnerships and unincorporated companies (SP). [94]

Table 5.2 – Comparison between Institutional Sectors (NA) and legal forms

	Legal forms for tax purposes				
Institutional Sectors (NA)	Individuals **(PF)**	Unincorporated companies **(SP)**	Corporations **(SC)**	Non-profit institutions **(ENC)**	Government **(AP)**

---

[90] By Marta Gallucci and Rosaria Vega Pansini (Italian Revenue Agency).

[91] Law n. 196/2009, Law n. 23/2014, Legislative Decree n. 160/2015

[92] http://www.mef.gov.it/ministero/commissioni/rel_ev/index.html

[93] The personal income tax base is the sum of all incomes received (except those subject to separate taxation) net of deductions.

[94] The acronyms adopted correspond to the denomination of the tax return to be filled.

Financial corporations		[Excluded]	[Excluded]	[Excluded]	
Non-financial corporations		PITaut	CIT	CIT	
General government			[CIT]	[CIT]	[Excluded]
Households: Employers and own-account workers	[PITdip]				
Households: Employees and Recipients of property and transfer income	PITaut + "Minimum"	PITaut			
Non-profit institutions serving households (NPIS)				[CIT[95]]	

Legend:

PITdip: personal income tax payed on income from employment, pensions and similar income

PITaut: personal income tax payed on income from enterprise and self-employment

"Minimum": short name for all subsided regimes which pay a separate tax

CIT and PITaut taxpayers may have similar economic behaviours in terms of tax compliance, especially if they share the same economic characteristics (size, sector of economic activity, etc.). Moreover, CIT and PITaut tax bases both originate from the results of the operating activity (operating surplus). These common features allow us to set up a partially common estimation procedure for CIT and PITaut gap, with some distinctions due to their respective specificities, whose first step is the identification and distinction of the target populations for the two taxes.

For CIT gap analysis, the target population is identified by the grey cells in Table 5.2. With respect to institutional units included in the Government sector, it should be noted that they comprise both "pure" public administrations (which are excluded from the analysis due to an assumption of no evasion) and publicly owned corporations that do not sell their services or that sell at non-economically relevant prices. These companies can be identified due to a list annually published by the Italian National Institute of Statistics (ISTAT).

- Sectors of economic activity

Moreover, there may be lack of correspondence with respect to sectors of economic activity. Both fiscal data and National Accounts adopt NACE rev. 2 Classification, but taxpayers classify themselves according to the prevalent economic activity while NA split multiple activities.

To deal with these definitions and classifications issues, a specific working group between the Italian National Institute of Statistics and the Italian Revenue Agency has been set up.

---

[95] Non-profit institutions are subject to CIT if they perform commercial activities, in which case they are classified in the institutional sector of corporations, so that no residual tax base should remain in this cell.

Description of the methodology

The methodology relies on comparing the potential tax base to the declared tax base, as will be explained below.

- **GOS: computation and relationship with tax base**

Table 5.3 represents a simplified version of an income statement according to the Italian civil law, whose resulting amount, called profit or loss of the year, is reported in the CIT tax return and it represents the starting point for the computation of the CIT tax base.

Table 5.3 – Simplified income statement according to the Italian civil law

A) Revenue	Operating section
B) Expenses	
- goods and services	
- labour costs	
- depreciation and amortization	
- other operating expenses	
Net operating surplus (A – B)	
C) Financial gains and costs	Non-operating section
D) Value adjustments to financial assets	
E) Extra-ordinary activities	
Result before taxes (A - B +/- C +/- D +/- E)	
F) Taxes	
G) Profit or loss of the year	

In order to reconstruct the **potential tax base**, the Gross Operating Surplus (GOS) is taken as a reference point. The GOS is defined as Net operating surplus + depreciation and amortization. The choice of this specific aggregate is based on several reasons:

1) it can be computed with respect to both potential and declared amounts, whereby a direct measure of the undeclared component can be derived;
2) its definition is standardized by ESA 2010;

3) it allows to neutralize the difference between the Gross and Net operating surplus that is the Consumption of Fixed Capital, which is not uniformly defined for statistical and fiscal purposes.[96]

Consequently, however, the resulting estimates mainly capture **tax evasion** related to the operating activity of the enterprises.

- **Declared side**

For the declared side, first we consider «Fiscal Value Added» (PLd) defined as:

PLd= Revenue (A) - Expenses for good and services and other operating expenses (B)

To obtain the **declared GOS** (GOSd), we subtract Labour Costs:[97]

$$GOSd = PLd - Labour\ costs\ (Wd)$$

The **declared tax base** (*BID*) is calculated as follows:

GOSd

      - Amortization and depreciation

      - Non-operating section

      +/- Fiscal corrections required by tax law

      - Carried over losses and other deductions

The difference between GOSd and BID is called *Δd.*

- **Potential side**

For the potential side, the Gross Value Added at Factor Cost from NA, as defined in ESA 2010 9.32, is corrected in order to adjust statistical definitions to fiscal ones (for example, subtracting non-taxable activities and deductible costs) in order to obtain a Potential «Fiscal Value Added» (PLP). Then Total labour costs (*Wt*) are subtracted to obtain **Potential GOS** (GOSp):

$$GOSp = PLP - Wt$$

where *Wt* = declared labour costs (*Wd*) + undeclared labour costs (*Wnd*, estimated by ISTAT).

A first measure of the undeclared component is obtained by difference:

$$GOSnd = GOSp - GOSd$$

To derive the corresponding **undeclared tax base** (*BIND*) the same items listed in *Δd* must be considered, so that:

$$BIND = GOSnd + \Delta nd = GOSnd + (\Delta p - \Delta d)$$

Since *Δp* is unknown in amount and shares, a working hypothesis must be adopted. Possible options are:

a) *Δd = Δp*, meaning that the elements that distinguish *GOS* from tax base do not affect the gap;

---

[96] Depreciation and amortisation are added back because fiscal amortisation is not comparable to statistical consumption of fixed capital.

[97] This passage is required because information comes from different tax returns.

b) *Δp = Δd*(GOSp/GOSd)*, i.e. *Δnd* is proportional to *GOSnd*, with a proportion that, for each sector of economic activity, is the same as that computed on the declared side;

c) Mixed hypothesis: some elements in *Δp* are the same as in *Δd* while other components follow a proportionality rule – this hypothesis depends on the gap definition adopted.

In the first application of this methodology, we adopted hypothesis b, while in the future we plan to switch to hypothesis c. Once the undeclared tax base (*BIND*) has been derived, the corresponding CIT gap is obtained by multiplying BIND by an implicit tax rate computed using the declared tax (*CITd*) and tax base (*BID*).

- **CIT gap**

In general, **CIT gap** may be written as:

$$CITgap = BIND * TaxRate = [GOSnd + (Δp – Δd)] * CITd/(GOSd + Δd)$$

The formula simplifies according to the hypothesis adopted for *Δp*:

a) Under hypothesis a: CITgap = GOSnd *CITd/(GOSd +Δd)
b) Under hypothesis b: CITgap = GOSnd *CITd/(GOSd)
c) Under hypothesis c[98]: $CITgap = (GOSnd + \Delta p_1 - \Delta d_1) * \frac{CITd}{GOSd + \Delta d_1 + \Delta d_2}$

The choice to use an implicit tax rate instead of the statutory one allows us to consider indirectly aspects not covered by the procedure (such as special benefits that reduce the actual liability). It also allows to reflect changes in the law and to take into account the composition of the base at macro level (while at individual level, with Δ known, the implicit tax rate corresponds to the statutory rate). In addition to the undeclared component, the tax gap should also include the missing payments component (*CITmp*), which is the difference between the declared tax and what is actually payed. This can be obtained through administrative data since the Italian tax law states that automated controls are to be performed on the whole population of taxpayers comparing tax returns with payment forms data.

5.3.2. Bottom-up method

The bottom-up method is based on the results from risk-based audits performed by Italian Revenue Agency. In Italy, random audits are not usually used by the fiscal administration. On the contrary, risk-based audits represent the most comprehensive type of control a firm may receive regarding income and revenues from its production activity. Risk-based audits are driven by a risk assessment performed by tax auditors. Thus, tax gap estimates using data from risk-based audits are affected by a selection bias linked to the fact that taxpayers with the highest yield are overrepresented in the data and this may lead to a mis-evaluation of total tax evasion and tax gap. There are different statistical methodologies that allow correcting for the selection bias, at least partially. Among these, the Heckman two-step procedure and the post stratification method are the most widely used in tax evasion estimates.

The Italian Revenue agency has produced some very preliminary results from the application of both methodologies to data derived from risk-based audits. In this chapter, the focus will be on the post

---

[98] Hypothesis c can be expressed as follows: $\Delta p = \Delta p\_1 + \Delta p\_2$, $\Delta d = \Delta d\_1 + \Delta d\_2$ where $\Delta p\_1 \neq \Delta d\_1$ and $\Delta p\_2 = \Delta d\_2$

stratification method.[99] The Heckman procedure, described in annex, has been applied only to self-employed taxpayers and small firms and it is still in the experimental stage.

Before actually performing tax gap computation, some data pre-processing is needed at different stages in order to have a first insight of the available information and obtain some direction for future analysis. The first is represented by a detailed exploration of available data through descriptive statistics (e.g. distribution of undeclared base and tax by audited fiscal year). The second is data cleaning and outlier detection based on non-parametric confidence intervals on the median value of the stratum. The third step is represented by the imputation of some value of the tax base and tax where not available. Given the features of Italian data on risk-based audits and the fact that their distribution is characterized by a positive skewness, we choose to use the median value of the stratum[100] in the imputation of data if not available. Since looking at the distribution of average and median value of tax base and taxes in the Italian case, the latter is always lower than the former, using the average value would lead to an overestimation of tax gap. The final step is represented by the post-stratification procedure that is presented in detail in the annex. Using the grossing up factor w_i we derive the estimate of undeclared tax base and tax gap by each stratum i, as:

$$\widehat{Y}_i = Y_i * w_i = \frac{Y_i}{\alpha_i}$$

The total tax gap is then computed as the sum of tax gap for all strata:

$$\bar{Z} = \sum_{i=1}^{N} \widehat{Y}_i$$

From the post stratification procedure, we exclude taxpayers with specific characteristics. First, bigger firms[101] are not considered since they are characterized by a high probability to be audited and so not really subject to a risk based assessment. Moreover, Italian Revenue Agency monitors bigger firms not only with risk-based audits but also with different form of controls, such as tutoring. We can therefore conclude that big firms are not subject to any selection bias. We also exclude taxpayers for which risk-based audits had a negative results, i.e. taxpayers that did not evade taxes in tax particular tax year. The number of compliant taxpayers per stratum has been also used to correct the correspondent population of taxpayers used in the grossing up. Finally, we exclude taxpayers that have been audited but did not complete their tax return in the first place. The reason for excluding such firms is the lack of sufficient information in order to use the corresponding tax evasion in the grossing up procedure to the population.

Special attention should be devoted to the features of data in terms of the 'timing' of risk-based audits and audited tax year. Given the characteristics of the audited process by the Italian Revenue Agency, we select those risk-based audit that are at the last stage of the process, i.e. those for which the Agency has worked in consultation with the taxpayer to determine the tax claim. We need on average two

---

[99] A post stratification method has been also applied by the INSEE to correct national accounts for the share of underground economy in France (Louvot-Runavot, 2011) and by Fiorio and D'Amuri (2005) to estimate income tax evasion by employed and self-employed taxpayers.

[100] In the methodology used, strata are defined by sector of economic activity (6), firm size defined in terms of turnover (4), and macro-regions (4).

[101] We exclude firms with revenues higher than 50 million euros.

years after the year of the audit to have final data on all claims. Moreover, as stated by the Italian tax law, one tax year can be audited until 5 years after the corresponding tax return has been completed. Considering this 'timing', estimates on a tax year are available with a seven-year lag. Table 5.4 provides a visual insight of the combination between audited year and year of audits used to complete bottom-up estimates.

Table 5.4 – Tax year and year of audit

Table 3. (Audited) tax year and year of audit												
	Starting year of Audit (x)											
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Audited Tax year	2005		x	x	x	x	x						
	2006			x	x	x	x	x					
	2007				x	x	x	x	x				
	2008					x	x	x	x	x			
	2009						x	x	x	x	x		
	2010							x	x	x	x	x	
	2011								x	x	x	x	x
	2012									x	x	x	x
	2013										x	x	x
	2014											x	x
	2015												x

5.4. Slovakia

Slovakia closely follows the IMF RA-GAP methodology to estimate the CIT gap. In particular, Slovakia was a pilot country in implementation of this methodology. This chapter provides Slovak specific information necessary for a more detailed understanding of results.[102] All main assumptions related to employed methodology are described in chapter 4.1.2.

IMF's technical assistance

CIT gap estimates are the result of IMF's technical assistance mission in cooperation with analytical body - Institute of Financial Policy at Ministry of finance of the Slovak republic. The mission was led by IMF's expert Mr. Junji Ueda and took approximately six months from October 2016 to March 2017. Whole mission can be decomposed into the 4 following phases:

1. Preparation phase (August – October 2016):
   Before the official start of the mission (in October 2016), IFP discussed the organization details with IMF. IFP received the draft of the methodology and prepared the necessary data that used during later stages of the project.

2. The first visit of IMF (18th of October – 1st of November 2016)
   During this period, the Slovak tax system was presented in detail to the IMF expert, through several meetings with various bodies including the legal department of the Ministry of Finance or Financial Administration representatives. The CIT gap model was filled in with data and the first results were derived.

3. Inter-visit period (November 2016 – March 2017)
   The top-down approach is highly data-intensive. Substantial amount of time was devoted to enhancement and fine-tuning of the CIT gap model and the initial results (i.e. identifying outliers, inconsistencies, and missing data). IMF and IFP had regular conference calls to discuss completed tasks and results.

4. Second visit of the IMF (8th – 14th of March 2017)
   The IMF expert presented the final CIT gap model and preliminary results. These were further updated by the IFP. Preliminary results were discussed with relevant bodies in the country.

Project requirements

High quality data described in detail in chapter 4.1.2 can be considered the main requirement. CIT gap model is filled with data from various databases (individual tax returns, business register and national accounts). Confidential data related to individual corporations was anonymized and a confidentiality agreement was signed with the IMF before the start of the project.

The building of the CIT gap model and data preparation might be intensive in terms of analytical capacities. The IFP committed three full-time analysts for this project. One analyst was fully devoted while two analysts acted as ad hoc consultants. Further involvement was needed in counterparties. Statistical office was regularly contacted to provide the details about national accounts methodology

---

[102] The application of the method in Slovakia was presented by Mr Jaroslav Bukovina (Ministry of Finance of the Slovak Republic) and discussed on Fiscalis TGPG meeting on 16 March 2017.

while Financial Administration provided further necessary data. The regular updates are less intensive as CIT gap model can be handled by one full-time analyst.

In terms of software, majority of individual corporation data was processed in Stata and final CIT gap model works in excel.

Model updates

CIT gap model will be regularly updated on an annual basis. Further updates should be discussed with Statistical Office because national accounts data might be a subject to revision covering previous three years.

Assumptions and adjustments

After careful considerations, the final CIT gap model provides CIT gap estimates for non-financial corporations classified as sector S11 in the national accounts. Sector S12 that covers the financial corporations is not included in CIT gap model due to limited data that measure the added value. Further data constraints can arise from factors like changes in asset prices, changes in value of reserves and allowances or bad debts writing off that might considerably influence financial accounting profit. Entities classified into sectors S13 – S15 were not included as well because it is not straightforward to derive potential CIT base or liability from national accounts data. The "reduction" of scope to S11 sector does not cause a significant bias for CIT gap estimates because this sector counts for approximately 85 % of total CIT revenues while sectors S12 and S13-S15 generate 12 % and 3 % revenues respectively. Furthermore, it is more likely that potential tax evasion due to intentional underreporting of taxable income occurs among non-financial corporations[103] compared to few dozens of banks and insurance companies that make up the Slovak financial sector.

Some national accounts data like inventory valuation adjustments are available only after 2010. Therefore the CIT gap results are available for the period starting from 2010.

In Slovakia, CIT base gap and CIT gap estimates provide the same information about the level of non-compliance. Following the methodology, CIT gap provides more information compared to CIT base gap only if independent data about deduction for carry forward losses and tax credits would be available.

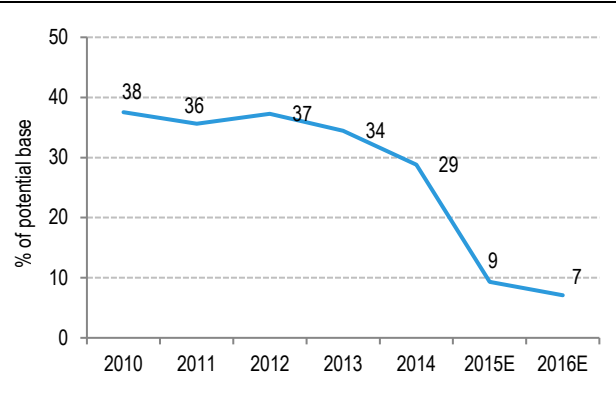**Results – accuracy and reliability**

Employed top-down approach has significant advantage to provide the estimates of non-compliance with currently available data. However, one has to take into account its limits due to employment of statistical data based on various surveys that might be subject to errors or non-responses. Therefore, estimates presented below have to be considered as work in progress or the initial evaluation and deserve a careful interpretation. Slovakia plans to enhance current results with estimates derived by bottom-up approach in a foreseeable future.

The estimated CIT base gap (Figure 5.1) and CIT gap (Figure 5.2) suggest stable reduction of underreported taxable income since 2010. The observed decrease is in the context of implemented measures to fight tax evasion especially on VAT introduced in 2012. Furthermore, reduction of

---

[103] e.g. Financial statements audits are mandatory for larger companies (Limited Liability Corporation or Joint Stock Company needs to meet at least two of the following three conditions: Assets are larger than EUR 1 million; Revenues from profit and services without VAT exceeded EUR 2 million; Corporation has more than 30 employees), Tax administration is not able to audit regularly large portion of corporations or it might select audit targets to achieve more revenues at least in a short run.
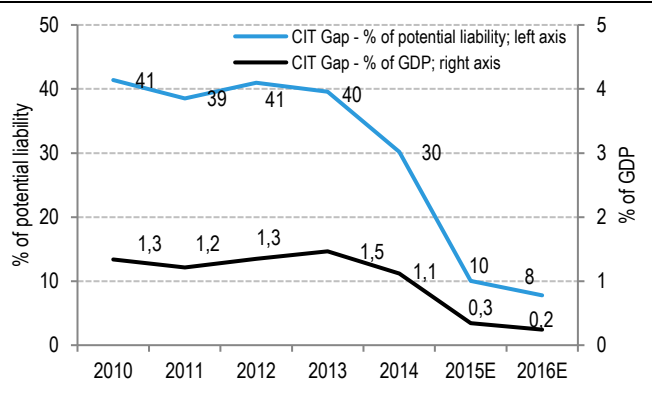
declared tax losses significantly contributed to decreasing tax gap, especially in 2015 and 2016. The introduction of the minimum income tax[104] and the introduction of a publicly available Register of financial statements[105] in 2014 are expected to have changed the motivation to overstate losses, especially for small and medium-sized corporations. When there is a mandatory minimum income tax, corporations are no longer motivated to underreport taxable income to zero or declare tax loss. Similarly, requirements to publicly share financial statements might contribute to voluntary compliance.

Figure 5.1: CIT base gap in non-financial sector (%)

Source: IFP

Figure 5.2: CIT gap[106] in non-financial sector (%)
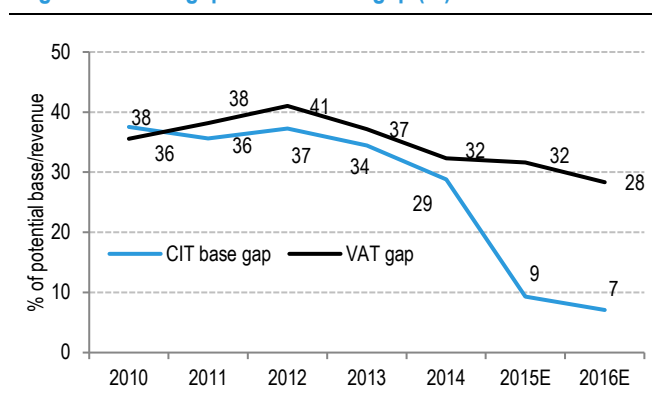

Source: IFP

Considering the reliability and accuracy of estimates, one can distinguish between results for 2010-2014 and 2015-2016. Due to potential revisions of national accounts data only 2010-2014 results can be considered as final, while 2015-2016 might be subject to change as national accounts data can be revised covering previous three years.

Furthermore, considering the limits of the national accounts data, one has to be careful interpreting the most recent estimates for 2015 and 2016. The significant drop of tax gap is supported by factors like the introduction of the minimum income tax, the substantial reduction in declared tax losses and a strong growth of CIT revenues. However, we suspect that a considerable part of the tax gap decrease might be attributed to an underestimated potential CIT base due to data constraints. The evidence for this is also supported by a comparison of the VAT gap and CIT base gap estimates (Figure 3). In Slovakia, for many taxpayers, CIT and VAT bases are overlapping. Moreover, it is much more straightforward to derive VAT base from national accounts compared to CIT. Therefore, the observed discrepancy in levels suggests that the potential CIT base might be underestimated.

---

[104] Remeta et al. (2015): Moving beyond the flat tax – tax policy reforms in the Slovak Republic, *OECD Taxation Working Papers*, No. 22. Available at: http://dx.doi.org/10.1787/5js4rtzr3ws2-en
[105] http://www.registeruz.sk/cruz-public/domain/accountingentity/simplesearch

[106] CIT gap to potential liability (Figure 5.2) is larger than CIT base gap estimate (Figure 5.1). By construction, numerator (potential CIT liability) and denominator (CIT gap) are smaller compared to CIT base gap due to deduction for carry forward losses and tax credits.

Figure 5.3: VAT gap and CIT base gap (%)

Source: IFP

In summary, to properly interpret the CIT gap estimates, one should focus, especially on long-term trend of CIT (base) gap compared to level estimates that might be biased due to data limits. Ministry of Finance intends to complement the analysis with a bottom-up estimate of CIT gap.

5.5. Sweden

a. Description of the method

The Swedish Tax Agency uses a random audit program, which samples sole traders and incorporated companies based on complexity of their declaration and turnover. The types of taxes that are audited are CIT, VAT and social security (payroll) tax.

The goal is to perform 1750 audits in 3 years to enable the collection of enough information for the analysis. The audits differ a bit from the regular audits done by the Swedish Tax Agency. It is expected that the audits take on average 12 days. The audits are conducted according to a certain audit programme that states precisely what the auditor shall look for. Quality controls of the audits are done regularly.

b. Tax evasion, tax avoidance or both?

The Swedish definition of the tax gap is:

"The tax gap is the difference between the tax that would have been determined – if all taxpayers had reported all their activities and transactions correctly – and the tax determined in practice"

The interpretation of 'correctly' is that the taxpayer is not breaking the law, hence tax avoidance is not considered to be part of the tax gap estimate. Tax evasion is covered as well as non-deliberate actions such as errors, omissions or bankruptcies.

c. Assumptions, adjustments, bias corrections, common errors

The assumption is that the sample is representative of the rest of the target population. The auditors who conduct random audits are located in a limited number of offices and therefore the random audits are conducted only in two out of the five "Swedish tax districts". However, previous studies suggested that these two districts are representative for the entire population.

It has been considered to assume that the sample population being representative for all companies but we have come to the conclusion that this assumption will not hold as the errors made in the different companies might be too diverse. It has been also considered grossing up the outcome of our audits with a multiplier to achieve "the entire tax gap" for the audited companies, but it has be understood that such a multiplier would be too uncertain.

d. Descriptions of the results

The Swedish Tax Agency is still in the process of finishing the first of three years of audits. Some interesting results can be seen already. The most common error is private costs deducted by a company. In these cases, the auditors have treated these private costs as salary. Since salary is a deductible expense, it lowers the CIT and therefore gives us a severe negative impact on the corporate income tax gap. However, taking account for VAT, payroll and tax on the employee income the overall impact is positive.

e. Data

As the methodology used is a bottom-up random audit study, data needs are not very hefty. In principle, the needed data are from filed tax declarations, though in addition, some general information about the audited companies is also used but that is of less importance.

Coverage and possible breakdowns

The coverage is limited to sole traders and incorporated companies with a maximum payroll of 50,000,000 SEK (approximately 5,000,000 EUR). To sort out the smallest companies, a turnover threshold of at least 100,000 SEK/year (approximately 10,000 EUR) is used.

When it comes to breakdowns, the Swedish Tax Agency uses a somewhat different approach than other countries. The purpose is not to break-down the results per sector or per region, but per risk area. The objective of the tax gap estimations is to serve as an input to risk assessment process. The random audits provide a good unbiased input on where the biggest risks are.

Resources

About 100 auditors work full time all year round and 2 analysts. We use mostly Excel for calculations and for the selection we use the Swedish Tax Agency's BI-software, Oracle Advanced Analytics.

f. Advantages and disadvantages of the method

Advantages

The big advantage of the method used is that it provides information about the specific errors made by the companies investigated. It is expected that after 3 years of random audits programme the number of audits will be enough to describe the errors found on such a detailed level that the result could be used in regular operations.

Disadvantages

There are two main disadvantages. First, not all the companies are covered as the large companies are missed out. Since the large companies are structured in such a different way than the small and medium size companies, it is not expected to find very much using the same auditing programme.

The second big disadvantage is that audits do not find all errors. Since only limited fast audits are performed and any third party information (for example bank statements) is not used, only a piece of

the tax gap in these companies is captured. If there is for instance any hidden labour or undeclared income, it will probably not be detected. In some cases, auditors might stumble over it in the company's accounting, but in most cases, they will not.

g. Accuracy and reliability

It is considered that what is found is accurate and robust, but what is found with this method is not reliable as a measure of the entire corporate income tax gap. There is a risk that the tax gap estimation resulting from this method will be considered wrongly as an entire tax gap of corporate income tax. In reality, it presents probably only a part of the tax gap of corporate income tax.

5.6. Countries experience based on publicly available information

Contrary to the previous chapters, the following information is exclusively based on publicly available information. This means that some aspects cannot be examined in as much details as for the other country experiences, in particular the costs and resources involved with gaps estimates. In addition, we lack information to discuss advantages and disadvantages of the various methodologies.

5.6.1. The United Kingdom

In the UK, the HM Revenue and Customs is estimating total tax gap, which includes also estimates for Corporate Tax gap. The tax gap estimations and general description of the methodology are presented in publicly available reports.[107] For corporate tax, the UK uses bottom-up methods. Particularly, random enquiries data are employed to estimate SMEs corporate tax gap while, to estimate larger companies' gap, the management information approach and experimental approach are used.

To estimate the tax gap for SMEs, the random audit sample is stratified based on the size of annual trading turnover, which increases the accuracy of the results. A smoothing approach is used as the random audit sample is relatively small and the levels of under-declared liabilities vary naturally year-to-year. Thus, the smoothing is made by using a three-year moving average and for the current year a double weighting is given.. In addition, to reduce year-to-year variability, the outliers with large yields are capped to a value of the mean yield of all settled enquiries.[108]

To estimate corporate tax gap for large companies, the management information approach uses data from risk registers, accounting systems and other databases available in the HM Revenue and Customs. The experimental approach provides illustrative estimates based on the assumptions made by operational experts; this approach is used in cases where limited information is available. The large companies' tax gap is estimated with the help of the case management system used by Large Business Service to support effective management of risk and resources. For the large companies tax specialists use different approaches (including detailed review of companies' accounts and tax returns) to detect possible tax issues and to establish initial estimate of tax under consideration. The tax under consideration is estimated in an initial phase of investigation and it reflects an estimated amount of additional potential tax liability, which however cannot be considered as tax owed or unpaid. The estimated amount of tax under consideration may be modified upwards or downwards depending on

---

[107] HM Revenue and Customs (2017a) 'Measuring tax gaps 2017 edition, Tax gap estimates for 2015-16' and HM Revenue and Customs (2017b) 'Measuring tax gaps 2017 edition, Methodological annex'.
[108] For other adjustments and assumptions used see HM Revenue and Customs (2017b).

the new information revealed during investigation. The corporate tax gap is calculated '*as the difference between tax under consideration and the compliance yield for avoidance risks and technical risks subject to litigation plus an uplift factor*'. The compliance yield represents amount of tax recovered or likely to be recovered due to compliance activities of HM Revenue and Customs. The uplift factor reflects unidentified risks as estimated by Large Business Risk Task Force. The methods used capture both tax evasion and tax avoidance and allows breakdown by, sector, customer group and behaviour. The HM Revenue and Customs publishes the results of tax gaps estimates and updates them annually (most recent estimates are 2015 – 2016).

5.6.2. Australia

Australia, through its Tax Office (ATO) estimated the CIT Gap for the periods 2008-2009 and 2014-2015.[109] The estimation was made public for the first time in October 2017, concerning the 2014-2015 fiscal year. Australia engaged on a tax gap estimation process to measure and publish tax gaps, "*where they are credible and reliable, to inject our perspective into the community debate*" (Australian Taxation Office, 2017), and also because "*Tax gap estimates are also important for us to better understand levels of compliance and risk in the tax and superannuation systems, to inform our resource allocation, and to assess the effectiveness of our work over time. Tax gaps are an indication of the system in operation. The insights gained from this analysis guide us in determining priority risks and development of strategies, including administrative design, help and education, and audit strategies.*" (Australian Taxation Office, 2017)

The tax gap is defined as "*…the difference between the total amount of income tax collected and the amount we estimate would have been collected if every one of these taxpayers was fully compliant*" (Australian Taxation Office, 2017). The estimation does not include the impact of tax concessions or other legislated benefits. The estimation covers only large corporate groups.

The method used is **bottom-up**, illustrative, meaning it gathers expert judgement and knowledge informing the assumptions, risk-based data, including the results of audit, review and related activities (compliance activities), and demographic information extracted from income tax returns in order to estimate the value of under-reported income tax from large corporate groups. The results are extrapolated to estimate a picture of the tax gap across the whole population of large corporate group.

The bottom-up approach is considered most suitable because, "*of the nature of the market, the design of the tax, and the data available*" (Australian Taxation Office, 2017). Top-down methods were discarded because, in ATO's view, "*…there is no independent data source, and so wouldn't enable the resulting estimate to provide a suitably reliable and credible estimate*" (Australian Taxation Office, 2017). In fact, data available at the Australian Bureau of Statistics depends at least partially on ATO data, compromising the independence needed.

Whilst bottom-up methodologies were chosen to estimate the gap, neither statistical methodologies or random audit programs were used because, besides being difficult to implement to achieve credible and reliable results, the cost and required number of random audits make such an approach too costly to implement.

Because the gap concerning this segment of taxpayers primarily reflects differences in the interpretation of complex areas of tax law, including profit shifting (transfer mispricing and thin capitalisation), treatment of offshore income and the use of controlled foreign companies, business

---

[109] Australian Taxation Office (2017).

restructures, and debt–equity tax arbitrage, it captures mainly **tax avoidance**. [110, 111] Concerning this aspect, ATO explicitly states that *"We do not observe that these taxpayers participate in the black economy or related fraud and evasion and, therefore, have not made allowance for the impact of the black economy. We find that large corporate groups lodge income tax returns as required and pay the liabilities that are due"* (Australian Taxation Office, 2017).[112]

5.6.3. Canada

Canada is at the early stages of the process of estimating the Tax Gap and, to date, it still has not published any estimation about CIT Gap. It started with a report ("Tax Gap in Canada: A Conceptual Study")[113] where it analyses the key ideas behind the concept of the tax gap, and sets the grounds on which it intends to understand the benefits and drawbacks of the process of estimating it. This process is seen as can providing "…*insight into the overall health of the tax system and approximate the level of non-compliance with tax laws. They can also act as a guide for tax administrators and enhance the value of the intelligence held by a tax administration on the sources of non-compliance within the tax system*". Canada Revenue Agency defines the tax gap broadly: "*the difference between the tax that would be paid if all obligations were fully met in all instances, and the tax actually paid and collected*" (Canada Revenue Agency, 2016a). It is expected to release soon a report concerning CIT Gap.[114]

5.6.4. Latin America

CIT gap estimates for some Latin America countries can be found in a study[115] published by the Economic Commission for Latin America and the Caribbean (ECLAC), a regional commission of the United Nations. The study highlights the importance of estimating income tax gap as it contributes to design better taxes and find more effective mechanisms to reduce avoidance and evasion. It also compiles estimates of personal and corporate income tax gap for Argentina, Chile, Ecuador, El Salvador, Guatemala, Mexico and Peru. Another study by Trigueros et al. (2013) provides estimates for Colombia and Costa Rica by using a top-down approach. All studies use the operating surplus of national accounts as their starting point, with the adjustments made to determine the taxable base varying from country to country. However, these estimates are limited by several difficulties, mainly due to problems with the quality and availability of data. The authors conclude that, despite these difficulties, there are strong reasons to perform tax gap estimates as they help to improve revenue collection and the ability of governments to carry out their policies to address inequalities and poverty.

---

[110] Source: https://www.ato.gov.au/About-ATO/Research-and-statistics/In-detail/Tax-gap/Large-corporate-groups-income-tax-gap/#Measuringthelargecorporategroupsincometa

[111] Nevertheless, in general, this is not the case in ATO tax gap estimates: "Our estimates solely reflect the gap in compliance with the law and the administrative approaches at the time. The gap includes tax evasion, fraud, incorrect reporting, non-payment of liabilities, non-registration and non-lodgment. It does not include interest charges or penalties.": https://www.ato.gov.au/About-ATO/Research-and-statistics/In-detail/Tax-gap/Principles-and-approaches-to-measuring-gaps/?anchor=Gapestimation#Gapestimation

[112] https://www.ato.gov.au/About-ATO/Research-and-statistics/In-detail/Tax-gap/Large-corporate-groups-income-tax-gap/#MethodologyOverview

[113] Canada Revenue Agency (2016a).

[114] Two other reports were released in 2016, concerning the tax gap related to the goods and services tax ("Estimating and Analyzing the Tax Gap Related to the Goods and Services Tax / Harmonized Sales Tax") and 2017, concerning the Personal Income Tax ("Tax Assured and Tax Gap for the Federal Personal Income Tax System").

[115] Jiménez et al. (2010), Tax Gap and Equity in Latin America and the Caribbean.

5.6.5. USA

The USA estimates the tax gap since long and the estimates are periodically updated. The IRS, the revenue service of the Federal Government of the USA, prepares the tax gap estimates. It is a process they believe is "*…a particular way of defining and analysing compliance and non-compliance (…) for use in formulating tax administration strategies*" (USA IRS).

The last study[116] available covers tax years 2008-2010 and it provides tax gap estimates on individual income tax, CIT, employment tax, and estate and excise tax, both for gross and net tax gap.[117] The result of the estimate shows that CIT gap represents 9.6% of gross tax gap and 8.6% of net tax gap. Total CIT gap is broken into Small Corporations and Large Corporations. Given that no information is provided concerning the methods used on these last estimations, we refer to methodology used for the 2006 tax year estimates (Internal Revenue Service, 2012), where a combination of bottom-up methods were used. To estimate the CIT gap for small companies, two alternative methods were used, which however gave similar results. First approach used risk-based audits results and a model (yield-curve) that relates tax change to audit coverage. In order to capture the amount of non-compliance auditors would detect were they to audit 100% of corporations.

The alternative estimation method employed an econometric model that adjusted for the fact that risk-based audits are not selected randomly, but rather are selected when non-compliance is suspected. This adjustment was made using compliance rates, estimated using data from risk-based audits and a sample of unaudited returns for 2004 tax year (Internal Revenue Service, 2012).

The tax gap estimations for medium-sized and large companies used also audit information, which indicated that large part of tax gap is concentrated in a relatively small number of companies. The method used the extreme values of non-compliances and distribution of audit adjustments to estimate the non-compliance in the rest of the population (Internal Revenue Service, 2012).

5.7. Conclusions

This chapter has shown that CIT gap estimates are being carried out or envisaged in an increasing number of countries. From the practice in Member States, there seems to be a tendency to rely more on bottom-up approaches, often based on audit data. Such methods have the advantage of providing more precision in the estimates, and more importantly to contribute to a better understanding of the cause of a tax gap. However, these estimates are generally available with a non-negligible time lag. Furthermore, it generally focuses on component of the tax gap (and not the overall gap) and is likely to underestimate its extent (focusing mostly on known dimension of tax compliance). Often, it does not cover tax avoidance, except in the methodology relying on propensity score matching. As regards top-down approaches, the IMF has put forward a framework of assessment which is currently applied in Slovakia, as suggested by preliminary results in chapter 5.4, and could be replicated across countries, including Finland. Top-down approaches provide for a global estimate of the tax gap, in a timelier manner, and may be better suited for comparison over time. However, the complexity of the CIT

---

[116] Internal Revenue Service (2016).
[117] The IRS defines two levels of tax gaps: the gross and the net tax gap. The gross tax gap is the amount of true tax liability that is not paid voluntarily and timely. The net tax gap is the gross tax gap less tax that will be subsequently collected (either paid voluntarily or as the result of IRS administrative and enforcement activities).

system calls for numerous adjustments, which may be complex. The proposed methods do not cover tax avoidance either (or only in a limited manner).

General Conclusions

Estimating the CIT gap is an important tool for policy-makers and for tax administrations. Its use goes beyond a measurement of potentially lost tax revenues due to non-compliance. It may also allow understanding the reasons behind non-compliance, assessing the effectiveness of the corporate income tax system or obtaining information on a tax administration's performance.

While gap estimates are valuable and increasingly in demand, they are complex to calculate, in particular for CIT. The specific challenge of CIT owes to the complexity of the system, with often numerous tax expenditures, making it difficult to identify what would have been a counterfactual scenario of perfect tax compliance. Secondly, tax gaps owe to a variety of reasons from deliberate actions by taxpayers (such as fraud, evasion or avoidance) to omissions, errors in interpretations or bankruptcies.

The report shares the practices of CIT gap estimations currently used by Member States and reviews selected methodologies developed by researchers, international organisations and other countries worldwide, and discusses strengths and weaknesses of the methodologies. However, the determination of a harmonised methodology as e.g. called on by European Parliament[118] is not yet feasible at this stage given all differences in the corporate income tax systems, statistical uncertainty and methodological complexities. The main hurdle is the absence of a consensus benchmark.

Very few methods (if any) allow capturing all types of non-compliance. Estimates made at national level often allowed capturing tax evasion, and/or non-deliberate action, but rarely captured tax avoidance, except for one methodology (propensity score matching). There exists however several methodologies that allow estimating the revenues lost at a regional or global level because of tax avoidance, but without capturing other forms of non-compliance.

The methodologies applied can broadly be grouped in two categories: bottom-up methods that start from the specific individual situations that are grossed up to estimate a total tax gap, and top-down approaches that start from macro-economic data based on which the tax gap is estimated based on a discrepancies approach.

Top-down methods are generally more easily replicable across years or countries, but are less precise and offer very little insight into the reasons behind non-compliance. Top-down estimates provide relatively comprehensive estimates of the tax gap. Based on the papers reviewed, they generally cover tax avoidance except for the IMF RA-GAP that covered tax evasion and non-deliberate actions (errors, omissions, etc.).

Bottom-up methods often - but not always - rely on information that is only available to tax administrations (audit results). They generally only cover one aspect of the tax gap, one component of it and therefore do not offer a general estimate of a tax gap of a country. It has the advantage to help understand the reasons for non-compliance, and be more precise in its estimate of components of the tax gap.

---

[118] Motion for a European Parliament Resolution with recommendations to the Commission on bringing transparency, coordination and convergence to Corporate Tax policies in the Union, 2 December 2015. http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A8-2015-0349+0+DOC+XML+V0//EN&language=en

The report provides the elements necessary for tax administrations or any other interested party to identify which methodology they should choose depending on their needs, available data, resources, timeframe.

References

Abbas, S.A., and A. Klemm (2013). A Partial Race to the Bottom: Corporate Tax Developments in Emerging and Developing Economies, *International Tax and Public Finance*, 20(4): 596–617.

Allingham, M. G. and A. Sandmo (1972), Income tax evasion: a theoretical analysis, *Journal of Public Economics*1: 323-338.

Alm, J., J. Martinez-Vazquez and C. Mccellan (2015). Corruption and Firm Tax Evasion, *Journal of Economic Behavior & Organization,* vol. 124, issue C, 146-163.

Australian Taxation Office (2017), Large corporate groups income tax gap. https://www.ato.gov.au/About-ATO/Research-and-statistics/In-detail/Tax-gap/Large-corporate-groups-income-tax-gap/

Bach, S. (2013), Has German Business Income Taxation Raised Too Little Revenue over the Last Decades?, *DIW Berlin Discussion Paper* No. 1303.

Barrios, S., H. Huizinga, L. Laeven, G. Nicodème, 2012, International taxation and

multinational firm location decisions, Journal of Public Economics, 96 (2012), 946-958.

Beer, S., M. Kasper, E. Kirchler, B. Erard (2015), Audit impact study, *2015 Annual Report to Congress*, Taxpayer Advocate Service.

Breusch, T. (2005a), Estimating the Underground Economy using MIMIC Models, Econometrics 0507003, EconWPA, revised 15 Dec 2005.

Breusch, T. (2005b), The Canadian Underground Economy: An Examination of Giles and Tedds Canadian Tax journal, Vol. 53, No. 2, p. 367, 2005.

Breusch, T. (2005c), Australia's Cash Economy: Are the Estimates Credible? Economic Record, The Economic Society of Australia 81 (255), 394-403.

Brown, R., and M. Mazur (2003), IRS's Comprehensive Approach to Compliance Measurement, *National Tax Journal,* 56(3): 689-800.

Bräutigam, R., C. Spengel and F. Streif (2016), Decline of CFC rules and rise of IP boxes: how the ECJ affects tax competition and economic distortions in Europe. Zentrum für Europäische Wirtschaftsforschung GmbH (ZEW), Discussion Paper No. 15-055.

Bushway, S., B.D. Johnson and L.A. Slocum (2007), Is the Magic Still There? The Use of the Heckman Two-Step Correction for Selection Bias in Criminology, *Journal of quantitative criminology*, 23: 151-178.

Canada Revenue Agency (2016a), Tax Gap in Canada: A Conceptual Study.

Canada Revenue Agency (2016b), Estimating and Analyzing the Tax Gap Related to the Goods and Services Tax/Harmonized Sales Tax.

Canada Revenue Agency (2017), Tax Assured and Tax Gap for the Federal Personal Income Tax System.

Cobham, A. and P. Janský (2015), Measuring Misalignment: the Location of US Multinationals' Economic Activity versus the Location of their Profits, *International Centre for Tax and Development Working Paper*, 2015(42). Brighton: Institute of Development Studies.

Cobham, A. and P. Janský (2017), Global distribution of revenue loss from tax avoidance: Re-estimation and country results, *WIDER Working Paper* 2017/55. Helsinki: UNU-WIDER

Collins, J., D. Kemsley and M. Lang (1998), Cross-jurisdictional income shifting and earnings valuation, *Journal of Accounting Research*, 36: 209–29.

Crivelli, E., R. de Mooij and M. Keen (2015), Base Erosion, Profit Shifting and Developing countries, *IMF Working Paper* 15/118.

Davies, R.B. (2004), Tax Treaties and Foreign Direct Investment: Potential versus Performance, *International tax and Public Finance,* 11: 775-802.

Dharmapala, D. (2014), What do we know about Base Erosion and Profit Shifting? A review of the empirical literature, *Fiscal Studies*, 35(4): 421-448.

Dover, R., B. Ferrett, D. Gravino, E. Jones and S. Merler, (2015), Bringing transparency, coordination and convergence to corporate tax policies in the European Union, I – Assessment of the magnitude of aggressive corporate tax planning, *Research Paper prepared for the European Parliament Research Service*.

Dyreng, S. and K. Markle (2013), The effect of financial constraints on tax-motivated income shifting by US multinationals, *Duke University and University of Waterloo, Working Paper*.

Egger, P., W. Eggert and H. Winner (2010), Saving Taxes through Foreign Plant Ownership, *Journal of International Economics*, 81: 99–108.

Erard, B., B. Erard and Associates & Chih-Chin Ho (2002), Developing an econometric model for measuring tax noncompliance using operational audit data, *Internal Revenue Service, Presented at the 2002 American Statistical Association*.

Erard, B. (2002), Compliance measurement and workload selection with operational audit data, *IRS Research Conference Report*, June 2002.

Feinstein, J. S. (1990), Detection Controlled Estimation, *The Journal of Law and Economics,* 33(1): 233-276.

Feinstein, J. S. (1999), Approaches for estimating noncompliance: Examples from Federal Taxation in the United States, *The Economic Journal*, 109: 360-369.

Finke, K. (2013), Tax Avoidance of German Multinationals and Implications for Tax Revenue Evidence from a Propensity Score Matching Approach, *mimeo*.

Fiorio C. V. and F. D'Amuri (2005), Workers' Tax Evasion in Italy, *Giornale degli Economisti e Annali di Economia, Nuova Serie*, 64 (Anno 118).

Fiscalis TGPG (2016), The Concept of Tax Gaps, Report on VAT Gap Estimations by FISCALIS Tax Gap Project Group (FPG/041), March 2016, https://ec.europa.eu/taxation_customs/sites/taxation/files/docs/body/tgpg_report_en.pdf

Franzoni L. A. (1998), Tax Evasion and |Tax Compliance, *Encyclopedia of Law and Economics*. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=137430

Glaeser, E. and A. Shleifer (2002), Legal Origins. *Quarterly Journal of Economics*. 117: 1193–1229.

Gemmel, N. and J. Hasseldine (2012), The Tax Gap - A Methodological Review, *Working Paper 09/2012 in Public Finance*, Victoria Business School, University of Wellington.

Gravelle, J. (2013), Tax Havens: International Tax Avoidance and Evasion, *CRS Report for Congress, Congressional Research Service*, January 2013 (first issue) and January 2015 (second issue).

Habu K. A. (2016), How aggressive are foreign multinational companies in avoiding corporation tax? Evidence from UK confidential corporate tax return, https://www.sbs.ox.ac.uk/sites/default/files/Business_Taxation/Events/conferences/symposia/2017/habu_how_aggressive_are_foreign_multinationals..pdf

Heckemeyer, J. and M. Overesch (2013), Multinationals' Profit Response to Tax Differentials: Effect Size and Shifting Channels, *ZEW Discussion Paper* No. 13-045.

Heckman, J. J. (1979), Sample Selection Bias as a Specification Error, *Econometrica,* 47, 153–161.

HM Revenue and Customs (2016 a), Measuring tax gaps 2016 edition, Tax gap estimates for 2014-15,

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/561312/HMRC-measuring-tax-gaps-2016.pdf

HM Revenue and Customs (2016 b), Measuring tax gaps 2016 edition, Methodological Annex, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/561314/HMRC-measuring-tax-gaps-2016-methodological-annex.pdf

Huizinga, H., L. Laeven and G. Nicodème (2008), Capital structure and international debt shifting, *Journal of Financial Economics,* 88 (1): 80-118.

Internal Revenue Service (2016), Tax Gap Estimates for Tax Years 2008–2010.

Internal Revenue Service (2012), Tax Year 2006 Tax Gap Estimate – Summary of Estimation Methods, January 2012.

Johansson A., Ø. Bieltvedt Skeie, S. Sorbe and C. Menon (2017), Tax planning by multinational firms: firm-level evidence from a cross-country database, *Economics Departments Working Papers* No. 1355, OECD.

Katz, S. P., U. Khan, and A. Schmidt (2013), Tax Avoidance and Future Profitability, *Columbia Business School Research Paper* No. 13-10.

Keen, M., V. Perry, R. de Mooij, T. Matheson, R. Schatan, P. Mullins and E. Crivelli (2014), Spillovers in International Corporate Taxation, *IMF Policy Paper*, May 9, 2014.

Klassen, K. J. and S. K. Laplante (2012), Are U.S. multinational corporations becoming more aggressive income shifters? *Journal of Accounting Research*, 50: 1245–85.

Louvot-Runavot, C. (2011) L'évaluation de l'activité dissimulée des entreprises sur la base des contrôles fiscaux et son insertion dans les comptes nationaux INSEE, *Documents de travail G 2011/09*, MAI 2011.

Magzhan, K. and H. M. Jani (2013), A review and evaluations of shortest path algorithms, *International journal of scientific & technology research*, 2(6): 99-104.

Mazur, M. and A. Plumley (2007), Understanding the tax gap, *National Tax Journal*, 60: 569–576.

Medina, L. and F. Schneider (2017), Shadow Economies Around the World: What Did We Learn Over the Last 20 Years? IMF Working Paper, WP18/17.

OECD (2007), Fundamental Reform of Corporate Income Tax, OECD Tax Policy Studies no 16.

OECD (2015), *Measuring and Monitoring BEPS, Action 11: 2015 Final Report*, Paris.

OECD, Glossary of Tax Terms, http://www.oecd.org/ctp/glossaryoftaxterms.htm.

Remeta, J, S. Perret, M. Jareš and B. Brys (2015): Moving beyond the flat tax – tax policy reforms in the Slovak Republic, *OECD Taxation Working Papers*, No. 22.

Risk Management Platform (2012), Tax Gap and Compliance Map Report, FISCALIS programme, not published report.

Robina A.A. and M. Rider (2008), Pakistan's Tax Gap: Estimates by Tax Calculation and Methodology.

Rubin, M. (2011), The practicality of a top-down approach to the direct tax gap, *HMRC, Working Paper* n.12, 2011.

Swedish Tax Agency (2008), Tax Gap Map for Sweden - How was it created and how it can be used, *Report_2008_1B*.

Swedish Tax Agency (2014), The Development of the Tax Gap in Sweden 2007-12, *Report 2014*: https://www.skatteverket.se/download/18.15532c7b1442f256baeae28/1395223863657/The+development+of+the+tax+gap+in+Sweden+2007-12.pdf

United States Government Accountability Office (GAO) (2012), *Tax Gap: Sources of Noncompliance and Strategies to Reduce It*, *GAO-12-651T*, Washington DC:GAO.

van't Riet, M. and A. Lejour, (2017), Optimal Tax Routing: Network Analysis of FDI Diversion, CentER Discussion Paper, Vol. 2017-022), Center for Economic Research, CentER, Tilburg.

Glossary

Base spillover   Base spillover refers to impact of one country's policy on other countries' tax bases.

Bottom-Up   Bottom-up methods rely on data obtained from individual taxpayers, mostly by means of surveys or audits, and build from these individual data, estimates for the tax gap in the economy as a whole. They are also called "micro" or "direct" methods.

CBCR   A Country-by-Country Report includes information for every tax jurisdiction in which a multinational group does business on the amount of revenue, the profit before income tax, the income tax paid and accrued, the number of employees, the stated capital, the retained earnings and the tangible assets.

Compliance gap   Compliance gap is used as a synonymous of tax gap for this report (see tax gap).

NOE   The Non-Observed Economy, or NOE, refers to all productive activities that may not be captured in the basic data sources used for compiling national accounts. The following activities are included: underground, informal (including those undertaken by households for their own final use), illegal, and other activities omitted due to deficiencies in the basic data collection program.

Policy gap   Policy gap is defined as the difference between the total amounts of tax theoretically collectable under the general rules of tax law (i.e. if no exemptions, etc. would apply) and the total amounts of tax theoretically collectable based on the applicable tax law.

Profit shifting   Allocation of income and expenses between related corporations or branches of the same legal entity (e.g. by using transfer pricing) in order to reduce the overall tax liability of the group or corporation[119]. Risk based audits   Also called "Operational audits", they are audits performed by the tax administration on taxpayers selected on the basis of risk criteria; they are not performed for tax gap analysis purposes but are part of the ordinary activity of the administration.

Strategic spillover   Strategic spillover refers to the impact of tax changes abroad on one country's policy choices.

Tax ruling   Tax ruling is a confirmation or assurance that tax authorities give to taxpayers on how their tax will be calculated. Tax rulings are mostly given in advance of the transaction taking place or a tax return being filed.

Tax avoidance   Tax avoidance refers to a company's legal arrangement to reduce actual tax liability, which is within the letter of the law but however is in contradiction

---

[119] Source: Glossary of Tax Terms.

	with the intent of the law. It includes debt shifting, strategic transfer pricing and location of intangibles.
Tax evasion	Tax evasion comprises illegal arrangements where liability is hidden or ignored.
Tax fraud	Tax fraud is a form of deliberate evasion which is generally punishable under criminal law. The term includes situations in which deliberately false statements are submitted or fake documents are produced.
Tax gap	Tax gap is the difference between tax revenue as it "should be" and as "it is" collected, for a given period and in a given jurisdiction or region. Tax gap is used as a synonymous of compliance gap for this report.
Top-down	A top-down method relies either on macroeconomic indicators or data from a country's national and financial accounts to estimate the theoretical tax liability or to identify discrepancies that can only be explained by the presence of economic activities which are not adequately reported to or observed by the tax authorities. It is also referred to as the macro or indirect method.

Annex I - List of participants

Country	Name of participant	Administration
BELGIË / BELGIQUE (Belgium)	Mr Geert VAN REYBROUCK	Federal Ministry of Finance, Belgium
	Mr Adriaan LUYTEN	Federal Ministry of Finance, Belgium
БЪЛГАРИЯ (Bulgaria)	Ms Vesela KOSTADINOVA	National Revenue Agency
ČESKÁ REPUBLIKA (Czech R.)	Ms Adela KELNEROVA	Ministry of Finance of the Czech Rep.
	Ms Jana STAVJAŇOVÁ	Ministry of Finance of the Czech Rep.
DANMARK (Denmark)	Mr Henrik MARKOCIEJSKI	Danish Tax Authority (SKAT)
DEUTSCHLAND (Germany)	Ms Stefanie KNOTH	Federal Ministry of Finance Germany
ESPAÑA (Spain)	Mr Ramiro LEDO ARIAS	Agencia Estatal de Administración Tributaria
ITALIA (Italy)	Mr Stefano PISANI	Agenzia delle Entrate (Italian Revenue Agency)
	Ms Marta GALLUCCI	Agenzia delle Entrate (Italian Revenue Agency)
	Mr Paolo DI CARO	The Italian Ministry of Economy and Finance
LATVIJA (Latvia)	Ms Natalija FILIPOVICA	The State Revenue Service of the Republic of Latvia
	Ms Marina ROJA	The State Revenue Service of the Republic of Latvia
LIETUVA (Lithuania)	Ms Jolita IVANAUSKIENĖ	State Tax Inspectorate Under the Ministry of Finance of the Republic of Lithuania
MAGYARORSZÁG (Hungary)	Mr András SVRAKA	Ministry for Finance
NEDERLAND (Netherlands)	Mr Hans RIJSBERGEN	Belastingdienst (Netherlands Tax and Customs Administration)

	Mr Sjoerd GOSLINGA	Belastingdienst (Netherlands Tax and Customs Administration)
POLSKA (Poland)	Mr Tomasz MAZUR	Ministry of Finance, Poland
PORTUGAL (Portugal)	Mr Miguel MARTINS	Risk Management Unit Portuguese Tax Authority
SLOVENSKO (Slovakia)	Mr Jaroslav BUKOVINA	Ministry of Finance of the Slovak republic
SUOMI (Finland)	Mr Aki SAVOLAINEN	Finnish Tax Administration
SVERIGE (Sweden)	Mr Robin NILSSON	Swedish Tax Agency
EUROPEAN COMMISSION	Mr Gaëtan NICODEME	Directorate General Taxation and Customs Union
	Ms Astrid VAN MIERLO	Directorate General Taxation and Customs Union
	Mr Cristian LARGEANU	Directorate General Taxation and Customs Union
	Mr Tanel PUETSEP	Directorate General Taxation and Customs Union
	Ms Catrine BOOGH-DAHLBERG	Eurostat
	Ms Hionia VLACHOU	Eurostat

Annex II - List of presentations and speakers

I.   Meeting: 28 September 2016, Brussels
- Mr Uwe Ihli (European Commission, DG TAXUD): Anti-Tax Avoidance Directive and upcoming Commission initiatives;
- Mr Gaëtan Nicodeme (European Commission, DG TAXUD): Introduction to available methods;
- Mr Juan Toro (IMF): the RA-GAP programme for CIT.

II.   Meeting: 17 January 2017, Brussels
- Prof Michael Overesch (University of Cologne): Multinationals' profit Response to tax differentials: Effect size and shifting channels;
- Mr Gaëtan Nicodeme, (European Commission, DG TAXUD): Capital structure and international debt shifting;
- Mr Ruud de Mooij (IMF, video conference): Spillovers in International Corporate Taxation;
- Mr Ruud de Mooij (IMF, video conference): Base Erosion, Profit Shifting and Developing countries.

III.   Meeting: 16 March 2017, Belgian Federal Ministry of Finance, Brussels
- Mr Junji Ueda (IMF, Fiscal Affairs Department): RA-GAP Corporate income tax gap estimation methodology;
- Mr Jaroslav Bukovina (Ministry of Finance of the Slovak Republic) application of RA-GAP CIT gap estimation methodology in Slovakia;
- Mr Tanel Puetsep (DG TAXUD) overview on the work of Fiscalis Tax gap project group on VAT fraud (MTIC) estimation methodologies.

IV.   Meeting: 10 May 2017, Brussels.
- Ms Katharina Nicolay (University of Mannheim): Tax Avoidance of German Multinationals and Implications for Tax Revenue, Evidence from a Propensity Score Matching Approach;
- Mr Henrik Markociejski (SKAT – Danish Tax Authority): Corporate tax gap estimation in Denmark;
- Mr Robin Nilsson (Swedish Tax Agency): Tax gap maps for Sweden;
- Mr Stefano Pisani (Italian Revenue Agency): Bottom-up estimates of Tax Gap by the Italian Revenue Agency;
- Ms Marta Gallucci (Italian Revenue Agency): Methodology to estimate CIT gap in Italy;
- Mr Martins José Miguel Barbosa (Portuguese Tax Authority): Overview on methodology used by Lee et al (2015) 'Re-examining the tax Gap, the Tax Gap in the MSCI world'.

V.   Meeting: 20 June 2017, Berlin.
- Ms Giorgia Maffini (OECD): Tools for Tracking Avoidance;

- Mr Christian Kastrop (OECD): Tax planning by multinational firms: firm-level evidence from a cross-country database;
- Mr Maarten van 't Riet (CPB Netherlands Bureau for Economic Policy Analysis): Optimal Tax Routing: Network Analysis of FDI diversion.

VI.   Meeting: 12 October 2017, Lisbon
- Presentation and discussion on draft report

VII.   Meeting 13 December 2017, Brussels
- Presentation and discussion on draft report

Annex III: Risk-based audits

1. Database

Data derived from risk-based audits should contain as much information as possible in order for the derived tax gap estimation to be the most informative. More specifically, the database should contain all the available information related to the audited taxpayer. For example, for the CIT, it should contain the declared and undeclared tax base and tax but also data on single components of the tax base (e.g. operating income, revenues, purchases, labour costs, etc.). Apart from administrative and fiscal data, the database should also contain information related to socio-economic characteristics of the firm/taxpayer that is directly connected to the audit selection process (e.g. sector of economic activity, firm size, business dimension, firm type). For this purpose, external data sources[120] can also be used.

Timing is also a very important feature of the database. Given the characteristics of audited process, data from risk-based audits are available with some time lag with respect to the audited tax year. It is crucial to classify information based on audited tax year instead of audit year: in other words, for tax gap estimation purposes, what is relevant is the year for which the taxpayer is being audited, not the year in which the audit takes place. Moreover, data should be included in the estimation only when the audit process is fully complete, i.e. when all the possible information on the firm has been used to derive the evaded tax base/tax.

Some approaches, like the Heckman model (see below) explicitly address the selection bias inherent in risk-based audit data, so that when applying these methodologies a preliminary assessment on the rules adopted to select the audited taxpayers (risk score) is performed. To do so, information on structural characteristic of the taxpayers (e.g. starting date of the activity, number of employees, etc.) and key performance indicators (e.g. mark up, productivity, inventory turnover) are needed.

2. Data pre-processing

Statistical analysis of the database

The preliminary step for every successive analysis is the exploration and summary of the available information by means of descriptive statistics, with some specific attention devoted to the study of the audit database. This can give useful insight not only on what kind of data is available but also on the statistical tools more suitable for its treatment.

Treatment of outliers

The aforementioned analysis allows to identify extreme values, or outliers, in the database. These can stem from reporting errors but also derive from exceptional cases, such as an audit on a very big firm. In both cases, data cleaning is necessary since also "real" outliers cannot be considered representative of the whole population and their involvement in the estimation process can produce biased results. This means that bigger firms are to be treated separately from the other subjects, due to their

---

[120] For example, additional information available within the tax administration (information not included in the audits database but relevant for the analysis) and information provided by other administrations following data exchange programmes.

structurally different features, always taking into account the context specificities: for example, if full coverage of this subset of population is possible, then it may be excluded from the grossing up procedure.

Identification of the main cluster

Once data cleaning has been performed, regularities in the data may lead to the identification of homogenous groups of taxpayers based on a few key features.

3. Estimation approaches

i.   The post stratification approach

Post stratification is based on a fairly simple concept: if you can divide taxpayers (both audited and non-audited) in subgroups (strata) using variables that are relevant in the selection process (e.g. dimension of firms, region, sector of economic activity) then you can assume that there is no selection bias within each stratum and compute the total tax gap as the sum of strata estimates, obtained by grossing-up audited figures using an appropriate coefficient.

Identification of the strata;

Stratification variables are to be chosen among available information in order to approximate as well as possible the selection criteria adopted in the auditing process. This could be done either according to experts' judgement (e.g. tax inspectors may provide a list of critical variables) or by means of a statistical or econometric models to identify significant variables.

The grossing up procedure

The grossing up factor (w_i) for the i-th stratum is defined as the inverse of the sampling (or inclusion) probability p_i:

$w_i = 1/p_i$

The sampling probability p_i can be computed in terms of number of taxpayers:

$p_i = n_i/N_i$

where n_i is number of audited taxpayers and N_i is the total number of taxpayers in the i-th stratum, thus obtaining a "demographic" parameter. This corresponds to assume that the "tax per taxpayer ratio" is uniform within each stratum. As an alternative, a "monetary" parameter can be defined by adopting a sampling probability definition in terms of declared tax:

$p_i = t_i/T_i$

where t_i is amount of declared tax by audited taxpayers and T_i is the total amount of declared tax in the i-th stratum. In this case, different weights can be associated to different taxpayers. These two parameters can also be combined in a mixed factor.

Weakness and strength of the method

The methodology is easy to implement once data pre-processing has been successfully performed and it can be used to obtain a first insight on the phenomenon. However, since it only partially corrects for selection bias, obtained results are not completely reliable.

ii. The Heckman approach

a) general remarks about the applicability of Heckman's model to tax gap estimation

When estimating tax gaps using results of non-random risk-based audits, sample selection bias arises because the selection process for audits is based on an estimate of the risk of non-compliance. The audit selection mechanism hence generates endogeneity in the sub-sample of audited firms. There are a number of econometric models that take this bias into account. Most of them are based on the seminal work of Heckman (1979).

The Heckman two step estimator corrects for sample selection bias by estimating both the selection process and the outcome variable in the same model. Hence the model consists of two equations: the selection equation and the outcome equation. The selection equation specifies the probability that an observation will be included in the sample. This equation is estimated in a Probit regression. The outcome equation models the variable of interest as a function of explanatory variables and a regressor that controls for the selection bias. This latter regressor is the inverse Mills ratio, and can be calculated from the estimated parameters of the selection equation. The outcome equation can be estimated by an OLS regression, including, as a regressor, a factor calculated in the first stage equation.

Mathematically, Heckman's two step estimator can be summarized as follows. The outcome equation specifies the level of non-compliance Y_i of taxpayer i as a function of taxpayer characteristics X_i:

$$Y_i = \beta' X_i + \epsilon_i$$

However, the value of Y_i is only observed if taxpayer i was selected for an audit $(S_i = 1)$. The probability of selection for audit can be estimated using the following probit model:

$$S_i^* = \beta_S' X_{si} + \epsilon_{Si}$$
$$with\ S = \begin{cases} 1 & if\ S_i^* > 0 \\ 0 & if\ S_i^* \leq 0. \end{cases}$$

The combination of the above equations allows one to model non-compliance as a function of taxpayer characteristics and the fact that the taxpayer was selected for audit:

$$E(Y_i|X_i, X_{Si}) = \beta' X_i + E(\epsilon_i | \beta_S' X_{Si} + \epsilon_{Si} > 0)$$
$$E(Y_i|X_i, X_{Si}) = \beta' X_i + E(\epsilon_i | \epsilon_{Si} > -\beta_S' X_{Si})$$

If the error terms ϵ_i and ϵ_{Si} are bivariate normally distributed, then

$$E(\epsilon_i | \epsilon_{Si} > -\beta_S' X_{Si}) = \rho \sigma_\epsilon \left(\frac{\phi(\beta_S' X_{Si})}{\Phi(\beta_S' X_{Si})} \right).$$

The latter expression, termed the inverse Mills ratio, can be obtained from the results of the probit estimation of the selection equation. When this inverse Mills ratio is included as a control variable in the outcome equation, the outcome model can be estimated without bias using an ordinary least squares method.

Two caveats apply in particular when using the Heckman approach to estimate the tax gap. First, the selection equation should have substantial explanatory power. Because the Heckman two step estimator is applied to obtain predicted values of non-compliance (rather than regression coefficients), the quality of the estimates hinges to a large extent on the explanatory power of the selection equation. Second, the selection equation should include at least one explanatory variable that does not affect non-compliance (the "exclusion restriction"). If not, the model may suffer from strongly inflated

standard errors caused by multicollinearity. In the context of tax gap estimation, this means that data on at least one determinant of selection for audit that is not related to the magnitude of non-compliance is required. When the selection for audit is exclusively based on estimated non-compliance, it may be difficult to find such a variable.

b) Specification of the selection equation

The choice of the appropriate model to estimate the selection equation depends on the level of discretion that auditors have when they decide which firms to audit and in which order. In one extreme, the selection is entirely done by the central administration (top-down). In the other extreme, the selection is left largely to the discretion of the auditors (bottom-up).

In top-down selection processes, the selection is usually the result of a data mining process. The central administration supplies each auditor with a list of firms to audit, and also specifies in which order the audits must be carried out. The priority rank is important in case the audit capacity is not sufficient to handle the entire list. The advantage of a top-down selection process is that it can be closely approximated in the selection equation, as there are no unobservable characteristics that affect selection. This increases the explanatory power of the selection equation, which results in more reliable estimates. However, under a top-down selection process it will be more difficult to satisfy the exclusion restriction. This will especially be the case if the selection is entirely based on estimated risk of non-compliance.

In bottom-up selection processes, auditors pick their targets based on perceived risk of non-compliance. Even though the auditor's assessment is presumably based on the records of the firm in question, one should take into account that the auditor's decision may be affected by unobservable characteristics. Feinstein (1999) describes how the Heckman model can be altered to take the role of expert judgement into account.

c) Specification of the outcome equation

The outcome equation specifies the result of the audit as a function of firm characteristics and tax return data. The dependent variable in this equation can either be the tax supplement or the change in the tax base resulting from the audit.

The explanatory variables are the characteristics of the firm or the tax return that signal non-compliance. Erard (2002) suggests a backward variable selection methodology to select an adequate set of explanatory variables: The analyst starts by identifying all tax return lines and firm characteristics that are potentially associated with non-compliance. Next, the outcome variable is estimated using all identified explanatory variables. After eliminating the variable with the smallest t-statistic, the model is re-estimated. This process is repeated until all remaining explanatory variables have a t-statistic that exceeds a minimum threshold.

d) Strengths and weaknesses of the model

Bottom-up approaches of estimating the tax gap have several advantages. First of all, risk-based audits produce the most precise figures on non-compliance. Furthermore, detailed information on taxpayers allows a breakdown of the tax gap by sector, region, type of firm, etc. In combination with the audit

reports, one can also investigate which types of fraud are most prevalent in a particular sector, region, etc. The Heckman approach allows exploiting all these advantages of bottom-up tax gap estimation even if audits are non-random.

The suitability of the Heckman approach to estimate the tax gap largely depends on operational and organizational aspects of the audit process. If audits are narrow in scope (e.g. limited to the underreporting of income) or targeted at a specific sector or type of firm, it will be difficult to get a reliable estimate of the tax gap.

A shortcoming of the Heckman approach (and of bottom-up approaches in general) is that it produces estimates of the tax gap that are biased downwards. The audit reports indicate to what extent the audited tax returns are in line with the administration's interpretation of tax rules. Tax avoidance is hence left largely untouched. Furthermore, it is possible that non-compliance remains partially undetected in the course of an audit. Finally, only registered tax payers can be selected for an risk-based audit.

Annex IV: Survey questionnaire

The following questionnaire was sent to all EU Member States:

Name of your country, institution:

1. Does your country estimate corporate income tax (CIT) gap or is planning to estimate it in the future (please indicate an expected date)?

2. Which method is used by your country to estimate the CIT Gap? In case, various methodologies are used, please tick all relevant boxes.

   ☐ Top-down

   ☐ Bottom-up

   ☐ Others:……

   Please give a short description for each methodology used. How is the calculation made? Which data are used?

3. Does the used method measure:

   ☐ tax evasion, or

   ☐ avoidance or

   ☐ both

4. Does the used method cover all types of companies or only a subset (e.g. large companies, SME, etc.)?

5. Who prepares the estimations (e.g. Ministry of Finance, Tax Authority, National Statistical Office or outsourced to contractor)?

6. What and how much resources are required (e.g. time, headcount (fte), software)?

7. How regularly are the estimates updated?

8. What is the last tax year for which the estimates are available? What is the time difference between the release of estimates and the reference year of the estimates?

9. Are the methodology and estimates published? If possible please indicate the link to the website?

10. What are the main issues and/or disadvantages of the methodology used?

11. Which assumptions are used and which bias corrections are applied?

12. Is it possible to break-down the results per sector, per region or otherwise?

Annex V: Summary of research papers discussed in the report

Chapter	Research paper	Overview on the method used	Method	Scope of gap	Data
4.1.4.	Crivelli et al. (2015), Base Erosion, Profit Shifting and Developing countries. (IMF)	The paper develops a method to distinguish between base spillovers effects through real investment decisions and through profit shifting, and to quantify the revenue costs of the latter. The paper uses a panel of 173 countries over 1980–2013 to estimate the magnitude and nature of BEPS using regression analysis. The empirical strategy is based on a theoretical model and the main variable of interest is the effect of the tax rates in the rest of the world on a country's tax base.	Top-down	Avoidance, Multiple countries.	Tax rates, revenues and other economic indicators from publicly available data from IMF[121] and the World Bank.[122]
4.1.5.	Keen et al. (2014), '*Spillovers in International Corporate Taxation*', (IMF)	To measure the impact of cross-border tax effects on country's CIT tax revenues, the CIT efficiency concept (a ratio of actual tax revenue to theoretically collectable amount) and by using Gross Operating Surplus (GOS) data, which is considered as tax base. The loss is estimated by comparing the actual CIT revenues with (simulated) CIT revenues without profit shifting. The weighted average CIT efficiency is assumed to be the benchmark reference for calculating the revenues without profit shifting. Revenue without profit shifting for a country is estimated by multiplying its CIT rate, GOS and an average CIT	Top-down	Avoidance and evasion, Multiple countries.	The GOS of corporations is based on the NA data from the UN Statistics division. Data on tax rates and CIT revenues come from the

[121] IMF Fiscal Affairs Department, World Revenue Longitudinal Data: http://data.imf.org/?sk=77413F1D-1525-450A-A23A-47AEED40FE78 and International Financial Statistics (IFS): http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B

[122] World Development Indicators (WDI): https://data.worldbank.org/data-catalog/world-development-indicators

		efficiency of the countries (Ē) (weighted by GOS).			IMF's Fiscal Affairs Department tax and revenue database.
4.2.3.	Finke 2013, '*Tax Avoidance of German Multinationals and Implications for Tax Revenue Evidence from a Propensity Score Matching Approach*'	The paper gives a method to estimate profit shifting of MNE in Germany through microeconometrics tools. Particularly it uses a propensity score matching approach between MNE and domestics firms to get an estimation of the profit shifting and to make a correction of the self-selection bias. Also, it uses a probit model with firm characteristics, as exogenous variables, to obtain the probability to incur in tax avoidance, a necessary step to make the matching between firms. This work is closely related to the paper of Egger et al. (2010), who use the same tools but to estimate BEPS of MNE in all Europe (with the AMADEUS database) and use regional characteristics instead of firm characteristics.	Bottom-up	Avoidance, Single country (Finke 2013); Multiple countries (Egger et al. 2010).	Microdata of German enterprises from DAFNE database of Bureau Van Dijk.
4.2.4.1.	Johansson, et al. (2017) '*Tax planning by multinational firms: firm-level evidence from a cross-country database*',	To analyse profit shifting, the paper uses the within group tax rate differentials, while the effects of mismatches between tax jurisdictions and preferential tax treatment is assessed by comparing the effective tax rate (ETR) of multinational group to the ETR of a domestic entity on its reported profit. The results are based on regression coefficients. To estimate the profit shifting, the effects on firm profitability are estimated using an equation which defines the "observed" profit as sum of the "true" profit (the potential one) and the shifted profit (as	Bottom-up	Avoidance, Multiple countries	Firm level data from ORBIS, which is compiled by Bureau van Dijk.[123]

---

[123] See https://www.bvdinfo.com/en-us/our-products/company-information/international-products/orbis .

	(OECD)	consequence of tax planning strategies). With this information the procedure uses a panel data model with the profitability as dependent variable, and the "true" and shifted profit as regressors.			
4.2.4.2.	Huizinga, et al. (2008), '*Capital structure and international debt shifting*'	The method analyses how much a multinational company's capital structure (debt vs equity financing) in a country depends on a weighted average of the national tax rate and differences between national and foreign tax rates. The paper presents a regression model of the optimal overall capital structure of multinational firm reflecting tax and non-tax factors and the evidence on the impact of taxation on firm indebtedness for a sample of 32 European countries over the period 1994 through 2003 using a firm-level data (AMADEUS). The study finds that the capital structure of a company depends on the national tax rates and debt shifting occurs towards high tax rate countries.	Bottom-up	Avoidance, Multiple countries	firm-level data from AMADEUS database. Information on statutory tax rates from International Bureau of Fiscal Documentation (IBFD) and various ministries.
4.2.4.3.	Heckemeyer, J. and M. Overesch (2013), '*Multinationals' Profit Response to Tax Differentials: Effect Size and*	The paper establishes a consensus estimate for the scale of profit shifting activity by analysing the existing evidence on tax elasticity of reported parent or subsidiary profits. The meta-analysis is undertaken as the empirical literature offers robust evidence on the reported profit responsiveness to international differences in corporate tax rates but the literature do no provide consensus estimate for the magnitude of this elasticity. The paper used meta-regression method to analyse 27 previously made studies, which include 203 estimates of MNEs' profit response to international tax rate differentials. The studies selected for	Bottom-up	Avoidance, Multiple countries	Meta-analysis uses 27 studies, which includes 203 estimates of MNEs' profit response to international tax rate differentials. The 27 studies

	Shifting Channels'	this meta-analysis exclusively estimate the empirical relationship between reported profitability of parent or subsidiary entity and profit-shifting incentives. The study explains the heterogeneity in empirical findings. The depended variable is the tax semi-elasticity[124] of reported profits estimated by previous studies. Variables reflect study characteristics (data sample characteristics, econometric specification etc).			used six different databases.
4.3.	van 't Riet, M., & Lejour, A. (2017), '*Optimal Tax Routing: Network Analysis of FDI Diversion'*	The paper uses the data of 108 jurisdictions in 2013 to estimate the "shortest paths" that can be used by multinational enterprises that seek to minimise tax payments, through treaty shopping, when repatriating profits. The empirical strategy constructs the indicator based on the network approach to international taxation where the links of the network are given as the cost of channelling corporate income from one country to another in terms of the lowest taxes to be paid. In particular, the tax payments are constructed from the corporate statutory rates, withholding taxes on dividends and the double tax relief methods. The results of the network analysis (the bilateral tax rates minimizing the tax costs and centrality measures for host and home country) and other explanatory variables (that control for FDI behaviour) are regressed with bilateral FDI stocks given as dependent variable.	Alternative	Avoidance (treaty shopping for dividend repatriation), Multiple countries	Tax rates are from publicly available data, especially the Worldwide Corporate Tax Guide 2013 from Ernst and Young. Explanatory variables used in OLS regression can be found at IMF and the World Bank databases.

---

[124] The semi-elasticity shows the percentage change of reported profits as reaction to a one-percentage change in the tax differential compared to international locations.