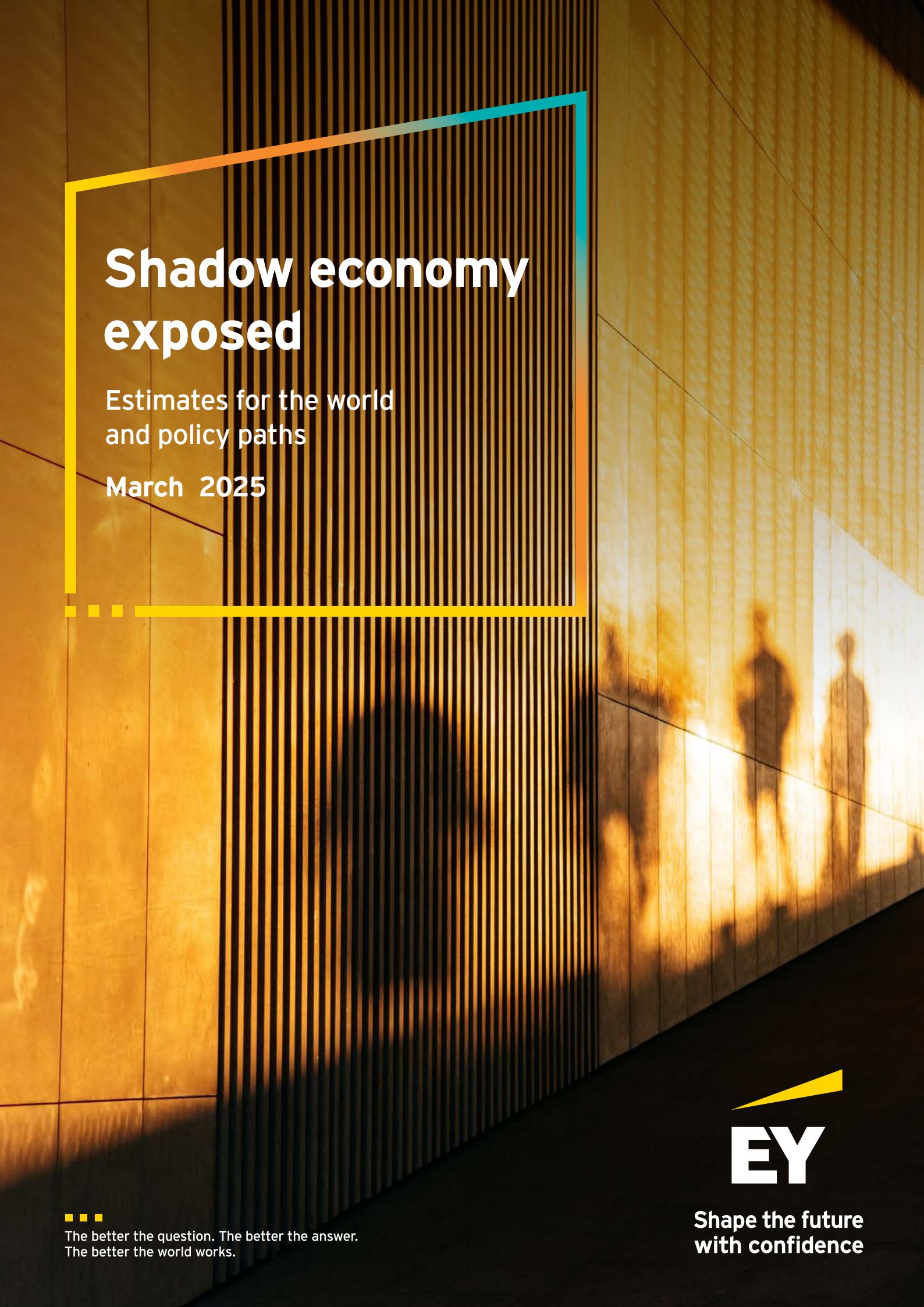

Shadow economy exposed

Estimates for the world and policy paths

March 2025

The better the question. The better the answer.
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Contents

Acknowledgments

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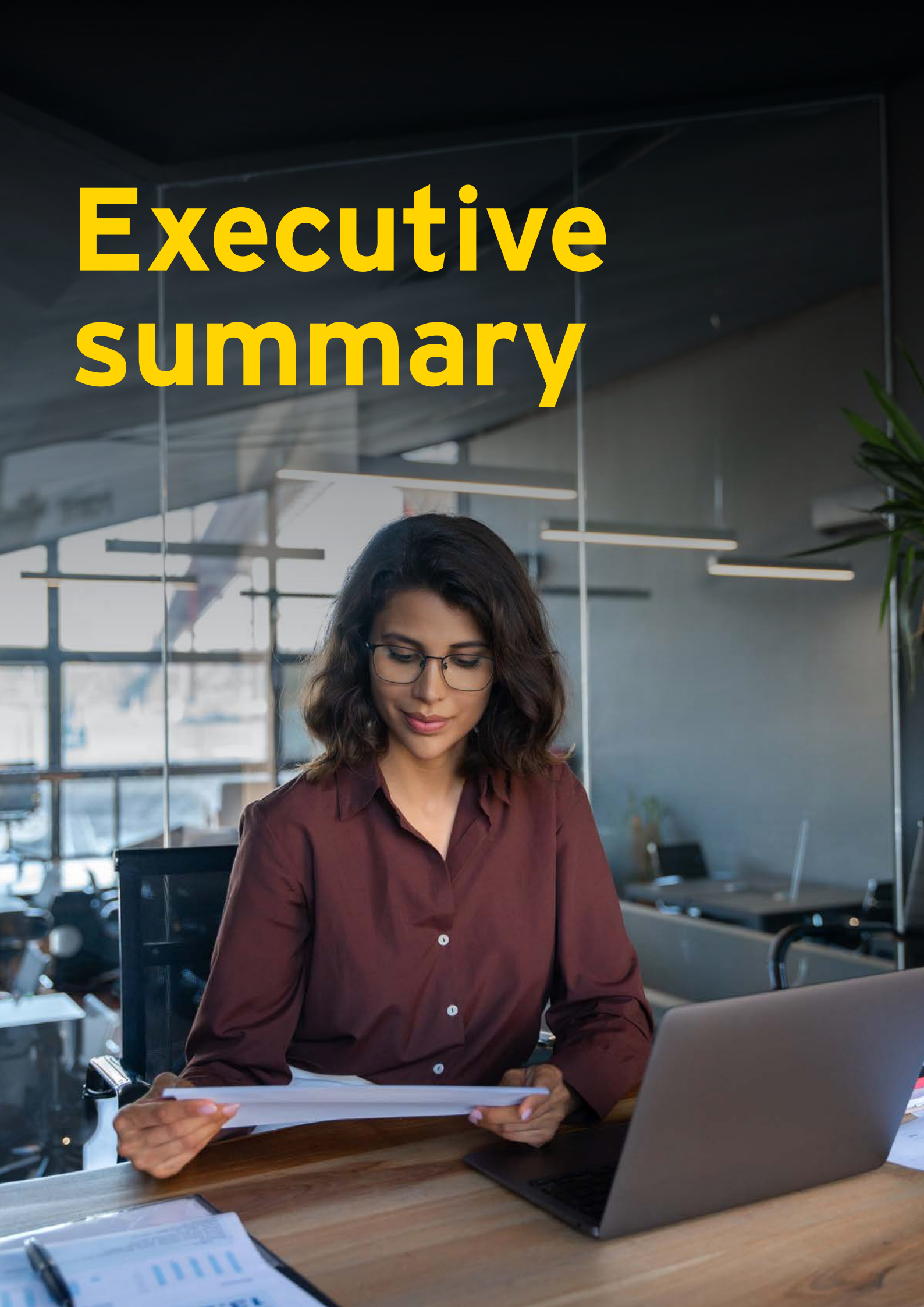
List of acronyms

Abbreviation	Description
AI	Artificial intelligence
B2B	Business-to-business
BMA	Bayesian model averaging
CDA	Currency demand approach
CIT	Corporate income tax
CRS	Common Reporting Standard
D(S)GE	Dynamic (stochastic) general equilibrium
EGDI	E-Government Development Index
ETCR	Electronically traceable cash receipt
FGLS	Feasible generalized least squares
IMF	International Monetary Fund
ISORA	International Survey on Revenue Administration
ILO	International Labour Organization
MIMIC	Multiple indicators multiple causes
MTIC	Missing trader intra-community
NMSE	Non-monetary shadow economy
NTS	National Tax Service (Korea)
OECD	Organisation for Economic Co-operation and Development
PCSE	Panel Corrected Standard Errors
PIP	Posterior inclusion probability
PIT	Personal income tax
POS	Point of sale
PPP	Purchasing power parity
SSEI	Sectoral Shadow Economy Index
VAT	Value-Added Tax
WGI	Worldwide Governance Indicators

Executive summary



Shadow economy: the key piece of the tax gap causing long-term harms

The COVID-19 pandemic, along with a series of unforeseen energy shocks, led to a severe economic slowdown globally in recent years. Many governments resorted to measures aimed at shielding households and businesses from the impact of these disruptions. While helping to avoid a deeper economic contraction, such policies often resulted in significant deficits and public finance imbalances.

Now, as governments navigate the path to recovery, they face additional financial pressures due to the urgency to transition toward more sustainable and digital economies. Investing in green technologies, infrastructure for renewable energy and digital transformation is not just an option but a necessity that demands high capital. At the same time, following monetary policy tightening by central banks, the cost of capital is and will likely remain higher for longer compared to before the pandemic.

Fiscal consolidation calls for spending cuts or revenue increases — and usually a mix of both. Considering social, economic and political costs associated with reducing government expenditure or increasing taxes, addressing the so-called tax gap — the difference between the total amount of taxes owed to the government vs. what is actually paid — gains a heightened significance. Larger tax gaps indicate more tax evasion and avoidance, leading to a shortfall in revenue that could have been used for the above-listed investment needs. Consequently, reducing the tax gap has emerged as a critical strategy for governments to secure needed additional finances.

Sources of the tax gap include tax frauds, tax evasion practices and other types of noncompliance, such as bankruptcies of businesses. However, one of the main culprits for this shortfall is the "shadow economy," also known as the "non-observed" or "unregistered" economy. It involves unreported economic activity from both registered and unregistered entities, where no invoices or fiscal receipts are issued, rendering transactions unreported and taxes unpaid.

This study presents an in-depth examination of the shadow economy, focusing on its multifaceted components as well as relationship with the tax gap and informal employment. We believe that it offers valuable insights into the functioning of these components, the detrimental effects they generate and the strategies that could be implemented to mitigate their adverse impacts.

Activities involved in the shadow economy range from hidden and underground operations of registered businesses to avoid official scrutiny and taxation, informal market activity by unregistered enterprises such as street vendors, illegal activities forbidden by law (e.g., drug production and selling), to household production of goods for own consumption.

It is important to note that the influence of the shadow economy and tax gap goes beyond financial discrepancies. It carries severe long-term negative consequences, like the reduction of government revenues, lower quality and quantity of public goods and services, distorted competition, deterrents to investment and economic growth, and the degradation of economic institutions and social attitudes. This fosters an environment of evasion, resulting in a heightened aversion to tax regulations. While noncompliant taxpayers may initially experience some benefits, such as decreased costs or increased business competitiveness, these gains are likely short-lived and individually owned. Eventually, especially at the national level, they should be outweighed by detrimental effects, as argued in the literature.

Refined shadow economy estimates: widespread decline and global disparities

In this report, we estimated the size of the shadow economy in 131 countries and its evolution over the 2000–23 period.

For that purpose, we used the currency demand approach (CDA). By addressing several limitations associated with the CDA, we hope to have enhanced this method and, in doing so, have made contribution to the economic literature.

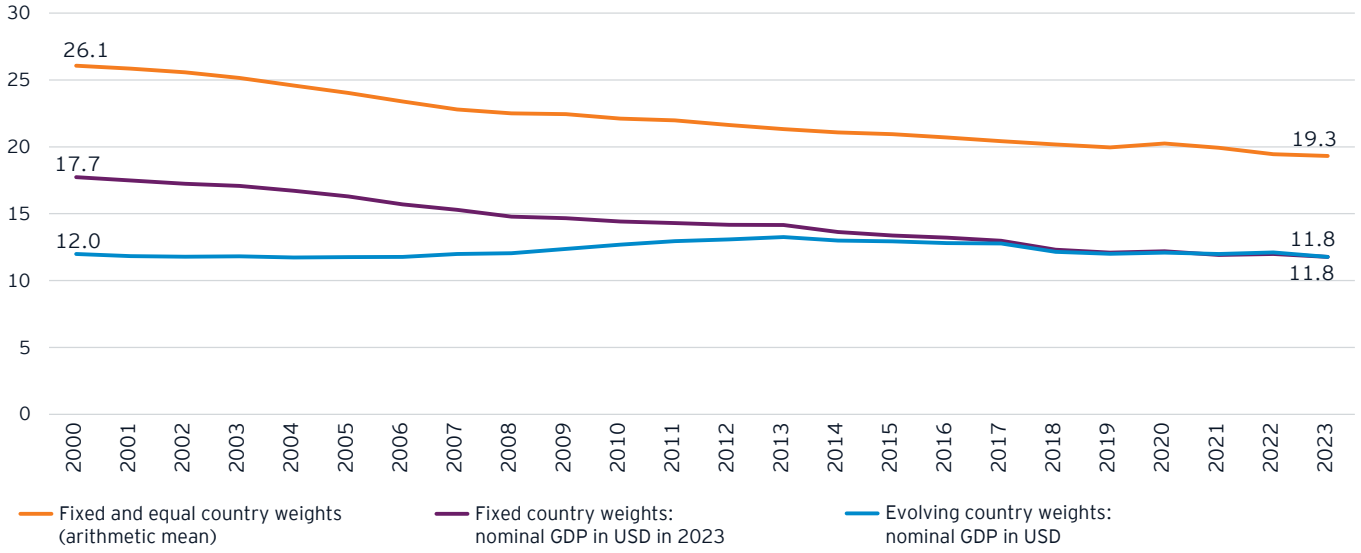
Specifically, to tackle the issue of explanatory variables and model selection, we constructed an extensive database incorporating numerous potential shadow economy determinants. We meticulously selected the most effective method for estimating the model's coefficients and employed Bayesian model averaging (BMA) techniques for an objective selection of explanatory variables from hundreds of thousands of their potential combinations.

In the process, our approach took into account the varying states of economic development in different countries. Moreover, based on our previous work for selected countries, we shared deeper insights into the shadow economy and tax gap, extending to their breakdown into sectors, geographic regions, and types of individuals or businesses.

According to our estimates, the shadow economy represented 11.8% of total global GDP in 2023. However, the arithmetic average of country-level figures was notably higher, equating to 19.3% of GDP (see Chart ES.1). This is because many lower-income and, as a result, smaller economies are more affected by unregistered transactions. These figures are to summarize more detailed data, but it is important to note that there is no single global fiscal pool.

In approximately half of the countries studied, the shadow economy constituted more than 19.0% of GDP. From 2000 to 2023, 119 out of the 131 analyzed nations experienced a reduction in their shadow economies. Within this period, 36 countries saw a reduction exceeding 10% of GDP, while 67 observed a contraction of more than 5% of GDP. The average decline in the shadow economy was 6.7% of GDP.

Chart ES.1. Shadow economy in the world (percentage of GDP)



Notes: Based on the aggregation of our country-level shadow economy estimates. Countries covered by EY analysis account for 97.2% of global GDP and 95.6% of global population. Evolving country weights with nominal GDP in USD show the role of the shadow economy in global GDP. Fixed country weights with nominal GDP in USD in 2023 show such outcomes if the contributions of various economies to global GDP were as in 2023. Fixed and equal country weights show the arithmetic mean of shadow economy estimates for the analyzed countries.

Source: EY analysis

According to our calculations, the shadow economy has been on a **downward trend across countries from all income groups**. The most significant reductions were estimated in low-income countries, while high-income countries displayed the least change, due to a smaller room for improvement in shadow economy drivers and relatively stable socioeconomic conditions.

EY analysis indicates that the pandemic-induced economic crisis has been accompanied by a temporary upswing in shadow economy activity, especially in lower-middle and low-income countries. Our cross-country analysis of the simplified misery index (a measure of unemployment and GDP changes) and our shadow economy estimates show that both measures increased in 2020 vs. 2019.

To allow a deeper insight, we divided the global economy into 14 distinct geographical regions. According to EY calculations, by 2023, the smallest shadow economies were in Northern America; Western, Northern and Southern Europe; and the Middle East, ranging from 5.0% to 8.2% of GDP. Conversely, the largest shadow economies were found in parts of Africa and Southern Asia, with figures varying between 24.1% and 41.6% of GDP. The most significant progress in shadow economy reduction was estimated in Western and Central Asia. By contrast, setbacks were estimated to take place in Southeast Asia and the Pacific, as well as in Southern Africa.

Higher levels of economic development are generally associated with a smaller shadow economy. However, the strength of this correlation weakens as GDP increases, suggesting that the more prosperous the country, the tougher it becomes to shrink the non-observed economy further.

Our analysis shows that countries where informal employment makes up a significant part of total employment generally have larger shadow economies, which suggests a positive correlation between these two elements. In most countries, the informal employment rate is significantly higher than the share of the shadow economy in GDP. The largest discrepancy was found in nations with high levels of unregistered labor, underscoring the notion that much of the non-observed production in these jurisdictions likely stems from unregistered businesses. Meanwhile, countries with smaller shadow economies are prone to more challenges with underreporting by registered businesses.

Large role of cash and significant tax losses

In the report, we distinguish the concept of the cash shadow economy. It stands for unregistered economic activity generated by cash payments that make it much easier for sellers not to report payments than in the case of digital transactions. However, in our study, we do not argue that all payments should be cashless. Cash transactions can play an important role not only due to privacy and security issues but also for financially excluded persons and in extreme scenarios with lack of electricity or access to the banking system.

Next, we break down the cash shadow economy into "committed" and "passive" components, depending on the characteristics of engaged sellers and buyers. The former component can be reduced through policies, such as improved controls, incentives (including to formalize unregistered businesses), education and efforts to bolster tax morale, while the latter can largely be addressed using measures aimed at promoting digital payments or increasing the registration of cash transactions.

Our empirical research shows that the committed component of the shadow economy dominates in developing countries, while the share of the passive shadow economy is typically larger within developed economies.

The shadow economy severely affects fiscal revenues, causing a significant loss that could be used to finance myriad public services, initiatives and investments. In most instances, value-added tax (VAT), sales taxes and business income taxes are the most significantly affected by the revenue losses from the shadow economy. EY studies across different countries show that tax losses due to the cash shadow economy range from 0.2% to 5.1% of their GDP. Clearly, in many countries, even a partial success in reducing the shadow economy can bring material gains.

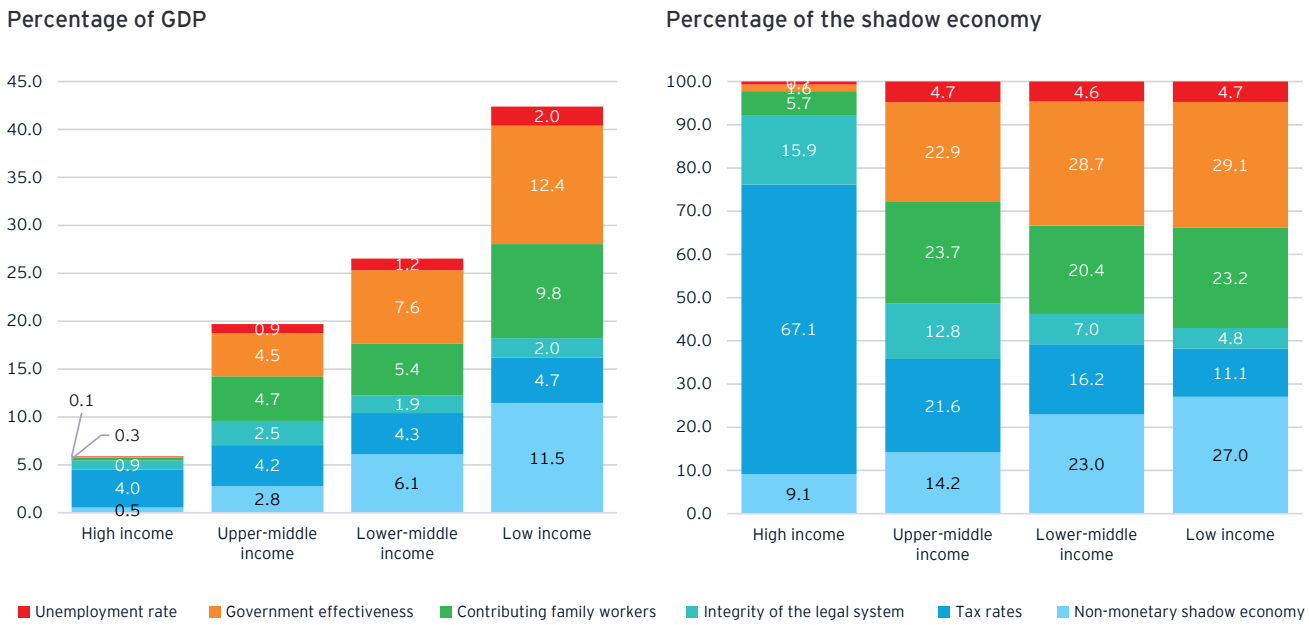
Tailored policies for differences in shadow economy drivers

Understanding the drivers of the shadow economy is critical for investigating potential solutions. In examining the elements that contribute to unregistered activities, we identified government effectiveness, integrity of the legal system, tax rates, levels of unemployment and the role of family workers as key factors.

The results of our analysis show that improving the quality of public services and policy formulation, as well as enhancing the transparency and impartiality of laws, can help to reduce the unregistered economy. Conversely, high prevalence of family workers, high unemployment and elevated tax rates can stimulate expansion of the shadow economy.

We find that the role of shadow economy drivers differs significantly among countries, income groups and regions. For instance, in low-income countries, issues with government effectiveness were responsible for, on average, 29.1% of the shadow economy, while the ratio of family workers to the working-age population accounted for 23.2%. Conversely, in developed countries, tax rates were the dominant factor, responsible for 67.1% of the unregistered economy (see Chart ES.2).

Chart ES.2. Shadow economy by income groups: contributions of different drivers in 2023



Notes: Weights used for countries aggregation: nominal GDP in USD. Income groups defined as in section 3.2.

Source: EY analysis

Increasingly, governments and regulatory agencies worldwide are grappling with reducing the shadow economy and, more broadly, bridging the tax gap. While it may be the first instinct, lowering tax rates and regulatory burden is a difficult policy path. This is due to their likely side effects and related trade-offs. For tax rates, it is usually shrinking funds for essential public services, which can harm government effectiveness in the long term. For other regulations, it is a potential weakening of existing protection for employees, consumers or environment.

EY analysis highlights five areas of actions undertaken by various governments to tackle tax noncompliance. These areas are (1) increasing taxpayers' trust toward public administration and the tax system, (2) overcoming businesses' lack of formalization, (3) increasing detection with the use of available technologies, (4) taking advantage of third-party information and (5) enhancing whole-of-government approaches and international cooperation (see Chart ES.3).

Chart ES.3. Areas of actions aimed at reducing the shadow economy and tax gap

Trust as an often missing ingredient for successful reforms	Uneasy road toward enterprise formalization	Harnessing technology and advanced analytics to increase detection	Taking advantage of third-party information	Enhancing whole-of-government approaches and international cooperation
■ Taxing and spending better ■ Counteracting corruption and abuse among tax officials and public service providers ■ Educating on why and how to pay taxes ■ Increasing transparency about how tax revenues are spent ■ Influencing tax compliance decisions by tax nudges	■ Cutting red tape with one-stop shops and e-government ■ Simplifying legal status and tax obligations for micro and small enterprises ■ Increasing benefits of formalization with financial development	■ Mandating the use of electronic fiscal devices ■ Limiting overreporting of deductions with electronic invoicing ■ Using advanced analytics to improve detection of high-risk taxpayers and transactions	■ Promoting financial inclusion and the use of electronic payments ■ Encouraging consumers to request receipts ■ Making adjustments, where necessary, in third-party reporting mechanism of VAT ■ Collecting third-party information from online platforms	■ Joining forces of several state actors ■ Improving information sharing and efficiency of collaboration through digital transformation ■ Establishing international cooperation

Source: EY analysis

Trust between taxpayers and the government is the bedrock of tax compliance. Research findings, including a recent World Bank report[1], show that establishing taxpayer trust can significantly boost voluntary tax compliance, also known as "tax morale." Trust-building strategies can include efforts to improve perceptions of fairness and equity within the tax system, demonstrating how taxes contribute to public goods and services, enhancing government accountability, and transparency. In this way, taxpayers' trust in the efficacy of tax revenues can be fostered, which can significantly contribute to reducing the shadow economy.

Closely linked to the issue of trust is the problem of businesses that operate informally or outside the regulatory framework. The challenge of achieving enterprise formalization is especially evident in emerging markets and developing economies where informality is widespread. Business formalization is a pivotal step in shrinking the shadow economy in those countries. Registered enterprises contribute to tax revenues, but the push toward formalization must consider the potential impact on vulnerable social groups. It is important to be cautious in this context and ideally promote productivity improvements that would naturally lead to more businesses operating formally in the long run. One such approach is the provision of better access to quality education.

Beyond this long-term effort, applied policy strategies to promote business formalization involve streamlining the registration and tax payment process, along with establishing tangible incentives to encourage compliance. This requires a suite of country-specific regulations, which may include cutting the red tape with one-stop shops where all formalities can be completed and creating simplified rules for micro and small enterprises that can be combined with (temporarily) lower taxes and social security contributions. Replacing face-to-face interactions with e-government services may also lead to increased taxpayer trust in the tax administration and boost tax morale.

Access to finance is one of the biggest benefits of enterprise formalization as it helps companies to grow and increase productivity. However, businesses operating in regions with an underdeveloped financial sector lose one of the crucial incentives to formalize. In this context, the empirical research stresses the role of increased access to bank services, which leads to a decrease in the share of informal output in GDP.

As argued in the literature, initially, the costs of formalization policies are likely to outweigh revenues stemming from broader tax base, but over time, formalization should lead to increased tax revenues.

Another used enabler in tackling tax noncompliance and the shadow economy is the application of technology to detect unregistered transactions and fraud. Digital solutions, such as electronic fiscal devices for recording transactions; e-invoicing; and advanced analytics incorporating machine learning models, artificial intelligence and text mining algorithms, are applied to improve the detection of noncompliance and increase tax revenues. To raise the chances for success, it is important to adapt policies to the technological maturity of the country.

Another common approach is the use of third-party data to improve detection of tax noncompliance. Electronic records of bank account balances and electronic payments offer a rich source of third-party data that are sometimes interesting for tax administrations. Tax authorities can also encourage consumers to request fiscal receipts by offering them lottery prizes or small tax reductions in exchange for acting as tax auditors. Through this strategy, some government agencies start to collect transaction information from online platforms.

From EY studies on digital payments, we found that access to accounts at financial institutions as well as sufficiently developed electronic payment acceptance network are crucial for the success of subsequent reforms promoting the use of cashless transactions.[2] While in advanced economies digital payments were used by almost 90% of adult population in 2021, in low-income countries this share was only around 30%.

1 Ohnsorge, F., Yu, S., eds. (2022), The Long Shadow of Informality: Challenges and Policies. Washington, DC: World Bank.

2 See section 4.5 of the report.

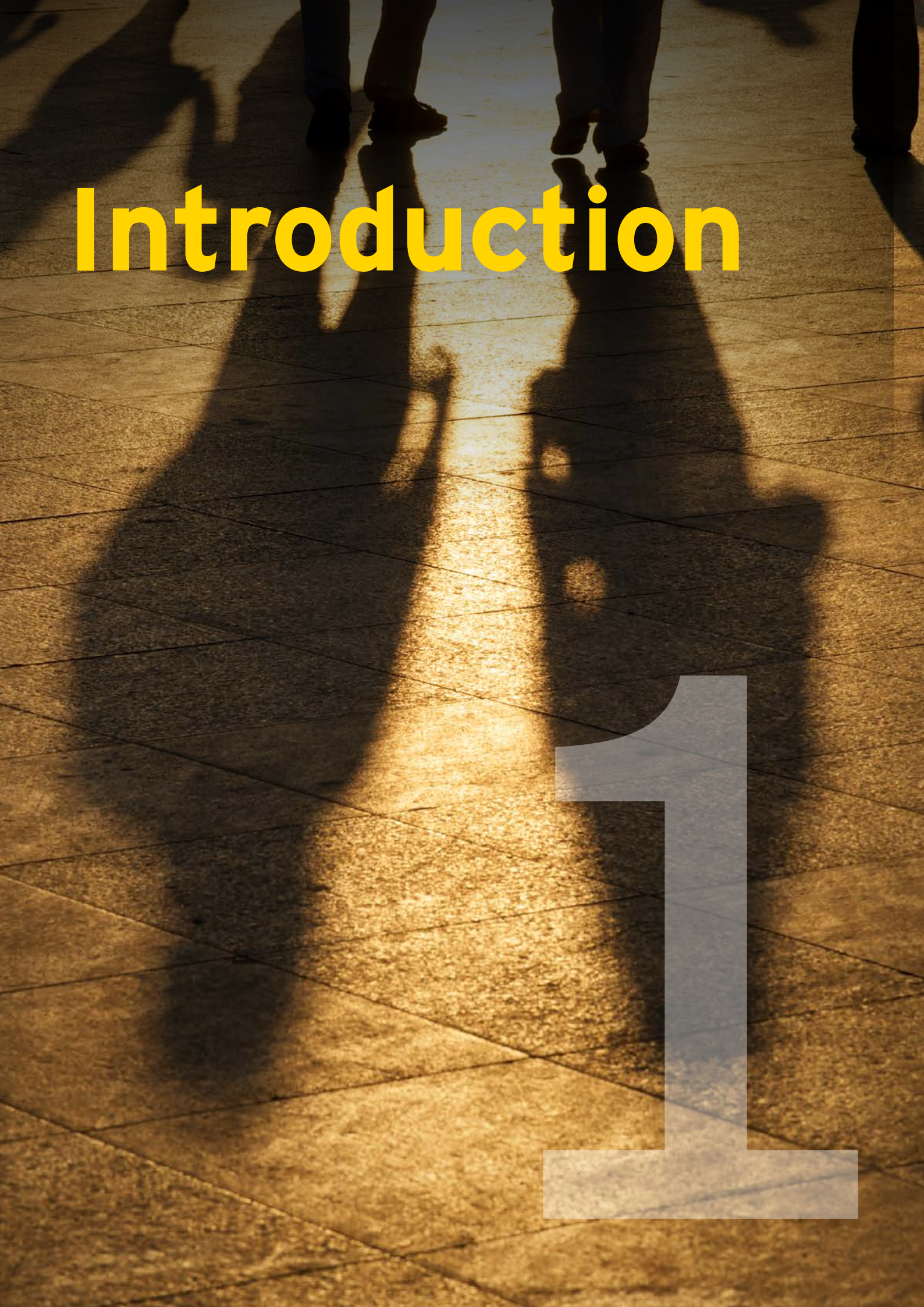
Finally, enhanced cooperation between various government bodies is often viewed as pivotal in addressing issues of tax noncompliance. To achieve this, public institutions employ a whole-of-government approach that maximizes data sharing and interdepartmental collaboration, aimed at significantly boosting tax compliance and reducing the shadow economy. This approach requires upgrading data systems for improved accessibility and proper confidentiality provisions, and having a robust governance structure overseeing the collaboration. Moreover, given the globalized nature of the modern economy, international cooperation is seen as essential in curbing tax evasion practices that transcend national borders.

Considering the timing and effects of policies, it is important to distinguish between long-term and short-term strategies. In less developed countries, it may be crucial to concentrate on long-term strategies aimed at reducing informality and improving the quality of institutions. Meanwhile, short- to medium-term initiatives could involve using technology and advanced analytics for better detection, leveraging third-party information and improving government cooperation. These shorter-term measures may yield quicker, albeit smaller, gains. As informality decreases and institutional quality improves, the impact of these policies is likely to grow, as the shadow economy shifts toward the hidden activities of registered businesses.

In addition to the horizontal solutions in the previously mentioned areas, there might also be a necessity for more targeted measures. These should be customized to suit the unique characteristics of every country's taxpayers and sectors. By doing so, not only could costs be reduced, but focusing on areas where unregistered transactions are prevalent could also enhance benefits. In this context, we provide examples of more detailed shadow economy and tax gap analyses for selected countries. For instance, to obtain a more in-depth and complex understanding of the shadow economy's development, we devised the Sectoral Shadow Economy Index (SSEI) to highlight the sectors most susceptible to unregistered activities.

At the same time, certain types of the shadow economy may not necessitate intervention or combating. For example, the reduction of the non-monetary shadow economy related to household production of goods for own consumption will take place on its own along with economic development and transition from agrarian economy to industry or services-oriented markets. Moreover, such production is generally not taxed due to difficulties in valuation, placing additional burden on already low-income groups and the practicality of their taxation. Another aspect highlighted in the literature emphasizes that policies intended to reduce the informal economy must be approached with caution, as informal activities frequently serve as a safety net for the poor.

In conclusion, the shadow economy and tax gap pose significant challenges that demand attention. This EY study highlights the benefits of a complex and customized approach to dealing with these issues. Actions to address tax noncompliance range from enhancing trust, improving the formalization process, and leveraging technology and third-party data, to promoting international cooperation and a whole-of-government approach. Prior to implementing specific policies and measures, an initial investigation to determine the size, dynamics and structure of a country's shadow economy is fundamental. The latter includes key drivers, sectoral and regional breakdowns, and understanding the relative role of informality and income underreporting. The impact of individual and household characteristics on behavior that generates a tax gap can also be examined and bring relevant insights. These key considerations underscore the critical importance of identifying the sources and areas of shadow economy concentration to design successful strategies going forward. Ultimately, it is only through comprehensive, bespoke and data-driven policies that we can expect to effectively alleviate the adverse effects of the shadow economy.



Introduction

1

A shadow economy emerges when businesses do not report some of their activities. The reasons behind this vary. Some companies hide part of their operations to save on taxes and avoid time-consuming bureaucratic tasks. This allows them to increase profit, while depriving the government of revenues. Additionally, they can gain an unfair advantage over companies that follow the regulations. Meanwhile, informality (i.e., lack of registration of a business or employment) can be a safety net for unproductive businesses and employees who lack financial means or knowledge necessary in the formal sector.

Kristalina Georgieva,
Managing Director of International Monetary Fund (IMF), wrote in the foreword to a 2021 IMF report on informal workforce[3]:

> “Countries or regions with higher informality also grow below their potential. Moreover, they do not collect sufficient taxes and cannot provide basic goods and services to the whole population, which reinforces informality. Reducing informality over time is essential for sustained and inclusive development, but this process will inevitably have to be gradual, given the importance of informal activities to the livelihoods of billions of people currently.

Transition from the shadow economy to the formal economy should be wisely designed. Reducing unregistered activities and, more broadly, the tax gap is much needed because:

- **It is a good way to mobilize domestic revenues in times of fiscal consolidation.** By registering shadow economy transactions and reducing tax fraud, governments will achieve better tax collection. This is especially important after the period of fiscal expansion aimed at cushioning of the adverse effects of the COVID-19 pandemic and energy shocks, resulting in elevated government deficits. Better tax collection is also socially and politically more attractive than raising taxes or cutting public spending.
- **It brings funding for much needed public spending, including health and education, digital transformation, and the transition to a low-carbon economy**. Underdevelopment and informality are closely interconnected. On the one hand, low-income countries struggle with large shadow economies that limit their government revenues. On the other hand, the same countries need to collect more in taxes to finance investments that can speed up their development. In particular, low productivity, which often leads to poverty in emerging markets and developing economies, can be tackled with more spending on health and education. Therefore, increased public expenditures are much needed in such countries, e.g., to achieve 2030 United Nations Sustainable Development Goals, including no poverty, zero hunger, good health and well-being, quality education, and decent work and economic growth.[4] However, even high-income countries face the need to increase public spending. For example, all over the world, there is a pressing case for substantial green investments in climate change mitigation and adaptation. In this context, the European Commission has pledged to mobilize at least EUR 1 trillion of public and private funds to finance sustainable investments and achieve the goals of the European Green Deal.[5]

3 Deléchat, C., Medina L., eds. (2021). The Global Informal Workforce: Priorities for Inclusive Growth (Foreword). Washington, DC: IMF.

4 https://sdgs.un.org/goals.

5 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal_en.

- **Curbing tax fraud, evasion and avoidance can improve tax morale and trust toward public administration**. General belief that "everyone pays their share" and dishonest taxpayers are held accountable should translate into taxpayers' greater willingness to comply with the law and enhanced satisfaction with public administration.[6]
- **It supports fair competition**. By incurring lower tax and regulatory costs, companies operating in the shadow economy often create unfair competition for businesses that adhere to the law. Reduction of such behavior will level the playing field.
- **Integrating informal business owners and employees into the formal economy would make them eligible for public aid in the event of a crisis and decrease inequality**. The COVID-19 pandemic highlighted and intensified the weaknesses of activities in the informal sector. Government support programs mitigating the economic effects of lockdowns did not reach many unregistered businesses and employees. Moreover, as many informal workers earned low incomes and were unable to accumulate savings, the crisis pushed them into extreme poverty. Informality in emerging markets and developing economies has also been associated with greater gender inequality – women have been overrepresented in the informal workforce, facing low incomes, lack of workers' rights and social protection, and poor working conditions.[7]

The global EY organization supports public administrations and private initiatives in reducing the shadow economy and tax gaps to enlarge the formal economy. This is in line with our purpose of building a better working world. We have gained vast and detailed experience in the analysis of tax gaps, shadow economies and illicit markets during numerous projects carried out in cooperation with public administrations, nongovernmental organizations, industry associations and private companies facing illicit market practices. In this report, we have summarized the main areas of our work on this topic and supplemented it with a review of other available studies, including recent reports by the World Bank, the IMF, the Organisation for Economic Co-operation and Development (OECD), and the International Labour Organization and academic articles written by EY professionals or other researchers.

In Chapter 2, we define the shadow economy and related concepts, and summarize their broad consequences. In Chapter 3, we present the results of our analyses on the shadow economy around the world, including our estimates of the shadow economy size, its drivers, and the consequences for government revenues. We also show a few examples of more disaggregated analyses that we have conducted, including estimates of the shadow economy at the level of regions and sectors of a given country. In Chapter 4, based on our experience and the recommendations of renowned international organizations, we present various measures public administrations use to reduce the size of the shadow economy and, more broadly, tax gap. Finally, in the appendices, we provide more technical details on our methods and describe some additional aspects of the covered topics.

Mari Pangestu,
the former Managing Director of Development Policy and Partnerships at the World Bank, made similar points to Georgieva in the foreword to the 2022 World Bank report on informality[8]:

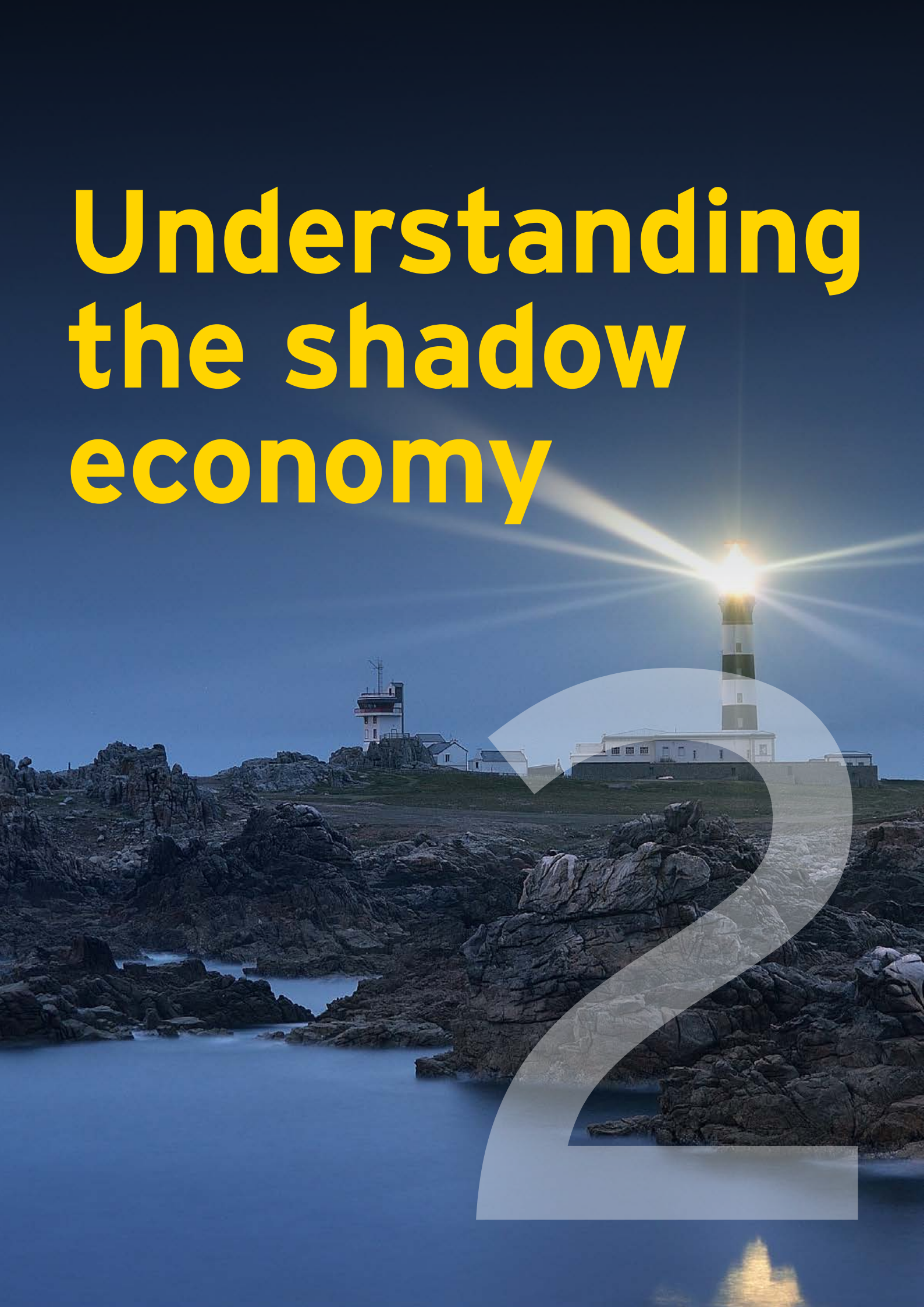
> "Rebuilding the global economy in the aftermath of COVID–19 will mean mobilizing every available reserve of productive power to generate green, resilient, and inclusive development. That effort must begin now — and it cannot succeed without full consideration of the challenges of the informal sector.

6 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), *Innovations in Tax Compliance: Building Trust, Navigating Politics, and Tailoring Reform*, Washington, DC: World Bank.

7 Ohnsorge, F., Yu, S., eds. (2022), The Long Shadow of Informality: Challenges and Policies. Washington, DC: World Bank.

8 Ohnsorge, F., Yu, S., eds. (2022), *op. cit.*

Understanding the shadow economy



2

In this chapter, we explain key aspects related to the shadow economy. What is its broader economic context? What are its defining elements? Which concepts are often confused with the shadow economy? What kinds of consequences does it generate? We address these questions and more.

2.1. Tax gap, shadow economy and informal employment

We first introduce a few key terms for our analysis, including tax gap, shadow economy and shadow employment. We explain important links between them and existing contrasts.

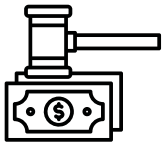
Tax gap

Tax gap is the difference between taxes that theoretically should be collected (based on the scale of economic activity and binding regulations) and the taxes actually collected. In other words, this is the most aggregate measure of various tax collection issues faced by tax administrations and ministries of finance.

Breaking this down into key components, main sources of the tax gap include the shadow economy, tax frauds, tax evasion and other issues (see Figure 1).

Figure 1. Tax gap and its sources

Tax gap

Shadow economy	Tax fraud	Tax evasion	Other
unreported value added (GDP) of (un)registered businesses	criminal activities, including submission and production of false documents	illegal, e.g., deliberate misrepresentation of information to reduce tax liabilities	legal disputes, bankruptcies, billing errors, tax avoidance
			

Source: EY analysis

These sources are more formally defined below[9]:

- **Shadow economy** (also non-observed, unreported or unregistered economy) comprises various kinds of unreported economic activity (GDP) of registered and unregistered businesses and is responsible only for a part (often significant, though) of the total tax gap (see more detailed definition in the next section).
- **Tax fraud** is a form of deliberate evasion of tax that is generally punishable under criminal law. The term includes situations in which deliberately false statements are submitted or fake documents are produced.
- **Tax evasion** generally involves illegal arrangements (other than shadow economy related) where tax liability is hidden or ignored, i.e., the taxpayer pays less tax than they are supposed to pay under the law (e.g., by deliberately misrepresenting information).[10]
- **Other** issues, often where the noncompliance is not deliberate, include legal disputes, bankruptcies and billing errors. Tax avoidance (acting within the law, sometimes at the edge of legality, to minimize or eliminate owed taxes) is quite a vague term. Consequently, the tax gap may or may not include it, depending on the research and applied methodology.

The discussion above focuses on the so-called compliance tax gap. In some research, the authors also distinguish the additional component described as the policy tax gap,[11] which stems from the existing irregularities in the tax system (e.g., reduced tax rates, exemptions, specific deductions). Since it results from deliberate decisions of policymakers, we do not concentrate on this aspect in our study.

Further, one can look at the tax gap from the perspective of various kinds of taxes, e.g., VAT (also sales tax) gap or income tax gap. In some cases, actions of the taxpayer may simultaneously generate different types of tax gaps (e.g., unregistered business revenues may increase both the VAT gap and income tax gap). Yet, in other instances, it may not be the case (e.g., unregistered labor will likely not directly impact the VAT gap, but may influence the income tax gap).

For some areas of the tax gap, one can additionally consider the specific business actions that contribute to the problem. For example, for a VAT gap, issues may include unreported sales of registered businesses, inflated costs of registered businesses, failure to register their own businesses, misclassification of product/business activities and various kinds of frauds.

In this report, we focus on the shadow economy, while other sources of the tax gap are mentioned when they share some common aspects with the shadow economy (e.g., consequences or policy actions). For analysis of the whole tax gap[12] or international tax evasion issues[13] (including global profit shifting and offshore wealth of households), refer to other publications.

Shadow economy

For this study, it is crucial to elaborate on the definition of the shadow economy, listing components and aspects that are outside this term.

Shadow (non-observed) economy is unreported value added (i.e., GDP) of registered and unregistered entities. Importantly, it is a measure of unregistered final products or services value, not related employment or lost taxes, which are often confused with this concept. To be precise, the shadow economy includes[14]:

9 Definitions of tax fraud, tax evasion and tax avoidance are from the European Commission, see e.g. https://taxation-customs.ec.europa.eu/time-get-missing-part-back_en.

10 Please note that in some publications tax evasion is understood in a wider way, including also lost taxes due to the shadow economy. In this report, tax evasion consists in other illegal arrangements than unreporting of economic activity (e.g. application of lower tax rates than should be used according to the law, etc.).

11 See e.g. European Commission, Directorate-General for Taxation and Customs Union, Poniatowski, G., Bonch-Osmolovskiy, M., Śmietanka, A. et al. (2022), VAT gap in the EU – Report 2022, *Publications Office of the European Union*.

12 For VAT gap analysis see, e.g., European Commission et al. (2022), *op. cit.*

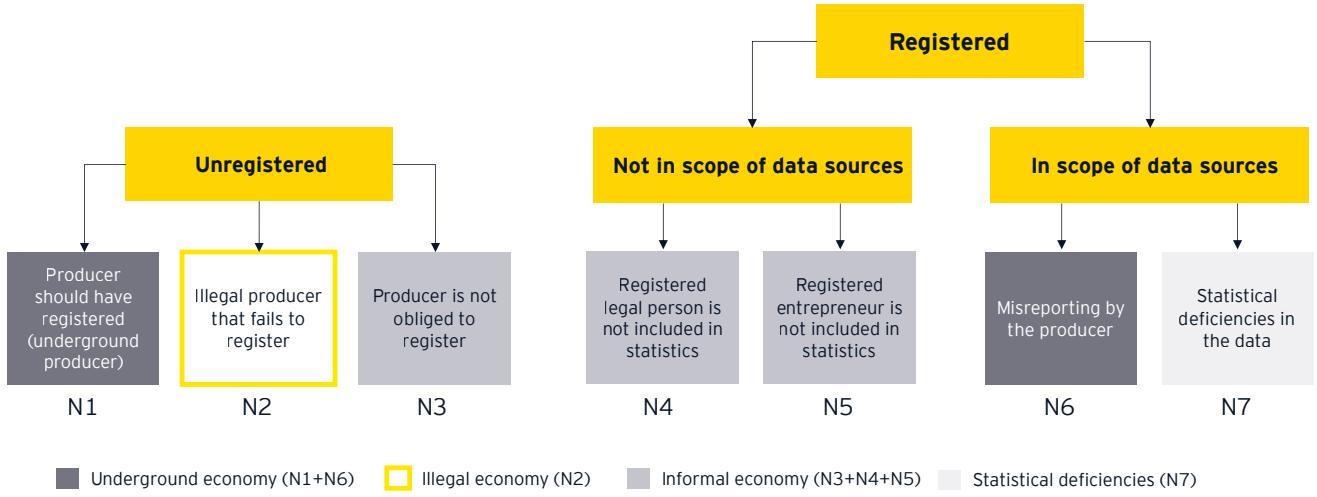
13 See, e.g., EU Tax Observatory (2023), Global tax evasion report 2024.

14 The presented definitions are based on key documents of international institutions working on the harmonization of the approach to the non-observed economy. Such publications include:
(i) OECD, IMF, ILO, & CIS Stat. (2002), Measuring the non-observed economy: A handbook, Paris: OECD Publications Service.
(ii) Eurostat (2013), European system of accounts. ESA 2010
(iii) Eurostat (2018), Building the System of National Accounts – non-observed sector. Statistics Explained.

- **Hidden and underground activities** where the transactions themselves are not against the law but are unreported to avoid official scrutiny (e.g., an unreported part of registered companies' revenues to avoid taxation)
- **Activities described as "informal"**, typically where no records are kept, conducted by unincorporated enterprises in the household sector that are unregistered and/or are less than a specified size in terms of employment and that have some market production (e.g., street vendors)
- **Illegal activities** where the parties are willing partners in an economic transaction or activity forbidden by the law (e.g., drug production and selling)
- **Household production of goods for own consumption** (not sold on the market), sometimes treated as a part of the non-observed economy, does not require monetary transactions (In this study, we describe it as "the non-monetary shadow economy.")
- **Deficiencies in the basic data collection** (an element of the non-observed economy distinguished in some countries)

Alternatively, the non-observed economy could be decomposed using the Eurostat's Tabular Approach to Exhaustiveness, which is presented, and linked with the elements described above, in Figure 2.

Figure 2. Breakdown of the non-observed economy according to the Eurostat's Tabular Approach to Exhaustiveness (TAE)



Source: Eurostat (2021a) as cited in Fernandes (2022), The non-observed economy in the national accounts, KU Leuven Working Paper, October 2022.

In addition, we discuss some confusing activities that are not part of the shadow economy in Frame 1.

Frame 1. What is not included in the shadow economy?

The shadow economy and the total economy, according to the national accounts guidelines used by statistical offices (e.g., to estimate GDP), exclude activities that are not related to production or that are hard to evaluate. For this reason, the shadow economy and GDP figures exclude:

- **Illegal activities where at least one of the parties is not a willing participant** (e.g., theft) and/or that do not lead to the creation of goods or services (e.g., tax fraud, corruption)
- **Value of traded second-hand goods**, since such trade leads mostly to a change in ownership of the already existing goods (not to creation of new goods)[15]
- **Household production of services for own consumption** (e.g., cooking for the family), since it is difficult to assign a specific monetary value to them (they are generally excluded from the national account system, e.g., from GDP calculations; imputed rents of owners-occupiers are an exception to this rule[16])

How do today's official GDP figures account for the shadow economy? For the most accurate figures, international guidelines suggest that statistical offices cover unreported activities. In practice, this is not always the case. When unreported activities are figured in, sometimes offices can assess the contribution of the shadow economy to GDP, while in other instances offices may include them indirectly (not being able to distinguish their value). Unfortunately, estimates of the non-observed economy are usually not published by statistical offices or are disseminated with significant delay. Such figures, in line with the Eurostat guidelines, are more often available in the EU. Still, some EU countries publish them only partly or not at all.[17] All this increases the demand for alternative unregistered activity estimates, including ours, which also suggests main drivers of the problem and potential policies.

Finally, to better understand results and policy discussions included in the next chapters, we have a few notes related to particular methods of analysis of the shadow economy.

The cash shadow economy is unregistered economic activity generated by cash payments. In this context, cash allows the seller not to report the transaction. With a few exceptions, if an electronic payment is used instead of cash, it is more difficult to hide the transaction.[18] We do not argue that all payments should be cashless. Aside from certain benefits, there are also many risks associated with such a scenario (e.g., privacy and security issues, challenges of financially excluded persons, extreme occurrences with lack of electricity or access to the banking system).

15 In contrast to the value of second-hand goods, margins related to their trade are treated as "production" of services and constitute a part of either the registered or shadow economy.

16 Imputed rents are related to housing services that homeowners implicitly provide for themselves. They are estimated to be equal to the rents that homeowners would have paid to live in dwellings of the same type, in the same district and with the same service facilities. They are included in GDP. If they were not, the GDP would be affected by changes in the share of people living in their own dwellings. It is assumed that, for example, a situation in which two homeowners living in their own dwellings start letting their dwellings to each other and paying regular rents should not affect the level of GDP. Indeed, such a change does not impact the level of GDP, since these "new" rents have already been included in GDP as imputed rents.

17 Fernandes A. (2022), The non-observed economy in the national accounts, *KU Leuven Working Paper*, October 2022.

18 The exceptions include, e.g., buying illegal goods or services with cryptocurrencies. In some countries also part of e-commerce transactions related to legal goods and services may be out of official scrutiny. Yet, in most countries for the time being such activities constitute a minor part of the whole economy.

The cash shadow economy has been analyzed in this report and some of our past research.[19] It is equal to the total shadow economy less the non-monetary shadow economy and a few exceptions of unreported activities generated by electronic payments.

In addition, within our framework, we sometimes break down the cash shadow economy into the passive shadow economy and the committed shadow economy, which supports policy considerations. In the passive shadow economy, consumers pay with cash (e.g., due to personal preference or lack of other payment infrastructure) and sellers use this opportunity to benefit from not reporting the transaction (consumer is often unaware of it).[20] In such a case cash is the cause of the shadow economy, and policies that limit cash payments or increase their registration may help reduce the tax gap. In the committed shadow economy, the sellers offer the consumers a lower price (without tax) or an opportunity to buy an illegal product or service if the payment is made in cash.[21] In that scenario, cash is just the consequence of joint parties' willingness to act in the shadow economy (or the fact that business is unregistered). To tackle this problem, other measures, such as controls, incentives, education and tax morale improvements may be required, and they may also help to address the passive shadow economy.

Informal employment

Informal employment (also unregistered or shadow employment), in brief, is an employment without a formal job contract, lacking the standard legal protection and omitting labor-related taxes and social security contributions. It may happen both within unregistered and registered enterprises.

According to the International Labour Organization,[22] informal employment includes own-account workers (with informal job characteristics indicated by their enterprise features), contributing family workers (who typically lack proper employment contracts) or employees holding informal jobs (without legal protections like income taxation or social protection). The category also covers individuals who produce goods solely for their households end use.

In the context of the shadow economy, it is worth noting that the share of the shadow economy in the total economy (GDP) is something different than the share of unregistered employment in the total employment.[23] Most often the former is lower than the latter. The are several reasons for that. The value of goods and services generated by unregistered workers may be lower (compared to registered employment) due to factors such as lower education and skills, limited access to capital, or poor organization of work and production processes. In addition, at least part of the value of products and services generated with the use of undeclared work may be included in the registered economy (e.g., a house built with the use of unregistered workers that is later legally sold). Moreover, undeclared work may involve fewer working hours (e.g., the seasonal employment in agriculture or construction).

While the factors outlined above explain why the share of the shadow economy in GDP may be lower than the share of informal workers in total employment, the opposite situation may also sometimes occur, such as when many businesses, despite having registered employees, do not report a significant share of their revenues to avoid paying taxes.

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19 See, e.g.:
EY (2019), Reducing the Shadow Economy in Albania Through Electronic Payments.
Dybka, P., Kowalczuk M., Olesiński B., Rozkrut M., Torój A. (2018), Currency demand and MIMIC models: towards a structured hybrid method of measuring the shadow economy, *International Tax and Public Finance*, pages 1–37.
Dybka, P., Olesiński, B., Rozkrut, M. and Torój A. (2022), Measuring the model uncertainty of shadow economy estimates, *International Tax and Public Finance*.

20 Such transaction could only happen within the hidden and underground activities of registered businesses.

21 This could happen especially within hidden and underground, illegal and informal activities, in particular among unregistered businesses.

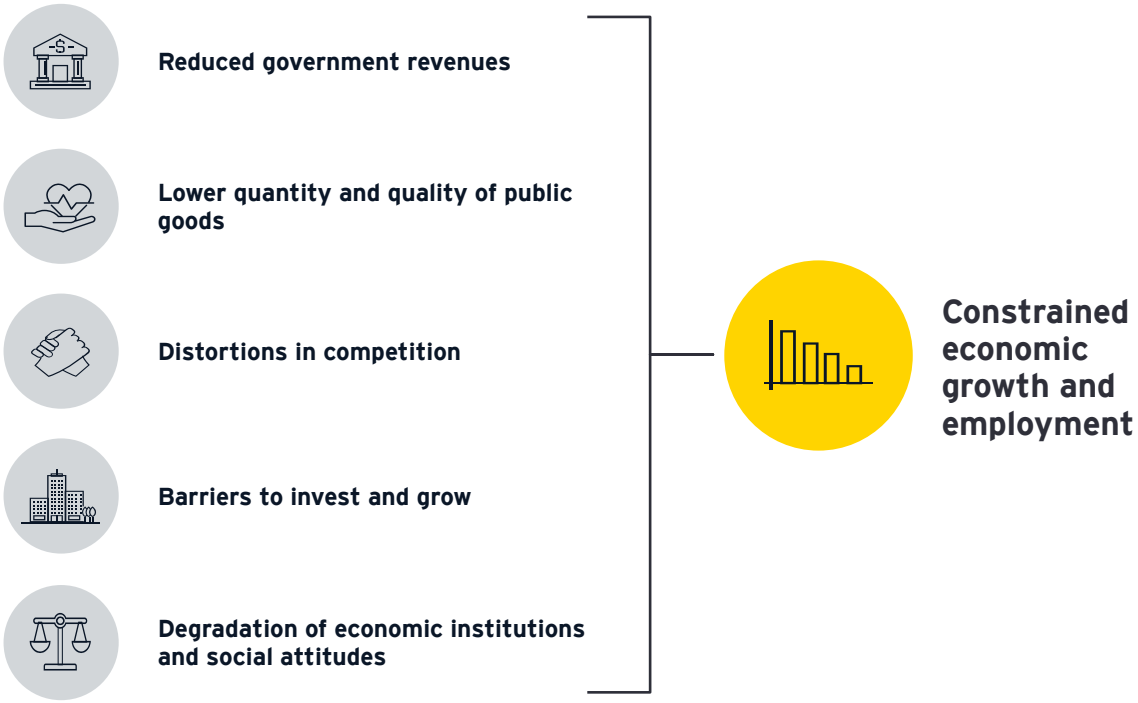
22 See e.g.:
https://ilostat.ilo.org/topics/employment/
https://unstats.un.org/wiki/display/SDGeHandbook/Indicator+8.3.1.

23 It is worth noting that for many countries data on informal employment excludes agriculture, likely due to measurement and/or conceptual issues.

2.2. Consequences of the shadow economy and tax gap

The shadow economy has significant economic and social implications. Potential adverse consequences of a high shadow economy (and other sources of the tax gap in many cases) are summarized in Figure 3 and described below.[24]

Figure 3. Consequences of the shadow economy and tax gap



Source: EY analysis

24 For a review of the literature on the consequences of the shadow economy see: Enste D. H., Schneider F. (2000), Shadow Economies: Size, Causes, and Consequences, *Journal of Economic Literature*, vol. 38(1), pages 77–114.

- **Reduced government revenues**. The shadow economy is associated with a willingness of individuals and enterprises to evade taxes, increasing the part of the economic pie that is not fully covered by the tax system. This may be a challenge to public finance management, including pressure on spending cuts and elevation of public debt. Such conditions can also increase vulnerability to macroeconomic shocks and reduce the space for counter-cyclical fiscal policy when it is needed.
- **Lower quantity and quality of public goods**. By decreasing government revenues, the shadow economy negatively impacts public expenditure. Among them, and especially harmful, may be cuts in the provision of public goods (e.g., public infrastructure) and services (e.g., education and health). This could have particularly far-reaching consequences in emerging markets and developing economies, leading to worse abilities and skills of people and, consequently, their limited productivity. However, even high-income countries face the need to increase public spending. For example, all over the world, there is a pressing case for substantial green investments in climate change mitigation and adaptation.
- **Distortions in competition**. Companies operating in the shadow economy benefit from reduced costs and thereby increase their competitiveness compared to fair companies. In the context of unregistered businesses, a reason for remaining informal is described in related literature as a "parasite" perspective. The study by Amin and Okou (2020)[25] used firm-level survey data from 18 countries and estimated that competition from unregistered firms leads to 20%-24% lower productivity of registered firms. The possible channels causing this effect are constrained access to finance for formal firms in sectors associated with high informality and reduced profitability of investments in productivity-boosting innovations for legal firms facing aggressive competition from companies operating in the shadow economy.[26]
- **Barriers to invest and grow**. Operating in the shadow economy may be easier or even temporarily necessary to survive for some micro businesses, especially in developing countries. Yet, it is linked with reduced access to finance, clients, suppliers and public support, which significantly decreases investment and growth opportunities.
- **Degradation of economic institutions and social attitudes**. Unpaid taxes, combined with the ease of avoiding penalties and deficiency of public goods and services, may result in a decrease in trust in the tax system and general willingness to pay taxes (tax morale) by legal businesses.[27] In addition, lowered tax revenues may force the government to increase tax rates to cover its expenses, which would mostly impact legally operating businesses. As a result, many honest companies might be encouraged (due to decrease in tax morale) or forced (due to loss of profitability) to move to the shadow economy or even leave the market.
- **Constrained economic growth and employment**. All of the above-listed channels can adversely affect the productivity level, while reduced fiscal space can limit countercyclical spending, increasing the duration and harm of economic slowdowns. This, in turn, constrains economic growth and employment (the latter could also be affected directly through some of the discussed channels).

However, there are areas associated not only with costs but also potentially beneficial socioeconomic effects of the shadow economy:

25 Amin, M., & Okou, C. (2020), Casting a shadow: Productivity of formal firms and informality, *Review of Development Economics*, 24(4), 1610-1630.

26 Ohnsorge, F., Yu, S.., eds. (2022), The Long Shadow of Informality: Challenges and Policies. Washington, DC: World Bank.

27 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), Innovations in Tax Compliance: Building Trust, Navigating Politics, and Tailoring Reform, Washington, DC: World Bank.

- **Competition with informal firms**. When it comes to unregistered businesses, many studies show that their level of productivity is much lower than the level of productivity of formal firms.[28] Therefore, the notion that they compete with legal businesses, in line with the parasite perspective, is challenged. Indeed, there are many small businesses, especially in developing countries, that are run by people on the verge of poverty. The lack of formalization may thus be a survival strategy of a firm that has no financial means to operate in the legal market. In this case, the low productivity of a business (and broader economic underdevelopment) is not only the consequence of the lack of formalization, but it is also an important reason for choosing such form of operations. The duality perspective on informality stresses that the informal economy is, to a large extent, separated from the formal economy. In other words, informal firms offer different products and services to different customers than registered firms and, thus, do not threaten their competitiveness.[29] Both the parasite and the duality perspective are present in the ongoing discussion on informal enterprises. However, there are many different reasons why companies choose to operate without registration. The best policy options aimed to reduce informality should account for that.
- **Shadow economy and corruption**. Some researchers present evidence that the shadow economy and corruption can be complementary (i.e., the larger the shadow economy, the more prevalent corruption is).[30] On the other hand, others claim that the shadow economy can mitigate government-induced distortions[31] and work as a substitute for corruption, decreasing its scale.
- **Informal employment issues**. Another controversial aspect of shadow economy consequences is related to the labor market. It is likely that some people are only able to find informal employment, for instance, in a period of economic downturn when the unemployment rate is high[32] or in the case of low-skilled workers who lack opportunities on the official market. The majority of informal employees work at small, unregistered companies that are associated with low productivity.[33] It could thus be argued that an unregistered job is better than no job. Moreover, even if a person is employed "off the books", likely a vast majority of their income[34] is spent on products and services provided by legal businesses. However, informal employment entails many risks and costs. People who are unofficially employed most often lack social and legal protection. Therefore, they may find it very hard to develop skills, be promoted, increase their earnings and get a legal employment contract in the future, thus being trapped in unregistered jobs.[35,36] Moreover, as previously discussed, some companies employ informal workers not to survive but to save on labor costs by evading income taxes and social security contributions. In this case, the reduced costs provide those businesses with an unfair competitive advantage over fair firms.

28 Amin, M., & Okou, C. (2020), *op.cit.*

29 La Porta, R., & Shleifer, A. (2014). Informality and development, *Journal of economic perspectives*, 28(3), 109-126.

30 Dreher A., Schneider F. (2010), Corruption and the shadow economy: an empirical analysis, *Public Choice*, vol. 144(1), pages 215-238.

31 Choi J. P., Thum M. (2005), Corruption And The Shadow Economy, *International Economic Review*, vol. 46(3), pages 817-836.

32 Bajada Ch., Schneider F. (2009), Unemployment and the Shadow Economy in the OECD, *Revue économique, Presses de Sciences-Po*, vol. 60(5), pages 1033-1067.

33 Deléchat, C., Medina L., eds. (2021). The Global Informal Workforce: Priorities for Inclusive Growth. Washington, DC: IMF.

34 At least two-thirds in the case of Germany and Austria. See: Enste and Schneider (2000), *op. cit.*

35 Bajada and Schneider (2009), *op. cit.*

36 ILO (2014), *op. cit.*

- **Shadow economy and environment**.
  A relatively new strand in the literature explores the consequences of the shadow economy for the natural environment, reaching two opposite conclusions. On one hand, businesses in the shadow economy limit the scale of their operations and are often labor-intensive. This can be due to low productivity or trying to hide their shadow economy activities. This scale effect might make shadow economy activities less harmful to the environment than the legal operations. On the other hand, as firms in the shadow economy in general do not attempt to meet any regulatory requirements, they may violate environmental standards from the official sector. Similarly, legal firms may move part of their production to the shadow economy to evade environmental taxes or avoid making green investments. This deregulation effect increases the environmental footprint of the shadow economy. A recent study of Chu and Hoang (2022),[37] based on the panel data of OECD countries, tried to find an answer to the question, which of these effects prevails? The authors concluded that at the low level of the shadow economy, the deregulation effect is more important, and the rise in the shadow economy leads to degradation of the natural environment. However, after reaching a certain threshold, the further growth in the shadow economy improves the ecosystem as the scale effect becomes more pronounced. The authors' policy recommendation is that reduction of the shadow economy would be beneficial for the natural environment, but the countries with lower environmental quality and larger shadow economies will see the benefits only after a significant decline in unregistered activities.

The arguments outlined above illustrate that while the shadow economy may have some advantages, they are likely outweighed by negative consequences of the non-observed economy, especially at the macroeconomic level and in the long run (though it may not be the case for some individual persons). Therefore, we believe it is important to seek tools and solutions that might effectively reduce the shadow economy and its negative outcomes. Such solutions should be, in our opinion, tailored to the specifics of activities that led to the expansion of the shadow economy. For example, in a developing country with a very large share of firms and workers choosing informality as a way of escaping poverty, the transition from the shadow economy to the official market should be much more gradual (and mostly focused on addressing broader underdevelopment challenges and human capital shortages causing low productivity) than in a welfare state where shadow economy is mostly associated with tax avoidance increasing profitability. In particular, it might be beneficial for agencies or organizations to first investigate the size, dynamics and structure of the shadow economy as well as available sectoral insights in a given country. Only after that should appropriate policies be designed and required measures introduced.

37 Chu, L. K., & Hoang, D. P. (2022), *T*he shadow economy–environmental quality nexus in OECD countries: empirical evidence from panel quantile regression, *Environmental Science and Pollution Research*, 29(43), 65233-65258.

Shadow economy around the world

In this chapter, we present our empirical estimates of the shadow economy for more than 130 countries and related outcomes. We begin with a short description of our methodological approach, including key contributions to the literature. Subsequently, we discuss our shadow economy estimates for the world, different income groups, regions and particular countries. We identify key drivers of unregistered economic activity and show their contribution to the shadow economy in various areas. Next, we delve into more detail about a crucial and direct shadow economy consequence — lost government revenues — and present our selected estimates in this domain. Finally, we provide examples of potential further research, shedding light on additional dimensions of the non-observed economy.

3.1. Our approach

Main idea and background of our shadow economy estimation method

For the analysis of the shadow economy, we mainly use the currency demand approach (CDA). The key assumption in the CDA is that unregistered transactions are usually settled with cash (with some exceptions, e.g., illegal transactions with cryptocurrencies). The CDA aims to econometrically break down the demand for cash into two components:

- **Cash used to facilitate the unregistered transactions** (shadow cash), explained with variables described as "shadow economy determinants"
- **Cash used in the formal economy**, explained with control variables

Using certain assumptions, the former component is later translated into the value of the cash shadow economy (see section 2.1 for the definition) as a percentage of GDP.

The idea of the CDA started with early contributions of Cagan (1958),[38] followed by Gutmann (1977)[39] and Feige (1979)[40] and with important developments provided by Tanzi (1980, 1983)[41] and Schneider (1986).[42] Later, more relevant contributions came from Giles and Tedds (2002),[43] Embaye (2007),[44] Ahumada et al. (2008),[45] Thießen (2010)[46] and Ardizzi

38 Cagan, P. (1958), The demand for currency relative to the total money supply, *Journal of Political Economy*, 66(4), 303–328.

39 Gutmann, P. M. (1977), The subterranean economy, *Financial Analysts Journal*, 33(6), 26–27.

40 Feige, E. L. (1979), How big is the irregular economy?, *Challenge*, 22(5), 5–13.

41 Tanzi, V. (1980), Underground economy built on illicit pursuits is growing concern of economic policymakers, Survey no. 4–2 Tanzi, V. (1983), The underground economy in the United States: Annual estimates, 1930–80, *Staff Papers* (International Monetary Fund), 30(2), 283–305.

42 Schneider, F. (1986). Estimating the Size of the Danish Shadow Economy using the Currency Demand Approach: An Attempt. *The Scandinavian Journal of Economics*, 88(4), 643–668. https://doi.org/10.2307/3440435.

43 Giles, D. E., Tedds, L. (2002), Taxes and the Canadian underground economy. Toronto: Canadian Tax Foundation.

44 Embaye, A. (2007), Underground economy estimates for non-OECD countries using currency demand method, 1984–2005, *MPRA Paper 20308*. Germany: University Library of Munich.

45 Ahumada, H., Alvaredo, F., & Canavese, A. (2008), The monetary method to measure the shadow economy: The forgotten problem of the initial conditions, *Economics Letters*, 101(2), 97–99.

46 Thiessen, U. (2010), The shadow economy in international comparison: Options for economic policy derived from an OECD panel analysis, *International Economic Journal*, 24, 481–509.

et al. (2014),[47] to name a few. The CDA framework was further developed by coauthors of this report, including addressing many issues encountered in the previous literature (see Dybka et al. (2019),[48] EY (2019)[49] and EY (2023)[50] for a detailed discussion of the issues and improvements) and analysis of uncertainty of the CDA-based shadow economy estimates (Dybka et al. (2022)).[51]

Because the CDA does not allow us to estimate the non-monetary shadow economy, its calculation is based on a different approach, relating its size with the role of the agricultural sector in the economy.

Pros and cons of the CDA: our key contributions to the literature

Below are some important advantages of the CDA vs. other shadow economy estimation methods:

- **Consistent approach**. It provides a framework that generates comparable shadow economy estimates for many countries and years.
- **Stand-alone methodology**. As opposed to the MIMIC (multiple indicators multiple causes) and D(S)GE (dynamic (stochastic) general equilibrium) approaches, it allows researchers to estimate not only the shadow economy dynamics but, crucially, also the shadow economy level (for analysis and critique of the MIMIC and D(S)GE approaches, see Dybka et al. (2019)[52] and Torój (2023),[53] respectively).
- **Availability of data**. The approach is most often based on publicly available data, so can be applied for many countries at the same time.
- **Limited issues with data quality**. The explained variable in the model (cash in circulation) is quite easily and precisely measured by the central bank, while factors that explain the shadow economy are relatively simple to measure by statistical offices or provided by international institutions (e.g., governance indicators). Therefore, this method is relatively effective regardless of the quality and scope of data available from the statistical office and tax administration in the given country. This contrasts with extensive data requirements for some other tax noncompliance estimation methods.
- **No reliance on exhaustiveness of a statistical office's data.** In particular, our method requires no assumption that the statistical office's data on economic activity accurately accounts for unregistered transactions, which is controversial in many countries but common for many approaches, especially in the area of the VAT gap estimation.[54]

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47 Ardizzi, G., Petraglia, C., Piacenza, M., & Turati, G. (2014), Measuring the underground economy with the currency demand approach: A reinterpretation of the methodology, with an application to Italy, *Review of Income and Wealth*, 60(4), 747–772.

48 Dybka, P., Kowalczuk, M., Olesiński, B., Rozkrut, M., Torój A. (2019), Currency demand and MIMIC models: towards a structured hybrid method of measuring the shadow economy", *International Tax and Public Finance*, vol. 26(1), pages 4-40.

49 EY (2019), Reducing the Shadow Economy Through Electronic Payments. Technical appendices, https://assets.ey.com/content/dam/ey-sites/ey-com/en_pl/topics/eat/pdf/03/ey-shadow-economy-study-technical-appendices.pdf.

50 EY (2023), Strengthening tax compliance by assessing external context and taxpayers' behaviour https://reform-support.ec.europa.eu/publications-0/strengthening-tax-compliance-assessing-external-context-and-taxpayers-behaviour_en.

51 Dybka, P., Olesiński, B., Rozkrut, M., Torój, A. (2022), Measuring the model uncertainty of shadow economy estimates, *International Tax and Public Finance*.

52 Dybka, P., Kowalczuk, M., Olesiński, B., Rozkrut, M., Torój A. (2019), *op. cit*.

53 Torój, A. (2023), House of Cards or Rock Solid? Shadow Economy Empirical Identification with D(S)GE, presentation at the "Shadow 2023" conference in Tallin.

54 This is the case, among others, for:
(1) VAT gap approach used in the European Union: European Commission, Directorate-General for Taxation and Customs Union, Poniatowski, G., Bonch-Osmolovskiy, M., Śmietanka, A. et al. (2022), VAT gap in the EU – Report 2022, *Publications Office of the European Union*
(2) VAT gap methodology supported by the IMF: Hutton, M. E. (2017), The Revenue Administration-Gap Analysis Program: Model and Methodology for Value-Added Tax Gap Estimation, *International Monetary Fund*.
(3) New approach to Evading Value-Added Duty Economy (EVADE) estimation: Pappadà, F., Rogoff, K., (2023), Rethinking the Informal Economy and the Hugo Effect, *NBER Working Papers 31963*, National Bureau of Economic Research, Inc.

- **Identification of shadow economy determinants and support in policy considerations**. Crucially, the CDA enables us to identify key drivers of the shadow economy and shows their changing contributions over time, thereby allowing better understanding of the shadow economy generation process, important areas for improvement and designing policies that could help address this issue.

Naturally, as with any analytical method, there are also some weaknesses. In the EY research we address many of the CDA disadvantages, hoping to have enhanced this method and contributed to the economic literature (see details in the technical appendix):

- **Model selection**. The CDA is based on an econometric model, so any issues with the right selection of key explanatory variables and estimation of corresponding coefficients impact the shadow economy estimates. To address the explanatory variables and model selection problem, we built a new, very large database with potential factors (see section A.2 and A.3 of the technical appendix), carefully chose the best method for estimation of the model's coefficients (section A.4) and, crucially, used the so-called Bayesian model averaging (BMA) techniques for the objective selection of explanatory variables among hundreds of thousands of their potential combinations (section A.5).
- **Accounting for differences between countries**. When using data for many countries and time periods (as in our case), additional important explanatory variables can be analyzed and the model's coefficients are estimated more precisely.[55] Yet, it comes at the cost of coefficients that show the average impact of variables in the group of countries, potentially not accounting for important specifics of a given economy. By testing and including in our model statistically significant interactions between the considered variables and GDP, we account for countries' heterogeneity with respect to the level of their economic development.
- **Assumptions for obtaining shadow economy estimates**. Obtaining non-observed economy estimates from the CDA is based on a certain procedure. We improved various steps and assumptions used in translating the econometric model results into the cash shadow economy estimate (e.g., noting that the results apply only to the monetary part of the economy and adjusting for this). In spite of this, some assumptions in the method are very difficult (if not impossible) for empirical verification, e.g., the assumption regarding the equal velocity of money (average number of transactions conducted by a monetary unit in a given period of time) in the registered and shadow economies.
- **Extensions of the analysis**. Finally, the standard CDA enables users only to investigate the shadow economy size at the national level and over time. By using different analytical methods, we provide for selected countries additional insights into the shadow economy and tax gap including their disaggregation into sectors, regions, and types of persons or businesses (see section 3.5).

A detailed description of our approach and data used is included in the technical appendix, which is divided into different thematic sections.

55 For example, quality of institutions or taxation vary mainly between countries, while their changes within states are more likely to be observed in the long term. In such case, our data structure is superior to data only for one country or period.

3.2. Shadow economy estimates

As a result of EY analysis, we obtained estimates of the total shadow economy for 131 countries.[56] Due to data availability, in our model estimation we focused on 101 states in the 1996–2020 period. At the later stage of work, we collected new data points and made certain assumptions when the data was missing to obtain the results for an additional 34 countries and to cover the 2021–23. Finally, due to outlying values, we decided to exclude from the results four countries.

Shadow economy in the world

We start with the broadest perspective possible, looking at shadow economy estimates for the whole world (see Chart 1). To underline their different aspects, we use three aggregation methods of country-level figures into global values: evolving country weights based on GDP, fixed country weights based on GDP in 2023 and the arithmetic mean.

Our first focus is the size of the problem. According to our estimates, the shadow economy accounted for 11.8% of the global GDP in 2023. The arithmetic average of country-level results is higher and amounts to 19.3%, because many lower-income and, as a result, smaller economies are more affected by unregistered transactions. These figures are to summarize more detailed data, but it is important to note that there is no single global fiscal pool.

Next, we investigate the trends. For the global GDP, there was almost no difference in the shadow economy role between 2000 (12.0% of the global GDP) and 2023 (11.8% of the global GDP) and there was even a temporary increase in the 2009–17 period. The good news is that this outcome is a statistical artifact.[57]

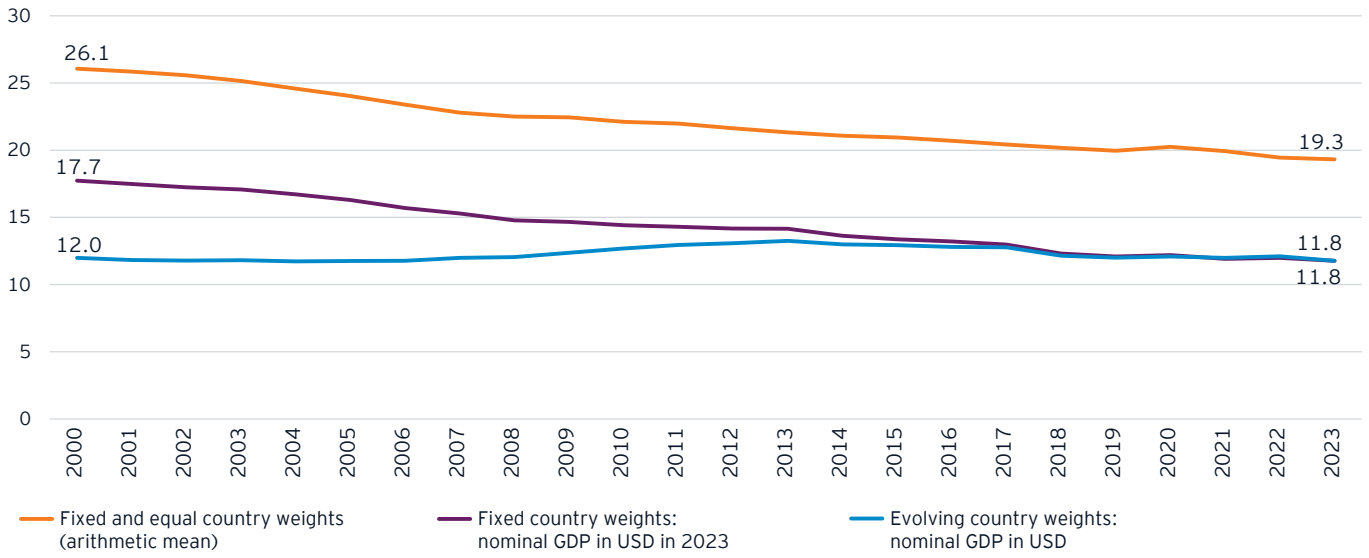
Some big countries which have relatively large unregistered economies, have been growing quickly. As they grow, they contribute more to the world's GDP, and that naturally affects the global shadow economy figures. By contrast, when we look at most individual countries and world aggregates with country weights fixed over time, there is a noticeable trend. From 2000 to 2023, the shadow economy actually shrank. It was a drop from 17.7% down to 11.8% of GDP – and that is when we use each country's GDP in 2023 as the weight. Using the arithmetic mean, where each country is weighted equally, the decrease is from 26.1% to 19.3%. Either way, there is a significant reduction in the shadow economy size, which is a positive trend.

The latter two methods of data aggregation also bring additional insights. Unfortunately, in most cases, a significant contraction of the shadow economy requires decade rather than a few years. We noted the non-observed economy shrank faster up to 2008 than in the following years. There were also minor variations from the general downward trajectory of the shadow economy over time, including a flattening of the trend in 2009 after the global financial crisis and a small increase in the pandemic year 2020.

56 By total shadow economy we mean the sum of the cash shadow economy and non-monetary shadow economy (see definitions in section 2.1). This does not cover some shadow economy transactions conducted with electronic payments (e.g., illegal services purchased with cryptocurrencies). Yet, the value of such transactions, at least for the time being, should be relatively small in majority of countries.

57 Statistical artifact is in this case a potentially misleading data pattern resulting from the way the data was analyzed (using evolving country weights based on current GDP).

Chart 1. Shadow economy in the world (percentage of GDP)



Notes: Based on the aggregation of our country-level shadow economy estimates. Countries covered by EY analysis account for 97.2% of global GDP and 95.6% of global population. Evolving country weights with nominal GDP in USD show the role of the shadow economy in global GDP. Fixed country weights with nominal GDP in USD in 2023 show such outcomes if the contributions of various economies to global GDP were as in 2023. Fixed and equal country weights show the arithmetic mean of shadow economy estimates for the analyzed countries.

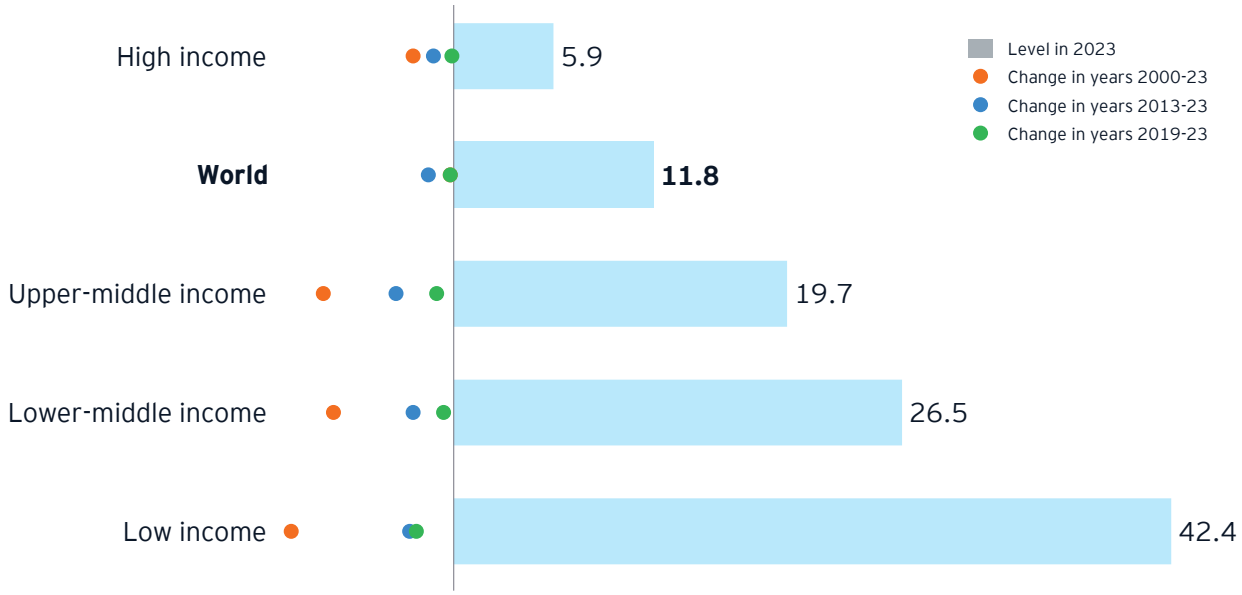
Source: EY analysis

Division by income groups

Breaking down our shadow economy results into various income groups reveals additional findings. Chart 2 illustrates the shadow economy (as a percentage of GDP) divided into four income groups. The bars represent our estimates of the shadow economy in 2023, demonstrating a negative correlation between income and the shadow economy level. What is more, the difference between upper-middle and lower-middle income countries is significantly smaller than if we compare these groups with high-income and low-income economies, respectively. In high-income countries, the level of the shadow economy was just 5.9% of GDP, while in low-income states it amounted to as much as 42.4% of GDP.

Dots on the chart indicate changes in the periods of 2000–23, 2013–23 and 2019–23, showcasing that the shadow economy was gradually declining in the analyzed groups. The largest reductions were observed for low-income countries, with a 9.6% GDP decline over 23 years and 2.2% GDP between 2019 to 2023. High-income countries exhibited the least variation in the shadow economy over the analyzed periods – a result of a lower scale of unregistered activities in this group and relatively stable socioeconomic conditions.

Chart 2. Shadow economy by income groups, level in 2023 (bars) and changes over time (dots) (percentage of GDP)



Notes: Weights used for countries aggregation: nominal GDP in USD (evolving country weights over time). Year used for countries classification into income groups: 2022 (fixed classification over time to avoid the effect of countries falling in and out of different groups). The division into income groups is based on the World Bank's classification[58] and is made according to 2022 gross national income (GNI) per capita (converted from local currency with the World Bank Atlas method in order to smooth exchange rate fluctuations). Countries are categorized as: high income (GNI per capita of $13,846 or more), upper-middle income (GNI per capita between $4,466 and $13,845), lower-middle income (GNI per capita between $1,136 and $4,465) and low income (GNI per capita lower than $1,135). Dots (changes over time in percentage of GDP) for the world aggregate are not always between dots for different analyzed groups due to the composition effect.

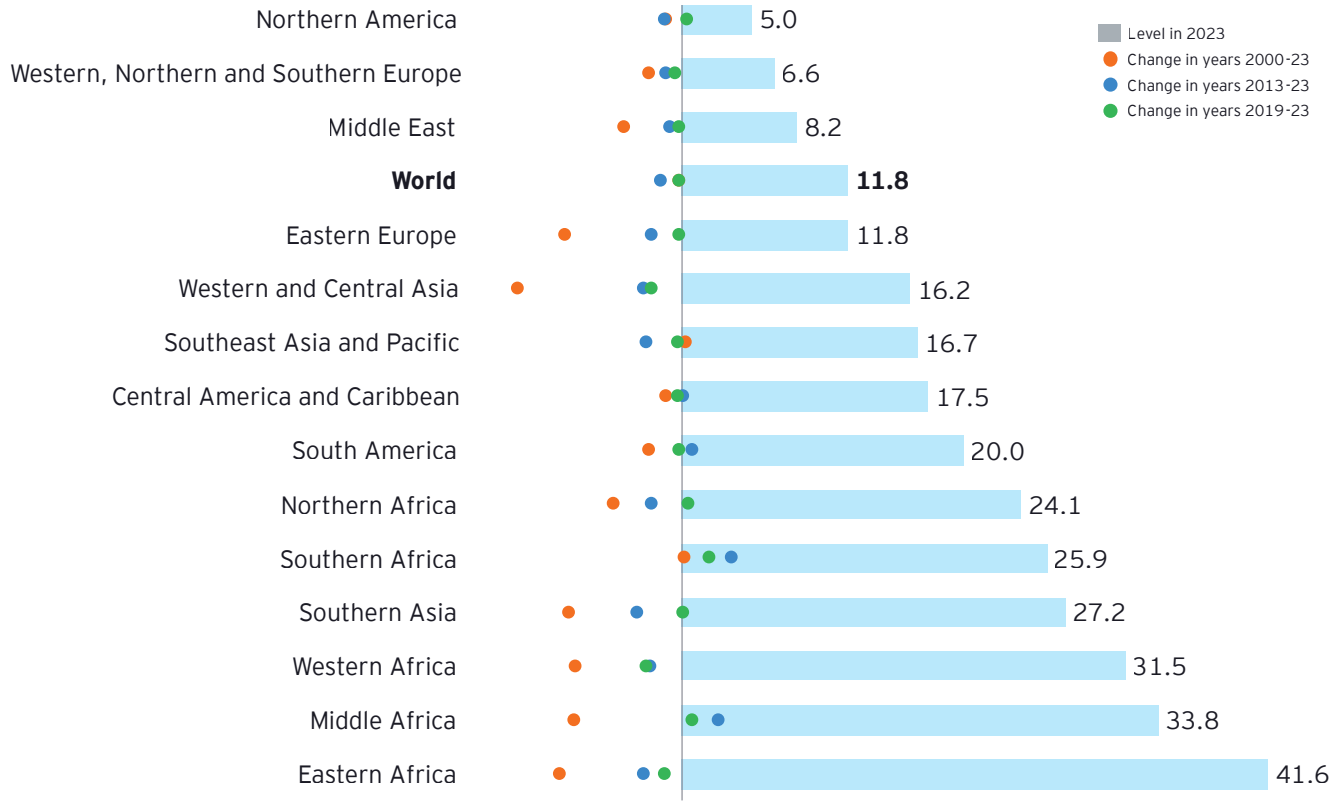
Source: EY analysis

58 https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html.

Regional breakdown

To further explore the shadow economy outcomes, we divided them into 14 distinct geographical regions (see Chart 3).[59] In 2023, the lowest values were observed in Northern America[60]; Western, Northern and Southern Europe; and the Middle East (they ranged from 5.0% to 8.2% of GDP). In contrast, the shadow economy level was the highest in distinct parts of Africa and in Southern Asia (it varied between 24.1% and 41.6% of GDP). The changes over time, indicated by dots, demonstrate that the most significant progress in reducing the shadow economy in the long run can be attributed to Western and Central Asia. Meanwhile, shadow economies grew in Southeast Asia and the Pacific as well as in Southern Africa.

Chart 3. Shadow economy by regions, level in 2023 (bars) and changes over time (dots) (percentage of GDP)



Notes: Weights used for countries aggregation: nominal GDP in USD (evolving country weights over time). See section A.7 for the regional aggregation of economies (in particular, Northern America includes only the US and Canada).
Source: EY analysis

59 For countries' classification into regions see section A.7 in the technical appendix.

60 This region includes only the United States and Canada, not to be confused with North America.

Individual countries

In this section, we present our shadow economy estimates for all the analyzed countries (Chart 4; for table with exact numbers, see section A.8 in the technical appendix). The results for 2023 vary significantly across countries, with Sierra Leone showing the highest level of the shadow economy (64.5% of GDP) and United Arab Emirates exhibiting the lowest level (2.1% of GDP). For illustrative purposes, if we divide our estimates into quartiles, we obtain the following conclusions: the shadow economy rate is below 7.6% in 25% of countries, less than 17.9% in half of the countries and under 26.9% in approximately 75% of countries. What is more, these numbers are likely downward biased. Since the countries missing from our analysis (due to unavailability of data) are relatively often characterized by low income and other socioeconomic issues, they probably also have relatively many unregistered transactions.

Furthermore, Chart 4 illustrates that the changes in the shadow economy were quite divergent among the analyzed countries. Some countries experienced significant fluctuations in the level of unregistered activities, while others had only minor adjustments. Yet, it is very important to underline that as many as 119 states (out of 131 with our estimates) saw a shadow economy reduction in the years 2000–23 (103 in 2013–23 and 95 in 2019–23). A reduction of the shadow economy by more than 10% of GDP was observed in 36 countries, while 67 states experienced a contraction exceeding 5% of GDP. The average reduction of the non-observed economy amounted to 6.7% of GDP (2.0% of GDP in 2013–23 and 0.6% of GDP in 2019–23).

There are a few **caveats to our results**. To make the analysis manageable for so many states, the presented estimates are based on an econometric model that, on average, best fits the data for all countries included in our estimation sample.[61] However, the specifics of a country may sometimes require a more in-depth analysis. When focusing exclusively on a particular state, we delve deeper and, if necessary, adjust the model to better align with its data.[62] In addition, our estimates are based on the identified drivers of the shadow economy that approximate relevant issues in this context (see section 3.3). If the value of a driver for a country is influenced by highly specific local factors or data collection challenges, this may skew our shadow economy estimates. In such cases, a more in-depth country-level analysis would be needed.[63]

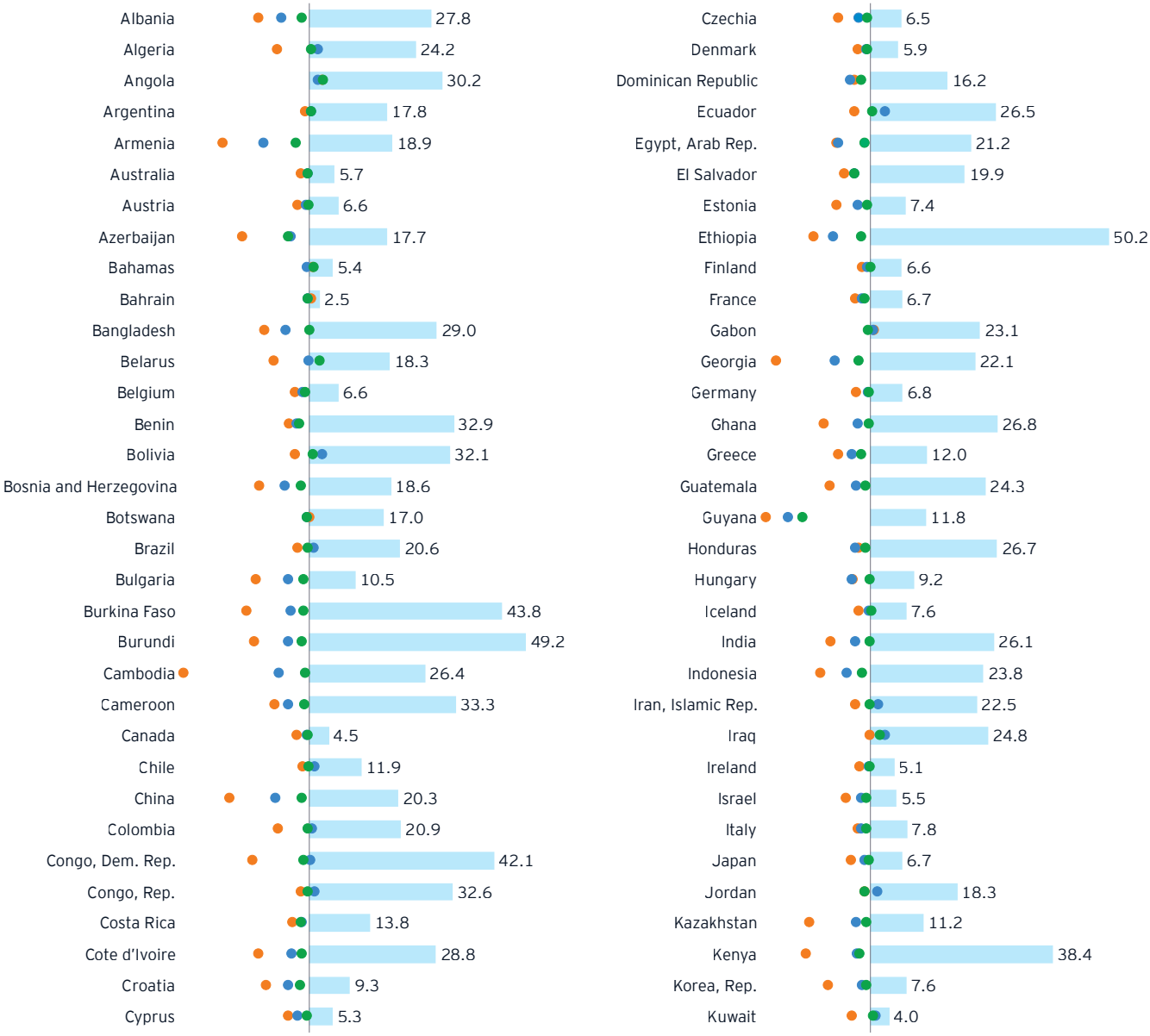
As an additional note, our experience shows that many people expect a much higher shadow economy in their country than what is realistically possible. There are a few reasons for that, including confusion of different concepts and focusing too much on selected aspects of personal experience as a consumer (see section A.8 of appendix for a detailed discussion).

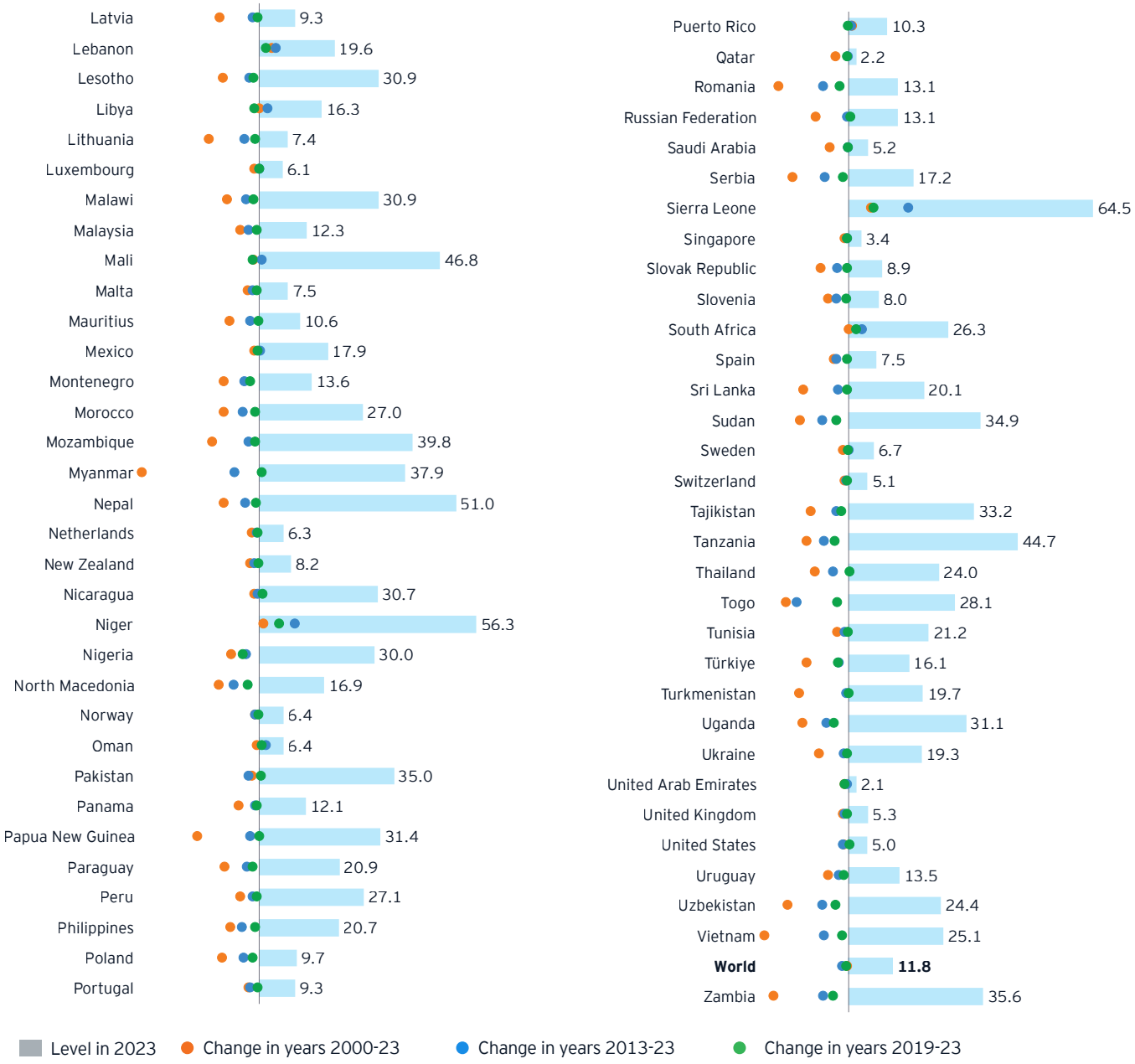
61 While we made the selection of explanatory variables as objective as possible and introduced so-called interaction terms with GDP per capita, to better account for some common specifics of countries at different level of economic development (see section A.5 and A.6 in the technical appendix), these cannot control for all specific cases.

62 For instance, our previous research has demonstrated that a tailored approach might be required for countries with a significant oil and mining sector, where state ownership is predominant. Another example is Italy, where external evidence, including research from the Italian statistical office, suggests that our estimate of the shadow economy in this country might be too conservative. This evidence indicates that the need for further, in-depth analysis could be relevant even in high-income countries.

63 For example, among our identified drivers of the shadow economy is the ratio of the so-called contributing family workers in the adult population. This ratio, for many countries, is expected to be strongly correlated with the prevalence of informal employment and enterprises, for which estimates are considerably less abundant. However, in some countries, such as Cambodia and Kazakhstan, the value of this ratio in the available data is unexpectedly low. This contrasts with some existing research that suggests informal employment plays a significant role in these countries.

Chart 4. Shadow economy by country (percentage of GDP), level in 2023 (bars) and changes over time (dots)





Notes: Countries sorted in alphabetical order. Weights used for the world aggregate: nominal GDP in USD (evolving country weights over time). Estimates based on the econometric model that, on average, best fits the data for all countries in the estimation sample. For some countries in-depth analysis accounting for their specifics may bring more precise estimates.

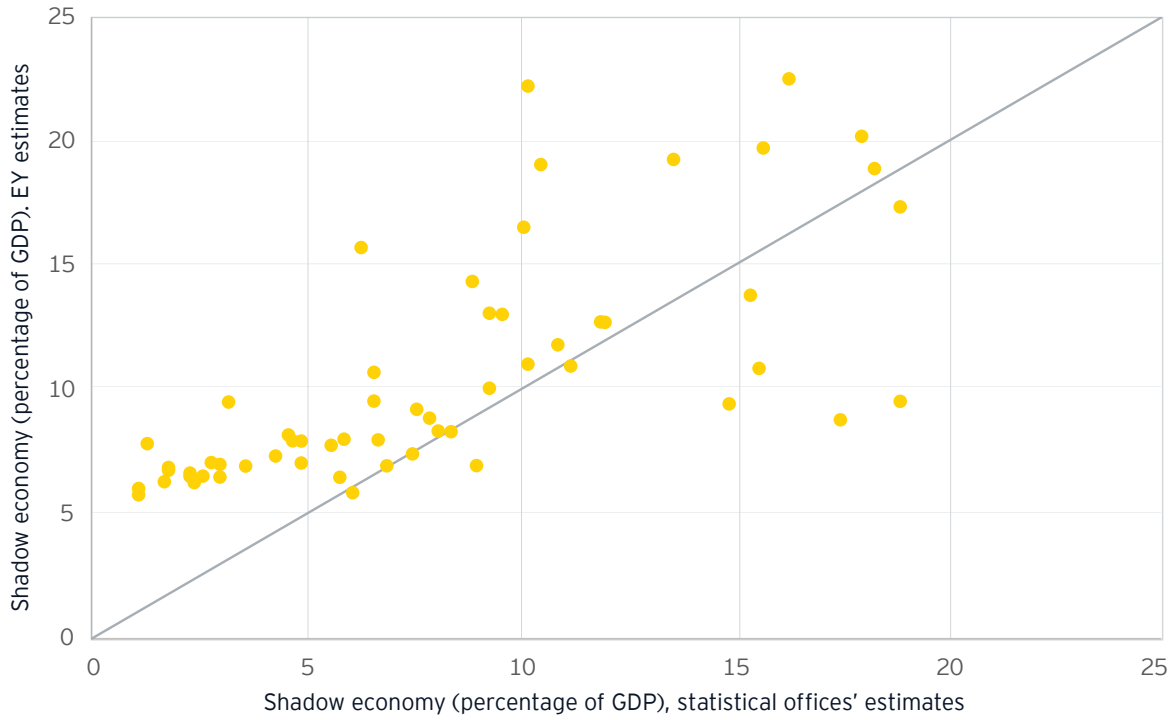
Source: EY analysis

Comparing the shadow economy estimates

Having shadow economy estimates for so many countries and time periods, we have an opportunity to compare them with other interesting data.

First, we assess our figures against the existing estimates of the non-observed economy by statistical offices (see Chart 5). We focus on the estimates for the EU and European Free Trade Association (EFTA) countries (see Fernandes (2022)),[64] since they are most readily available. Such countries should apply similar guidelines of Eurostat, at least for the more recent periods. We found a high and positive correlation between the estimates from the statistical offices and our estimates. The dashed line illustrates a hypothetical case in which the estimates are equal. While many points on the chart are close to this line, there are some exceptions, especially for countries with a relatively large shadow economy and data points for the early 2000s, when the Eurostat's guidelines were less precise and likely less often applied. The differences between our and statistical offices' estimates are quite symmetrical (sometimes positive, sometimes negative), suggesting no consistent bias in our results. Importantly, the recent research on the analyzed figures of statistical offices (Fernandes (2022)) concludes that there are still large methodological gaps between different EU countries: "These figures depend heavily on national accounts compilation particularities in each Member State." This makes such estimates less comparable with any analytical method, including our approach. By contrast, since we apply exactly the same methodology for different countries, our ranking of states according to the shadow economy size may be more consistent than classification based on the estimates provided by national statistical offices.

Chart 5. Comparison of EY and statistical offices' shadow economy estimates, EU-28 and EFTA countries, different years



Notes: Romania was removed as an outlier in statistical offices' estimates. First, its non-observed economy was more than two times larger than all but one figure for other countries. Second, as much as 4.2% of GDP in its total non-observed economy was related to "statistical deficiency in the data" category, making the estimate less reliable.

Source: EY analysis, Fernandes (2022)

64 Fernandes A. (2022), The non-observed economy in the national accounts, *KU Leuven Working Paper*, October 2022.

Next, we investigate the link between GDP per capita and the shadow economy, despite GDP alone not being a direct determinant of the shadow economy in our model (it can approximate a few other relevant drivers, though). Chart 6 confirms that higher economic development is associated with a lower shadow economy. However, the strength of this relationship is weakening for higher GDP levels. This suggests that the higher the country's GDP is, the more difficult it is to further reduce the non-observed economy. Our analysis is also useful for checking whether a given country's shadow economy is above or below its expected size given the country's economic development level.

Chart 6. Correlation between the shadow economy and GDP per capita, 2023

Notes: Ireland, Luxembourg, Singapore and Qatar (countries with very large GDP per capita) were removed as outliers.
Source: EY analysis

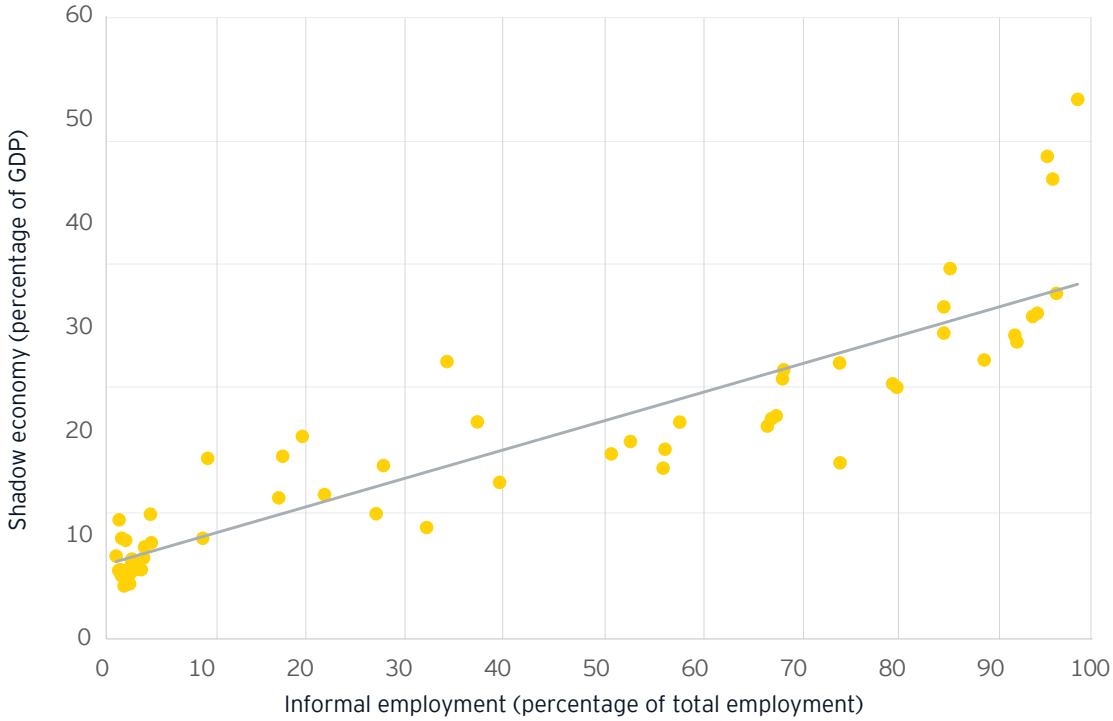
Further, we examine our shadow economy estimates against informal employment rates[65] for countries for which such figures are available (see Chart 7). Countries with an elevated role of informal employment tend to exhibit larger shadow economies, indicating a positive correlation between the two issues. Moreover, in most states the informal employment rate is significantly higher than the share of the shadow economy in GDP (for reasons, see section 2.1). The discrepancy is particularly strong where the share of unregistered workers in the labor market is especially elevated.

This suggests that a lot of non-observed production in such states may be due to informal activity of unregistered businesses.[66] In contrast, in countries with a lower shadow economy there are likely more issues with underreporting of transactions by registered businesses. This finding is important, because different policies should be considered for such structures of the shadow economy (see Chapter 4). It is also linked with the two types of the cash shadow economy – passive and committed – that we distinguish in our research (see section 2.1).

65 See section 2.1 for definitions, links and differences.

66 As we mentioned earlier, productivity in this type of activity is often low.

Chart 7. Correlation between informal employment and the shadow economy, 2022



Notes: Estimates for the informal employment rate were obtained from the International Labour Organization (ILO).

Source: EY analysis (shadow economy), ILO (informal employment)

Finally, we discuss the shadow economy estimates during the pandemic period. Our shadow economy model contains a cyclical component related to the changes in the unemployment rate and to GDP (which interacts with the two shadow economy variables from our model, where one of them is the unemployment rate). Nevertheless, during the pandemic years, there were visible changes in the structure of the economy and significant policy interventions, which our approach does not directly account for. At that time, various restrictions were introduced, which made some entrepreneurs move their business to the shadow economy (as there was sometimes no other way to continue their activity). Individuals exposed to large financial losses were also motivated to undertake similar actions. Chart 8 depicts the changes in the simplified misery index (a measure that captures changes in unemployment and GDP) and our shadow economy estimates (as a percentage of GDP) between 2019 and pandemic year 2020. In line with our results, the pandemic-related economic crisis has induced more activity in the shadow economy.

There are also two important observations in the policy context. First, in countries with a controversial and poorly communicated government response to the pandemic, the decline in government trust, tax morale and, as a result, an increase in the shadow economy may last for some years. Second, the pandemic showed an additional benefit of registering business operations. Since in many countries the scale of the government support was conditional on declared revenues or employment in the previous accounting period, the companies that hid part or all of their activity were not fully or at all entitled to financial aid.

Chart 8. Pandemic's impact on the shadow economy level, 2019–20 change

Notes: The change in the (simplified) misery index stands for the sum of the percentage decline in GDP and increase in unemployment rate (in percentage points). It means that the higher value of the index change indicates a more severe economic downturn. Guyana was removed as an outlier.

Source: EY analysis

3.3. Drivers of the shadow economy

As we explore the drivers of the shadow economy, we begin with a look at the existing literature, then move to our results.

Types of shadow economy determinants in the existing literature

The existing literature on the shadow economy determinants applies different theoretical frameworks. Using the OECD (2004)[67] BISEP model (further discussed in Chapter 4), shadow economy determinants could be divided into the following types:

- **Business factors** (e.g., size and legal form of the business)
- **Industry factors** (e.g., the level of competition, working patterns, productivity and regulations specific to the taxpayer's industry)
- **Sociological factors** (e.g., age, gender and education of the taxpayer)
- **Economic factors** (e.g., investments, taxation, macroeconomic and labor-market situation, influence of the international markets)
- **Psychological factors** (e.g., values, the level of risk tolerance, greed, taxpayer's assessment of the opportunities to evade)

Another approach, e.g., applied by EY (2023),[68] is to break down determinants according to their role in influencing the tax compliance, especially from the perspective of tax administration. Such defined drivers can be grouped into:

- **Direct factors** related to the work of tax administration and government (e.g., tax system or structure, tax rate, tax at risk, perceived probability of detection, third-party reporting available,[69] perceived tax system quality)
- **Indirect factors** related to characteristics of taxpayers that are quite constant over time (e.g., demographics, education, household type, sector, occupation, business form)
- **Attitudes and perceptions** of taxpayers that could be to some extent influenced by policy measures but rather in the long run (e.g., perceived fairness of tax system and public governance/service quality, trust in government, social norms, risk appetite)

Finally, in macroeconomic research,[70] the following categories are often identified and considered causes of the shadow economy:

- **Rule of law and government effectiveness**. A sense of being protected by the law can be related to stable regulations and an effective judicial system. This creates incentives to abide by the law and act in the registered economy. Furthermore, increasing the risk of detection discourages individuals from entering the shadow economy. By contrast, a low-quality administration and justice system, along with widespread acceptance of noncompliance, may be conducive to entering or remaining in the non-observed economy.
- **Values and attitudes**. A high level of trust in other people, government and related high tax morale discourages violating the law, including activity in the shadow economy.
- **Taxes and social contributions**. Perceived benefits of avoiding the payment of income tax, VAT and other taxes as well as social security contributions are often considered an important factor driving individuals into the non-observed economy.

67 OECD (2004), Compliance Risk Management: Managing and Improving Tax Compliance (guidance note).

68 EY (2023), Strengthening tax compliance by assessing external context and taxpayers' behaviour https://reform-support.ec.europa.eu/publications-0/strengthening-tax-compliance-assessing-external-context-and-taxpayers-behaviour_en.

69 For examples of third-party data used by tax administration see section 4.5.

70 See, for example, Thiessen U. (2010), "The Shadow Economy in International Comparison: Options for Economic Policy Derived from an OECD Panel Analysis", *International Economic Journal*, vol. 24(4), pages 481–509.

- **Administrative and regulatory burden**. Registration of activity may be hindered by administrative burdens and different regulations that are costly for businesses to comply with.
- **Business cycle**. An economic slowdown and reduced opportunities to obtain income and find a job in the official sector may encourage people to engage in non-observed activities.
- **Structure of the labor market**. High prevalence of specific labor market structures, such as self-employment, own account work, family work and precarious work, may be associated with a higher level of informal activity.
- **Payment practices**. Cash payments leave fewer traces, so transactions performed using cash are more likely to be unregistered than digital payments.

Our empirical analysis

There are two important caveats to the existing literature differentiating drivers of the shadow economy. First, there are many studies with quite a narrow focus. Thus, they do not enable a strong comparison of various shadow economy determinants and their effects or any generalizations to the macroeconomic level. This is often a result of applying analytical methods to a selected country or over a relatively short time, often with a limited range of analyzed types of businesses or individuals. Second, there is a large stream of research where such drivers are determined at the macroeconomic level within or using the estimates from the MIMIC and D(S)GE models. Such models require stronger assumptions than the CDA and suffer from various methodological issues (e.g., they mostly account for shadow economy dynamics but not its level; for the discussion of the issues with the two models, see Dybka et al. (2019)[71] and Torój (2023),[72] respectively). In addition, depending on the study, the number of considered shadow economy determinants can be limited and the process of selecting the best among them may not always be transparent.

In our approach, we aimed to identify the key drivers of the shadow economy at the country level, considering a wide range of potential determinants and using a procedure that is as objective as possible. We initially evaluated as many as 71 different variables. After excluding those for which not enough data was available, our list still included more than 40 variables (see sections A.2 and A.3 of the technical appendix). This gave us an enormous number of combinations of determinants and related models. To navigate and select the best explanatory variables, we applied a three-step procedure. First, we carefully chose the method for estimation of the model's coefficients based on a sample of considered models (section A.4). Second, we used the BMA techniques for the summary and objective selection of explanatory variables out of hundreds of thousands of their combinations (section A.5). Third, based on the BMA outcomes, we compared several pre-selected models and chose the final one based on its various statistical properties as well as consistency with economic theory and research (section A.6). As a result of our comprehensive procedure, we identified the following variables as key drivers of the shadow economy (see Table 1 for their detailed description and data sources):

- **Government effectiveness** (name of the variable in our dataset: GOV_EFFECTIVENESS)
- **Integrity of the legal system** (INTEGRITY)
- **Contributing family workers** (FAMILY_WORK)
- **Tax rates** (TAX_RATES)
- **Unemployment rate** (UNEMP)

According to our model, an increase in the quality of public services and policy formulation (government effectiveness) as well as more transparent and impartial laws (integrity of the legal system) are associated with the reduction of the shadow economy. On the other hand, high prevalence of family-based work relationships (contributing family workers) and problems with finding a job (unemployment) stimulate the expansion of the shadow economy. It is also the case for elevated tax rates, holding all other factors constant. Yet, lower tax rates (if associated with

71 Dybka, P., Kowalczuk, M., Olesiński, B., Rozkrut, M., Torój A. (2019), *op. cit.*

72 Torój, A. (2023), House of Cards or Rock Solid? Shadow Economy Empirical Identification with D(S)GE, presentation at the "Shadow 2023" conference in Tallin.

stimulate the shadow economy through deterioration of public institutions' quality.

In addition, our analysis of the so-called interaction terms in the model shows that the impact of government effectiveness and unemployment on the shadow economy declines with the economic development level. For joblessness in higher-income countries, it could be linked with lower incentives or opportunities to engage in unregistered activity despite turbulences on the labor market (e.g., due to more accumulated savings and wealth, more available social security, better options to borrow money).

For improvements in government effectiveness, their impact on the shadow economy may be lower in more affluent countries, e.g., due to the more complex nature of the remaining shadow economy there (which requires increasingly large efforts to be reduced). In contrast, the impact of the other identified drivers does not seem to vary with economic development level.

For more detailed results, including the estimated model's coefficients and their interpretation, see section A.6 of the technical appendix.

Table 1. Variables in the final econometric model of the currency demand and cash shadow economy

Group of variables	Name of the variable	Short description and source
Dependent (explained) variable	CASH_M1	Share of the currency in circulation in the M1 monetary aggregate (currency in circulation + transferable deposits), %. *Source: International Monetary Fund*
Shadow economy determinant: institutional/ regulatory	GOV_ EFFECTIVENESS	Indicator measuring the government effectiveness from the Worldwide Governance Indicators. It ranges from approximately -2.5 (low government effectiveness) to 2.5 (high government effectiveness). It reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.* *Source: World Bank – Worldwide Governance Indicators*
Shadow economy determinant: institutional/ regulatory	INTEGRITY	Integrity of the legal system, index with values from 0 (worst) to 10 (best). It reflects strength and impartiality of the legal system, popular observance of the law and compliance with the High Court, judicial review, transparent laws with predictable enforcement, and access to justice. *Source: Economic Freedom of the World, Fraser Institute*
Shadow economy determinant: labor market/ role of small and specific entities	FAMILY_WORK	Ratio of the number of contributing family workers to the population aged 15-64, %. Contributing family workers are own-account workers in the market-oriented business that is conducted by a related person who lives in the same household. *Source: International Labour Organization, own calculations*

Group of variables	Name of the variable	Short description and source
Shadow economy determinant: business cycle	UNEMP	Unemployment rate, percentage of total labor force (economically active population). The same definition as "unemployment rate" (percentage of total labor force) in the IMF, for which there are publicly available forecasts. *Source: World Bank – modeled ILO estimate*
Shadow economy determinant: taxation	TAX_RATES	Average of standard value-added tax (VAT) rate and corporate income tax (CIT) rate, % *Source: VAT – International Monetary Fund, CIT – Tax Foundation*
Control variable and for interactions with selected shadow economy determinants (modifying the determinants' impact depending on the GDP level)	GDP_PER_CAPITA	GDP per capita based on purchasing power parity (PPP), thousands of constant 2017 international dollars. The same definition as "gross domestic product per capita, constant prices" (purchasing power parity; 2017 international dollar) in the IMF, for which there are publicly available forecasts. *Source: World Bank – International Comparison Program, World Development Indicators database, Eurostat-OECD PPP Programme*
Control variable	URBAN_POPULATION	Share of urban population in the total population, % *Source: World Bank – United Nations Population Division, World Urbanization Prospects: 2018 Revision*
Control variable	CREDIT_GDP	Domestic credit to private sector, percentage of GDP *Source: World Bank – International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates*
Control variable	INTERNET_ACCESS	Share of population with internet access, % *Source: World Bank – International Telecommunication Union*
Control variable	DUMMY_IND	Binary variable controlling for the effect of demonetization in India in 2016, 2016=1 *Source: EY analysis*
Control variable	DUMMY_ROU	Binary variable controlling for the credit boom in Romania starting in 2007, 2007-10=1 *Source: EY analysis*

Notes: The table shows not only the shadow economy determinants (drivers) but also control variables that explain the non-shadow economy-related components of the demand for currency.

** We are aware that the government effectiveness indicator is prepared in such way that its average value among countries is equal to zero in each year. Yet, due to very small changes over time for the global average value of the indicator in the raw (unscaled) data, it can also be used in the panel data setup, which is often done in various research. In addition, we checked that even if we accounted for small changes in the global average over time, it would not significantly impact our estimated coefficient for this variable. For more details see section A.5 of the technical appendix.*

Source: EY analysis

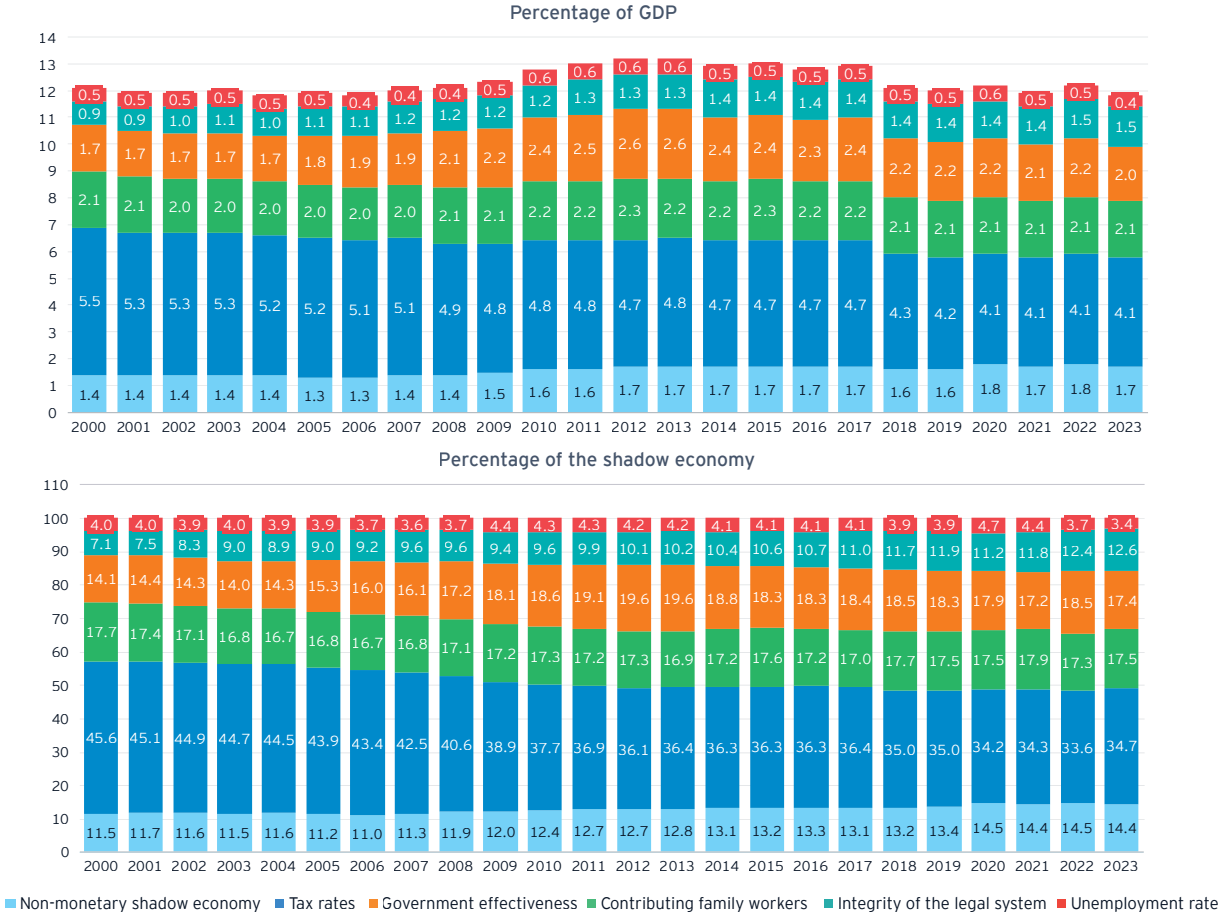
Shadow economy drivers around the world

Based on our model, we calculated the role of different drivers in generating the shadow economy, which varies across the analyzed (groups of) countries. In each chart we present the results in terms of 1) percentage of GDP and 2) percentage of the shadow economy.

Our estimates of the global shadow economy in the years 2000–23 (see Chart 9) show that:

- In 2023, the major drivers of the shadow economy included tax rates (4.1% of GDP or 34.7% of the shadow economy), followed by contributing family workers (2.1% of GDP or 17.5% of the shadow economy), while the smallest role among the identified factors was related to the unemployment rate (0.4% of GDP or 3.4% of the shadow economy).
- The temporary increase in the global shadow economy in 2009–13 was mainly due to the deterioration of government effectiveness observed in countries with a relatively large nominal GDP.
- Over 2000–23, the ranking of shadow economy drivers has remained relatively stable.
- Even though the ranking has not changed much, we saw the largest shift in terms of percentage of GDP occur in tax rates – over the past two decades, their contribution has decreased from 5.5% to 4.1%. There has also been a noticeable increase in the role of integrity of the legal system and government effectiveness. At the same time, the unemployment rate, contributing family workers and the non-monetary shadow economy underwent only a minor change. Similar variations can be observed in terms of percentage of the shadow economy, with the exception of increase in the non-monetary shadow economy (however, changes as a percentage of the shadow economy may be the result of changes in the share as a percentage of GDP of other drivers).

Chart 9. Shadow economy in the global economy: contributions of different factors



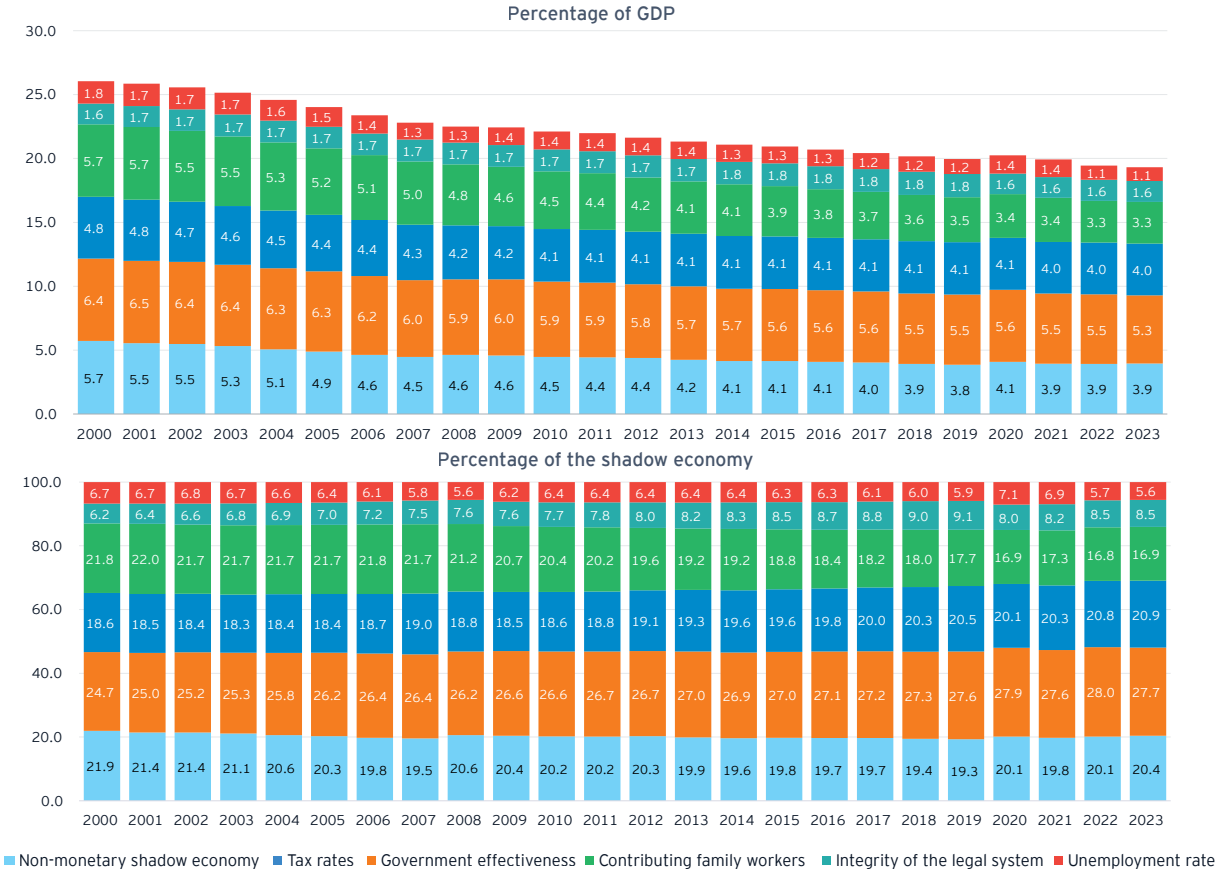
Notes: Weights used for countries aggregation: nominal GDP in USD (evolving country weights over time).

Source: EY analysis

Next, we investigate the results for the average country in the world, which are, in many aspects, different than the insights for the global economy (see Chart 10). As previously discussed, in such approach, the shadow economy has been in a steady downward trend, with the exception of 2020. Our calculations show that:

- In 2023, the key shadow economy driver was related to government effectiveness (5.3% of GDP, 27.7% of the shadow economy), followed by tax rates (4.0% of GDP, 20.9% of the shadow economy), showing that most countries should consider improvements in these crucial but complex area. Other significant factors included the non-monetary shadow economy (3.9% of GDP, 20.4% of the shadow economy) and contributing family workers (3.3% of GDP, 16.9% of the shadow economy), which are related to more traditional structures of some economies.
- The downward trend in the shadow economy in 2000–23 was driven by various factors. The most important have been structural changes in the average country, including a decreasing role of contributing family workers and non-monetary shadow economy size, which was linked with a diminishing role of the agriculture sector.
- The ranking of the shadow economy drivers remained relatively stable, apart from the integrity of the legal system and tax rates, which became more important than the unemployment rate and contributing family workers, respectively.

Chart 10. Shadow economy in the average country: contributions of different factors



Notes: Arithmetic mean of results obtained for different countries.

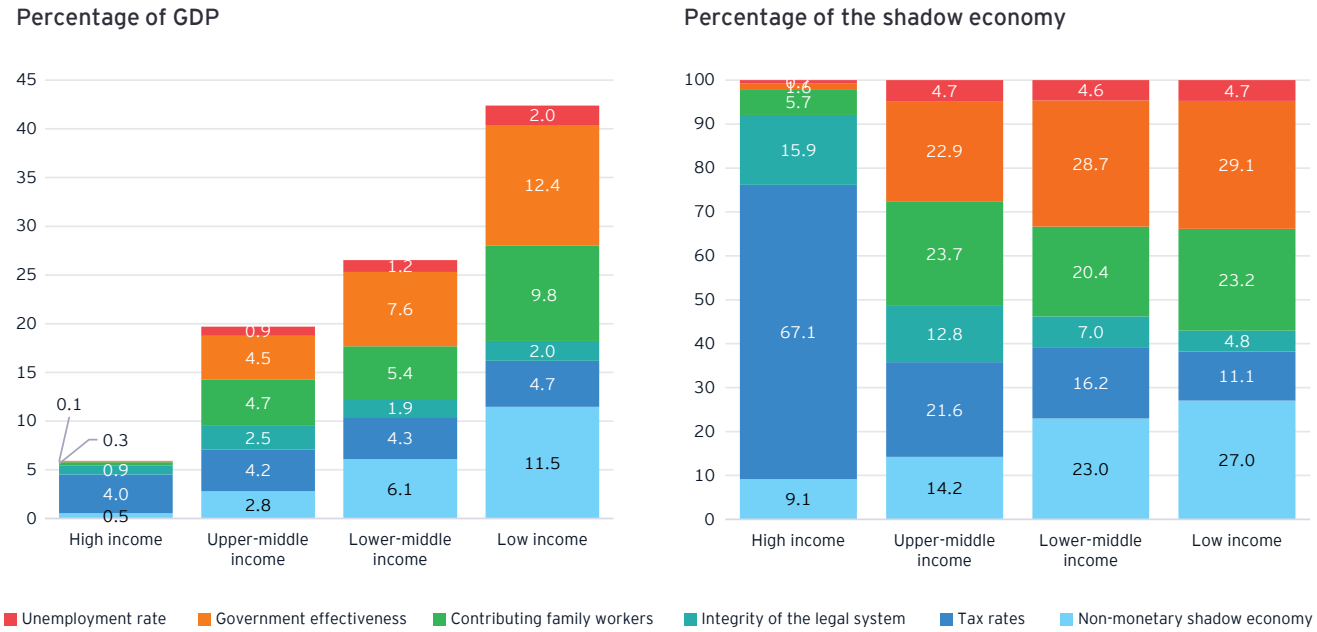
Source: EY analysis

Division by income groups

In the next step, we investigate drivers of the shadow economy across income groups in 2023 (see Chart 11). Our analysis shows that the key sources of the unregistered economy differ considerably between those groups. In terms of percentage of GDP, the share of most shadow economy drivers was higher in countries with a lower income, illustrating that such economies need to cope with numerous sources of the unregistered economy. This is especially the case for the non-monetary shadow economy, government effectiveness and contributing family workers. On the other hand, there were less significant differences between the role of tax rates (however, it could be larger in high-income countries had some Middle Eastern countries and tax havens with low taxes been excluded from this group).

We find that high-income countries differ significantly from other income groups in terms of the key drivers of unreported transactions when measured by their percentage contribution to the shadow economy. Among high-income countries, tax rates play a very large role in generating the shadow economy (67.1% of its total value). Another important determinant is the integrity of the legal system (15.9% of the shadow economy). Along with the decline in income level, the relevance of these two variables diminishes. By contrast, in low-income countries, most important drivers include government effectiveness (29.1% of the shadow economy), the non-monetary shadow economy (27.0% of the shadow economy), and contributing family workers (23.2% of the shadow economy). This shows that high-income states distinguish themselves in their capacity to provide effective governance and maintain superior public services, with relatively low shares of contributing family workers and non-monetary shadow economy.

Chart 11. Shadow economy by income groups: contributions of different drivers in 2023

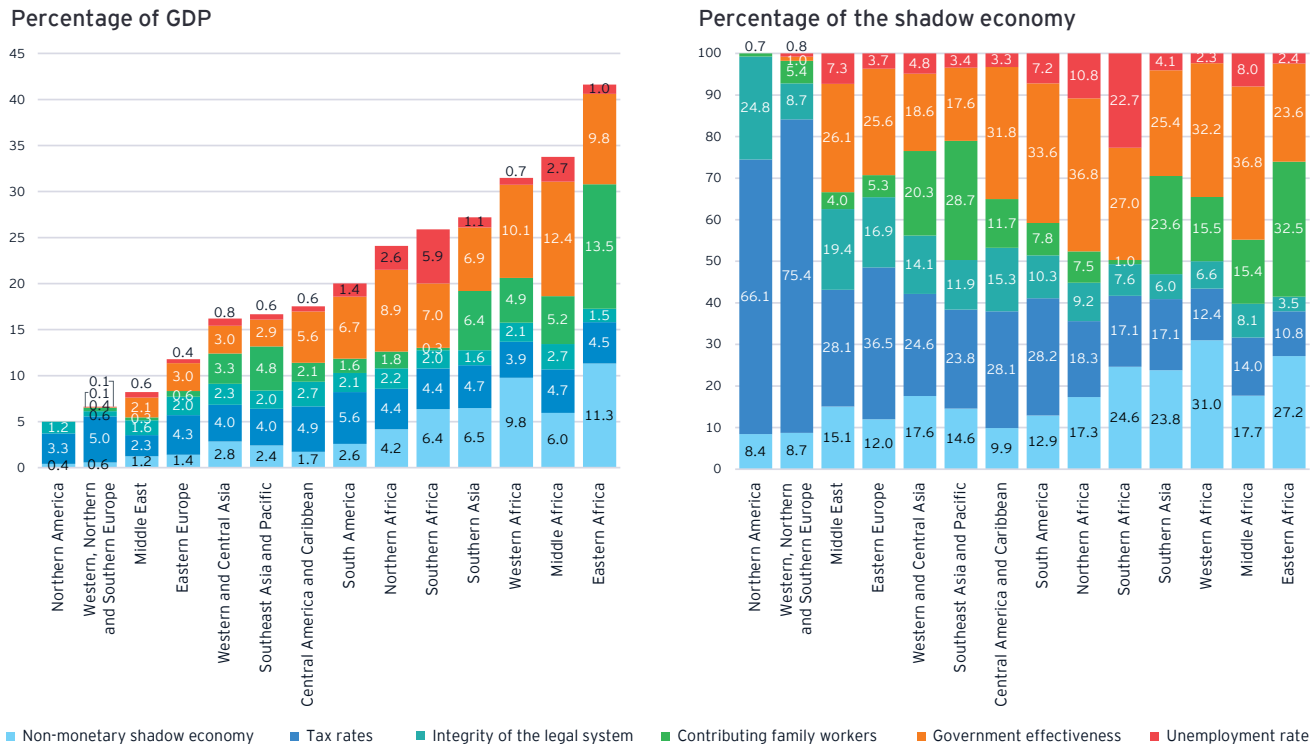


Notes: Weights used for countries aggregation: nominal GDP in USD. Income groups defined as in section 3.2.
Source: EY analysis

Regional breakdown

The data indicates that the role of various shadow economy drivers differs significantly across regions, as shown in Chart 12. Chart 12 stresses the importance of tax rates and the integrity of legal systems in countries with the lowest levels of the shadow economy, particularly in Northern America (66.1% of the shadow economy can be attributed to tax rates, while the integrity of the legal system accounts for 24.8%) and Western, Northern and Southern Europe (75.4% and 8.7% of the shadow economy, respectively). As the unregistered economy level increases, the significance of those factors tends to diminish, reaching 10.8% and 3.5% in the region with the highest shadow economy – Eastern Africa. At the same time, contributing family workers and the non-monetary shadow economy have a greater impact in regions with larger non-observed economies. Government effectiveness turns out to be a significant determinant of the shadow economy in almost all regions, while the unemployment rate usually has a limited impact, with the significant exception of Southern Africa.

Chart 12. Shadow economy by regions: contributions of different factors in 2023



Notes: Weights used for countries aggregation: nominal GDP in USD. See section A.7 for the regional aggregation of economies (in particular, Northern America includes only the US and Canada).

Source: EY analysis

3.4. Impact on government revenues

One of the most important and direct consequences of the shadow economy's existence is lost government revenues, which could otherwise finance various useful goals. A few important points need to be made here.

First, as described in section 2.1, the shadow economy is responsible for a large (often major) part of the tax gap but not all of it. For example, another significant source of the tax gap may be tax frauds, which include criminal activities with the use of fake documents.

Second, even within the scope of the shadow economy, there are some activities that are not or seem impractical to be taxed. For example, although the households' production of goods for own final use (e.g., agricultural output that stays within the farmer's family) is defined as the non-monetary shadow economy, there is likely no sense in its taxation, not least due to issues with valuation and additional burden on (usually) low-income groups. The same logic applies to some informal activities and business operations below a certain legal threshold (for more on this policy aspect, see section 4.2). Further, in the case of illegal activities (e.g., drug selling), the aim of many governments is simply to eliminate them, not to register and tax.

Third, VAT (or sales taxes) and business income taxes (corporate income tax (CIT), personal income tax (PIT) or other tax regimes, depending on the country and form of business) account for most of the tax gap stemming from shadow economy activities. Yet, in some cases a pressure to comply with revenue reporting requirements may, to some extent, be offset by an increase in reported expenses.[73] This may happen for business income tax, if it is based on profits (not revenues) as well as for VAT (via higher input VAT), especially if the scope of expenses that could be treated as tax costs is wide, imprecise and rarely controlled. When it comes to lost PIT revenues due to unreported income of employees, it is related mostly to the scale of shadow (unregistered) employment, not the shadow economy itself (see discussion in section 2.1).

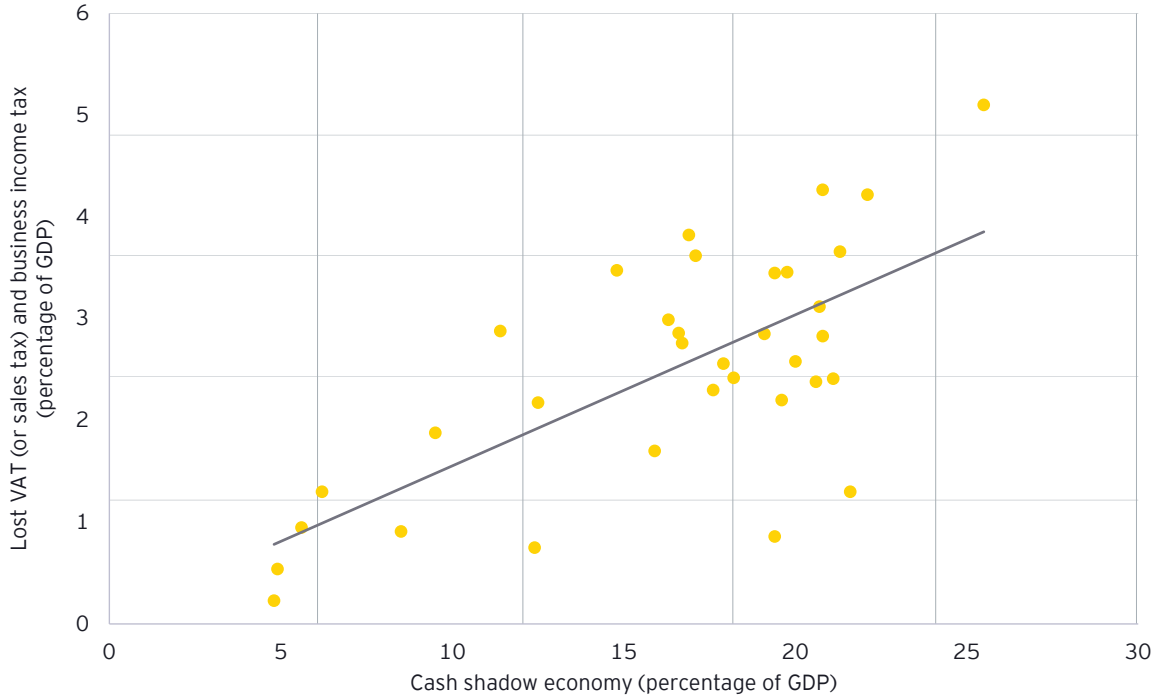
An additional issue in this area could be the so-called envelope wages, i.e., a situation where only a part of remuneration (e.g., equal to the minimum wage) is officially reported, while the remainder is paid out in cash, without any information for tax authorities. In some sectors, an unregistered activity may also decrease revenues from excise tax (e.g., illicit tobacco products).

Due to the various issues described above, there is no simple algorithm to estimate lost government revenues due to the shadow economy for all the countries covered by our analysis. Yet, in our different projects focusing on individual countries, we were able to account for their economy and tax system specifics.[74] Drawing on the results of our previous studies, in Chart 13 we present the estimates of lost government revenues and compare them with the estimated levels of the cash shadow economy in 34 countries. Unsurprisingly, there is a visible positive relationship between them. Yet, due to differences in tax rates and other country characteristics, there may be significant disparities in lost taxes even for a similar scale of unregistered activity.

73 See e.g. Slemrod J., Collins B., Hoopes J.L., Reck D., Sebastiani M. (2017), Does credit card information reporting improve small business tax compliance?, *Journal of Public Economics*, vol. 149, pages 1–19.

74 For example, for our approach in Bulgaria see EY (2023), Strengthening tax compliance by assessing external context and taxpayers' behaviour https://reform-support.ec.europa.eu/publications-0/strengthening-tax-compliance-assessing-external-context-and-taxpayers-behaviour_en.

Chart 13. Cash shadow economy and related lost VAT (or sales tax) and business income tax revenues



Notes: Calculations based on separate EY research for 34 countries. Depending on the country, calculations performed for different years from 2014 to 2022 (we only show estimates for the last available year in a given country).

Source: EY analysis

3.5. Examples of further analyses

In the previous sections, we have analyzed the shadow economy size, related drivers and lost government revenues at the national level. Further insights may be gained by investigating additional dimensions of the unregistered economy and tax gap, including their sectoral and regional breakdowns and the role of individual characteristics of taxpayers. We can also analyze a tax gap from the perspective of different types of government revenues, e.g., VAT or PIT. Once we identify a given part of the economy that is likely to be significantly affected by unregistered or even illegal activities, it is worth considering a more in-depth analysis focusing on this particular area. Such insights could allow governments to better design and target different policy measures, including tax controls. In this section, we briefly present selected approaches and our work in these domains.

Sectors

There is much less research on the shadow economy in sectors than at the national level. The main exceptions include estimates of statistical offices (published only by selected institutions,[75] for aggregate sectors and often with significant delay) and surveys of businesses, which can be negatively influenced by dishonest answers of respondents and issues with representativeness of the sample.

We can analyze the sectoral shadow economy or tax gap with the use of detailed data on taxes and businesses characteristics, if available, for many years and industries as well as various quantitative frameworks. An example of such approach includes our research on the sectoral VAT gap in Bulgaria.[76] However, such analyses are not possible without access to very detailed data that requires cooperation and significant involvement of tax administrations.

As an alternative to data-demanding approaches, we developed the Sectoral Shadow Economy Index (SSEI). SSEI combines various sectoral factors and transforms them into one value per industry that represents its relative size of the shadow economy. These factors include various causes or traces of the shadow economy. They are selected based on the existing research, economic theory and data availability. They may cover, e.g., sectoral data on the role of small companies, consumer transactions, cash payments, competition and issues with taxes (based on business surveys). Each factor (component) value is rescaled to range from 0 to 1. Zero corresponds to the lowest (highest) value of the factor and 1 to the highest (lowest) value of the factor, if the component is assumed to be positively (negatively) correlated with the shadow economy. The final index is computed as a weighted average of all the components (arithmetic mean in the simplest case with equal weights). An exemplary result of such index constructed for Poland in 2024 is presented in Chart 14. It shows that in this country the shadow operations likely play the largest role in the sectors of retail sales at stalls and markets (also some other types of retail), food and beverage service activities and other personal service activities.

75 See, e.g., Fernandes A. (2022), The non-observed economy in the national accounts, *KU Leuven Working Paper,* October 2022.

76 EY (2023), *op. cit*.

Chart 14. Sectoral Shadow Economy Index in Poland: top sectors

Sector code	Sector name	Sectoral Shadow Economy Index
G478	Retail sale via stalls and markets	0.71
I56	Food and beverage service activities	0.71
G479	Retail trade not in stores, stalls, or markets	0.68
G472	Retail sale of food, beverages, and tobacco in specialized stores	0.68
S96	Other personal service activities	0.67
G476	Retail sale of cultural and recreation goods in specialized stores	0.67
R90	Creative, arts and entertainment activities	0.65
I55	Accommodation	0.65
G473	Retail sale of automotive fuel in specialized stores	0.64
R93	Sports activities and amusement and recreation activities	0.64
F43	Specialized construction activities	0.64
F41	Construction of buildings	0.62
G475	Retail sale of household goods in specialized stores	0.62
S95	Repair of computers and personal and household goods	0.62
G471	Retail sale in non-specialized stores	0.61
G474	Retail sale of information and communication equipment in specialized stores	0.61
F42	Civil engineering	0.61
G477	Retail sale of other goods in specialized stores	0.61
H50	Water transport	0.60

Notes: Higher value = higher role of the shadow economy in the sector. Different factors included in the index were based on data for different time periods.

Source: EY analysis

Naturally, the SSEI can only rank the sectors but cannot exactly determine the scale of the shadow economy or lost government revenues in different industries (for that purpose, the analysis would need to be supplemented with a different method, e.g., in the area of sectoral VAT gap, the production-side approach developed by the IMF).[77] Another shortcoming of the index is that the selection of factors and their corresponding weights are arbitrary. This can be addressed with a sensitivity analysis showing a distribution of the calculated index for sectors with different values of weights and components (the weights could be selected at random multiple times and summarized). Our analysis for Poland included such simulations. It showed that the ranking of sectors based on the SSEI was very robust in variation of weights and quite robust to changes in the selected factors. In other words, the impact of researchers' arbitrary choices on the final results turned out to be limited.

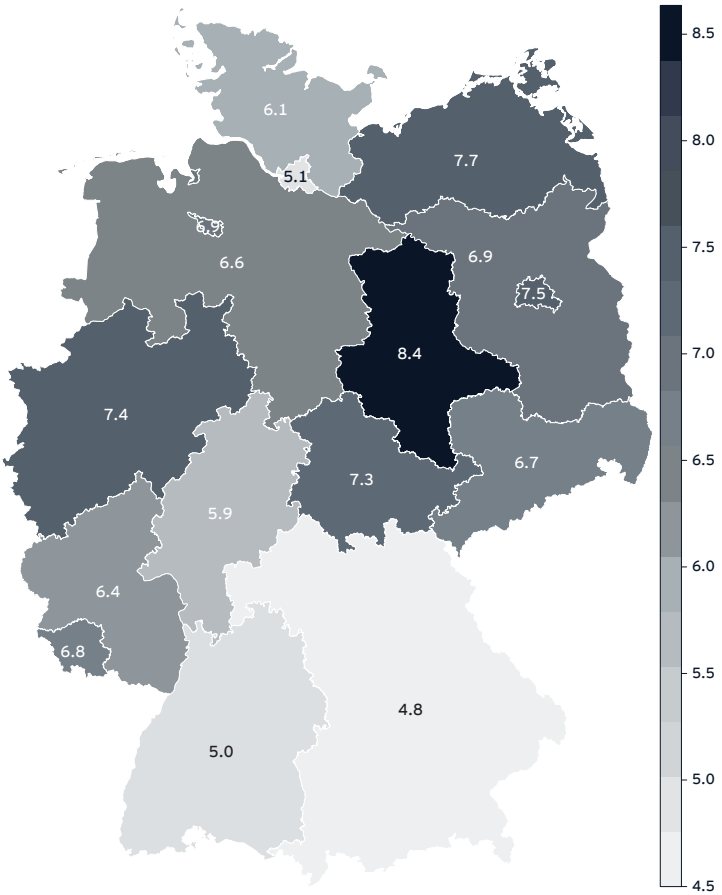
77 See Hutton, M. E. (2017). The Revenue Administration-Gap Analysis Program: Model and Methodology for Value-Added Tax Gap Estimation, International Monetary Fund.

Regions

Estimation of the regional shadow economy can be particularly important for larger countries, with substantial socioeconomic disparities between regions as well as significant roles of local governments and revenues from the regional activity in their financing. Here we present an example of our analysis of unregistered activity in German states (Länder) in 2017 (Chart 15). It indicates that four out of the five states with the largest cash shadow economy were in the former East Germany, proving the high importance of historical developments and persistence of their effects.

We obtained such disaggregation of non-observed economy estimates using regional values (or approximations) of shadow economy drivers identified at the country level with the CDA. First, some factors, e.g., related to the state of the labor market, were directly available at the state level. Second, the missing factors, e.g., institutional quality variables, were approximated for regions based on highly correlated data available both at the national and the regional levels. This, together with the country-level shadow economy estimate, allowed us to calculate the final regional shadow economy figures.

Chart 15. Cash shadow economy in German states (percentage of state GDP)



Notes: Estimates for 2017. The CDA used for this analysis was based on an older and narrower set of data than the model applied in the larger study covered in this report.

Source: EY analysis

Individual characteristics and type of taxation

Another interesting aspect of the shadow economy and tax-gap generating behavior is whether and how it differs between various types of individuals or households. Again, the insights based on direct surveys are likely to be biased, while the evidence from (natural) experiments is limited and often hard to generalize. Even if a tax administration has access to taxpayer-level data and audit results, conclusions from a simple analysis of tax noncompliance may be distorted due to the already applied targeting of specific activities and characteristics.

One of the options to overcome these issues is to apply an extended version of the well-established traces-of-true-income methodology developed by Pissarides and Weber (1989).[78] The approach requires only access to household budget survey data (available in most countries) at the level of anonymized individuals, optionally merged with information on declared income from tax returns. In this method, one indirectly measures the tax noncompliance by examining disparities in reported (food) expenditure and income patterns through econometric modeling.

We applied this method, subject to several extensions, to our PIT gap analysis in Bulgaria for 2017-21,[79,80] which is an example of focus on the role of households' characteristics associated with underreporting of particular kinds of income. Our analysis uncovered significant income underreporting among both self-employed individuals and private sector employees in Bulgaria (public sector workers were assumed to be fully compliant in this approach). In our sample, on average for 2017-21, the model revealed an income gap of 26.0% (of reported and unreported net labor income) for private sector employee households and 50.7% for self-employed households. Yet, these shares should not be interpreted in relation to the total income of such groups in the economy due to the significant underrepresentation of more affluent households in the analyzed sample. Using certain assumptions, we translated the obtained shares into relevant macroeconomic figures. We estimated that unreported labor income accounted for about 6.4% of Bulgaria's GDP. Out of this total, 5.4 percentage points were attributed to the private sector employees, with the remainder attributed to self-employed individuals. The resulting PIT and social security contribution gaps were equal to 13.8% and 16.5%, respectively.

Our important addition to the Pissarides-Weber framework included the extension of the econometric modeling in a way that allowed us to estimate income gaps for different socioeconomic groups. The conclusions from such analysis are presented in Table 2. For example, focusing on private sector employee households, we see that the income gap (measuring the scale of income underreporting) was noticeably higher than the baseline 26.0% among households with children, living in cities with up to 50,000 inhabitants, with primary earners that are young or employed in the industry sector as well as households with unemployed persons. Unfortunately, due to the limited size of the analyzed data sample in Bulgaria, we were not able to investigate the impact of different characteristics controlling at the same time for the value of other factors.

78 Pissarides, C. A. and G. Weber (1989), "An Expenditure-Based Estimate of Britain's Black Economy", *Journal of Public Economics 39*, 17-32.

79 EY (2023), *op. cit.*

80 The analysis did not include the pandemic year of 2020 for which the data was not available. Due to relatively small sample sizes for single years, in most analyses we investigated the whole 2017-2021 period together.

Table 2. Difference in estimated income gap between a given socioeconomic group (on the left) and average (separate for private sector employee households and self-employed households)

		Private sector employee households	Self-employed households
Children in the household	No	-	=
	Yes	+	=
Settlement size	Capital city	-	=
	Cities over 50,000 inhabitants	=	=
	Cities up to 50,000 inhabitants	+	=
	Villages	-	-
Sex of the household's primary earner	Female	=	=
	Male	=	=
Age group of the household's primary earner	18-39	+	=
	40-59	=	+
	60+	-	-
Unemployed person in the household	No	=	=
	Yes	+	+
Industry of the primary earner	Agriculture	-	-
	Industry	+	-
	Services	=	+

Notes: Please note that due to many more private sector employee households than self-employed households in our sample, the results for the former are likely more reliable.

The equal sign (=) indicates that the income gap estimate is significant and matches the estimate from the baseline model (+/- 5 percentage points (pp) for the private sector employee households; +/- 10 pp for self-employed households).

The plus sign (+) indicates that the income gap estimate is significant and higher by more than 5 pp in the case of private sector employee households and by more than 10 pp in the case of self-employed households than the corresponding estimates in the baseline model.

The minus sign (-) indicates that the income gap estimate is not significant (i.e., likely equal to zero = no non-reporting) or lower by more than 5 pp in the case of private sector employee households and by more than 10 pp in the case of self-employed households than the corresponding estimates in the baseline model.

Source: EY analysis

Focused, in-depth analyses

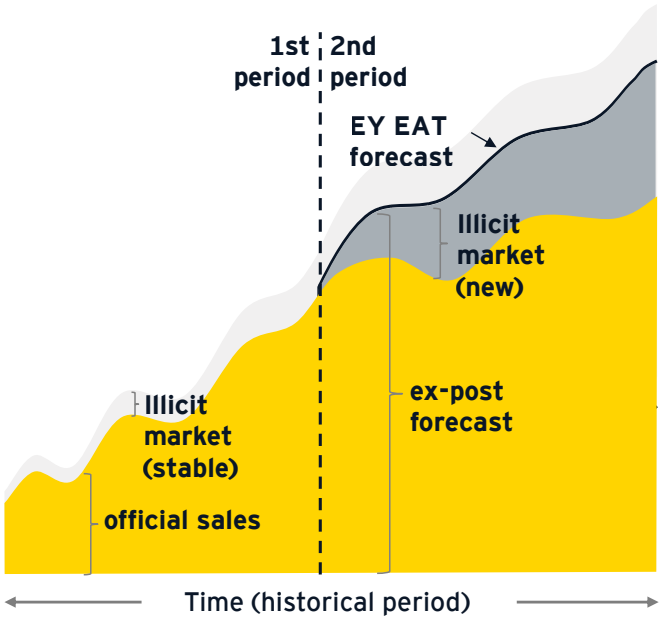
As an example of a focused, in-depth analysis, here we present our approach used in the study of the illicit diesel market in Poland.

Prior to 2011, the share of the illicit products in the diesel market in Poland was likely relatively stable, as confirmed by industry experts. In the following years, however, there were various signals of a strong expansion of illegal activities. We estimated the scale of an increase in the illicit diesel market in Poland after 2011. For this purpose, we distinguished two subperiods:

- 1st period: in which the role of the illicit market was assumed to be relatively stable
- 2nd period: in which the illicit market increase was identified and estimated

With the use of econometric modeling (vector error correction model (VECM)), we determined variables that explained official sales of diesel in the first period (demand model). Next, with the same variables, ex-post forecasts of diesel sales for the second period were made. In the last step, our forecasts were compared with official data on sales for the second period. It turned out that the forecast suggested significantly larger sales than were officially registered. As there were no structural changes in the demand for diesel between the analyzed subperiods, a difference between our forecast and actual sales in the second period was attributed to the illicit market development after 2011. See Chart 16 for the illustration of this method.

Chart 16. Illustration of the illicit diesel market estimation



Source: EY analysis

Reducing the shadow economy and other sources of the tax gap

In this chapter, we describe policy measures used to reduce the shadow economy and other sources of tax gap. We draw from our own research, reports published by renowned international organizations, information provided by tax administrations and academic articles.

First, we point to the multifaceted nature of tax noncompliance, which explains why a mix of different solutions is often required to address this problem.

Next, bearing in mind the complexity of noncompliance, we describe in greater detail five areas of actions implemented by governments to limit the shadow economy and tax gap (see Chart 17):

1. Increasing taxpayers' trust toward public administration and the tax system.
2. Overcoming businesses' lack of formalization.
3. Increasing detection with the use of available technologies.
4. Taking advantage of third-party information.
5. Embracing whole-of-government approaches and international cooperation.

Remembering that each case is unique, we will discuss how the major challenges and available solutions may vary between countries with different income levels. We will focus on solutions that affect a large portion of taxpayers, although we will also mention actions taken to combat noncompliance in individual sectors of the economy.

Chart 17. Areas of actions aimed at reducing the shadow economy and tax noncompliance

Trust as an often missing ingredient for successful reforms	Uneasy road toward enterprise formalization	Harnessing technology and advanced analytics to increase detection	Taking advantage of third-party information	Enhancing whole-of-government approaches and international cooperation
■ Taxing and spending better. ■ Counteracting corruption and abuse among tax officials and public service providers. ■ Educating on why and how to pay taxes. ■ Increasing transparency about how tax revenues are spent. ■ Influencing tax compliance decisions by tax nudges.	■ Cutting red tape with one-stop shops and e-government. ■ Simplifying legal status and tax obligations for micro and small enterprises. ■ Increasing benefits of formalization with financial development.	■ Mandating the use of electronic fiscal devices. ■ Limiting overreporting of deductions with electronic invoicing. ■ Using advanced analytics to improve detection of high-risk taxpayers and transactions.	■ Promoting financial inclusion and the use of electronic payments. ■ Encouraging consumers to request receipts. ■ Making adjustments, where necessary, in third-party reporting mechanism of VAT. ■ Collecting third-party information from online platforms.	■ Joining forces of several state actors. ■ Improving information sharing and efficiency of collaboration through digital transformation. ■ Establishing international cooperation.

Source: EY analysis

4.1. Complexity of noncompliance creates the need for various solutions

Diversity of issues and importance of local context

The multifaceted nature of the shadow economy and tax compliance poses a major challenge for regulators. While there is no single cure for noncompliance, treatment strategies are numerous. Policymakers draw inspiration from foreign tax administrations that have made significant progress in reducing the shadow economy. In addition to knowledge exchange, they also participate in inter-institutional data sharing, allowing faster identification of high-risk taxpayers. Furthermore, tax administrations take advantage of the latest technology, which is increasingly helping in the creation, collection and processing of all sorts of information that can be useful in fighting noncompliance. Most importantly though, it is necessary to understand their local context very well in order to identify the most needed measures as well as the right pace and order of their implementation.

This last conclusion can be drawn from a range of research, including our econometric analysis of the shadow economy summarized in Chapter 3. In line with our approach, total shadow economy consists of non-monetary shadow economy and cash shadow economy. The latter results from five contributing factors or cash shadow economy drivers: government effectiveness, integrity of the legal system, the ratio of family workers to the working-age population, unemployment rate and average tax rate. Chart 11 in section 3.3 illustrates the differences in the average relative importance of those determinants to the shadow economy depending on a country income level. The conclusion is that the main sources of the shadow economy are very different in developing and high-income economies. The most important cash shadow economy contributors in low-income countries are (1) government effectiveness issues (this factor accounts for 29.1% of the total shadow economy in such states) related to the quality of public goods and policy implementation and (2) the ratio of family workers to the working-age population (23.2%) that can be associated with the level of formalization of micro businesses and employment relations. The non-monetary shadow economy (household production of goods for own final use) is also very important among low-income countries (27.0% of the total shadow economy), but such activities are mainly related to subsistence agriculture.

Meanwhile, the shadow economy in high-income countries is to the largest extent due to the relatively high tax rates (67.1%) that lead taxpayers to hide (part of) their income in order to gain significant financial benefits. Of course, one of the reasons for this discrepancy is that advanced economies rank higher than emerging economies in government effectiveness index and business formalization rate. However, even though the room for improvement for high-income countries is decreasing, they can still continue to advance in those areas.

Challenge of lowering taxes and regulatory burden

While it may be the first instinct, reducing tax rates and regulatory burden is a difficult policy path. These issues are among key motivators for noncompliant behavior. If they could be limited without any significant side effects, e.g., when there is a structural budgetary surplus or a given regulation is simply redundant, this is naturally not controversial. The trouble, however, is that various side effects and related trade-offs are often present.

When it comes to lowering tax rates, it usually shrinks tax revenues, cutting financing for essential public services. Especially in the long term, this could also harm government effectiveness – an important shadow economy driver. Simpler taxes may help, unless they

backfire by significantly worsening the perceived equity of the tax system, which could undermine the taxpayer's trust and tax morale (see section 4.2). Moreover, empirical research, including ours, does not clearly pinpoint the kinds of taxes that most contribute to the non-observed economy. Economic theory suggests that levies that are less dependent on the scale of business activity, such as real estate or land taxes, should generate fewer unregistered transactions. Further, VAT may encourage the registration of business-to-business transactions to claim VAT inputs. Alternatively, it could motivate informality, giving unfair businesses an advantage when offering VAT-free prices in consumer sales. The prevailing effect likely depends on the type of business.

When it comes to limiting regulations other than taxes, in well-managed countries they often protect employees, consumers or environment. Thus, careful design is critical when considering changes to these regulations.

As argued in the literature, certain types of the shadow economy may not necessitate intervention or active combat.[81] For example, in the context of our analysis, the reduction of the non-monetary shadow economy related to household production of goods for own consumption may take place on its own along with economic development and transition from agrarian economy to industry or services-oriented markets. It is also worth remaining cautious when it comes to reducing the size of the informal economy, which often constitutes a safety net for the poor. However, in this case, there are some policies available that can help in the gradual transition toward formality (although they may not provide immediate fiscal benefits). The least controversy is related to the fight against hidden (underground) legal activities as well as illegal activities (for the latter, the aim is often to eliminate them, not to register such activities).

Breakdown of the cash shadow economy and time horizon of policies

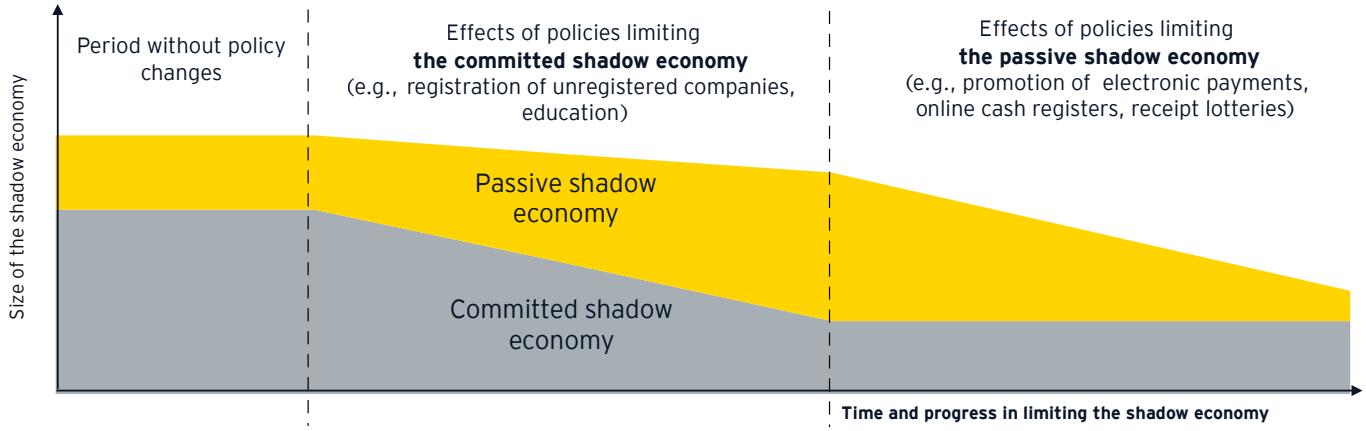
Another contribution of our analysis to the discussion on how to reduce the shadow economy lies in the breakdown of the cash shadow economy into the committed and passive components (see section 2.1). In the case of the committed shadow economy, both the seller and the consumer profit from hiding the transaction, e.g., the seller decreases the price for the consumer willing to forgo an invoice or a receipt. The committed shadow economy is largely related to informality but also to illegal and some part of underground activities. Meanwhile, in the passive shadow economy, the seller is a registered business but chooses to underreport income. Consumers do not profit from the fact that the transaction is hidden and can be unaware that the seller is not registering the transaction in order to save on taxes (the passive shadow economy is closely related to underground activities, see section 2.1).

We observed that the committed shadow economy accounts for a larger share of the cash shadow economy in developing countries while the passive component plays a critical role in advanced economies (this conclusion is also supported by the comparison of our shadow economy estimates and informal employment rates, as discussed in section 3.2). Based on this finding, we proposed a potential sequential approach to reducing the shadow economy, illustrated in Chart 18. It can be summarized as follows. If the country is dealing with a large committed shadow economy, it should focus on limiting the committed component in the first stage and later move to the policies limiting the passive shadow economy. It results from two assumptions. First, each component of the cash shadow economy requires different policy measures. In the case of the committed shadow economy, the starting point should be to create conditions under which more companies are willing to register and operate, at least partially, in the formal economy. In the case of the passive shadow economy, technology and third-party information (e.g., resulting from traces left by electronic payments) are often used by tax administrations to increase the share

81 See e.g., Joshi A. et al. (2012), Taxing the Informal Economy: Challenges, Possibilities and Remaining Questions, International Centre for Tax and Development.

of registered transactions. Second, the reduction in the committed shadow economy will likely cause an expansion of the passive component as some of the newly registered enterprises will start to hide part of their revenues. That is why policies aimed at reducing the passive shadow economy are particularly important once the committed component starts decreasing. Having said that, both types of the cash shadow economy are present in almost every country. Therefore, it may be beneficial for policymakers to take both of them under consideration while designing their strategies.

Chart 18. Sequential approach to limiting committed and passive shadow economy components



Source: EY analysis

Long-term vs. short-term policies make up another important perspective for reducing the shadow economy and tax gap. For instance, in less developed countries, tackling informality and improving quality of institutions may be key policy areas, but this could be a long-run process. On the other hand, initiatives from areas harnessing technology and advanced analytics to increase detection, taking advantage of third-party information, and enhancing whole-of-government approaches and international cooperation may bring smaller gains but already in the short to medium term. As already mentioned, once the informality is reduced and the quality of institutions is enhanced, the importance of such actions should further increase (since the shadow economy would be more focused around hidden activities of registered enterprises).

Model for strategy on tax compliance

Apart from our contribution, there are many other formalized models that can be used for designing a good strategy to increase tax compliance. Those models can be more general in the way that they take into account components of the tax gap that we classify outside of the shadow economy, such as tax avoidance. For example, the BISEP model has been promoted in many OECD publications starting from 2004 (see Chart 19).[82] The name of the model is an abbreviation of five broad factors that influence taxpayers' behavior toward compliance (see section 3.3).

The multitude of factors that are associated with taxpayers' compliant/noncompliant behavior again shows the complexity of the task that tax administrations all over the world are facing. The BISEP model structures the discussion around the compliance strategies by classifying taxpayers into four groups, two noncompliant and two compliant:

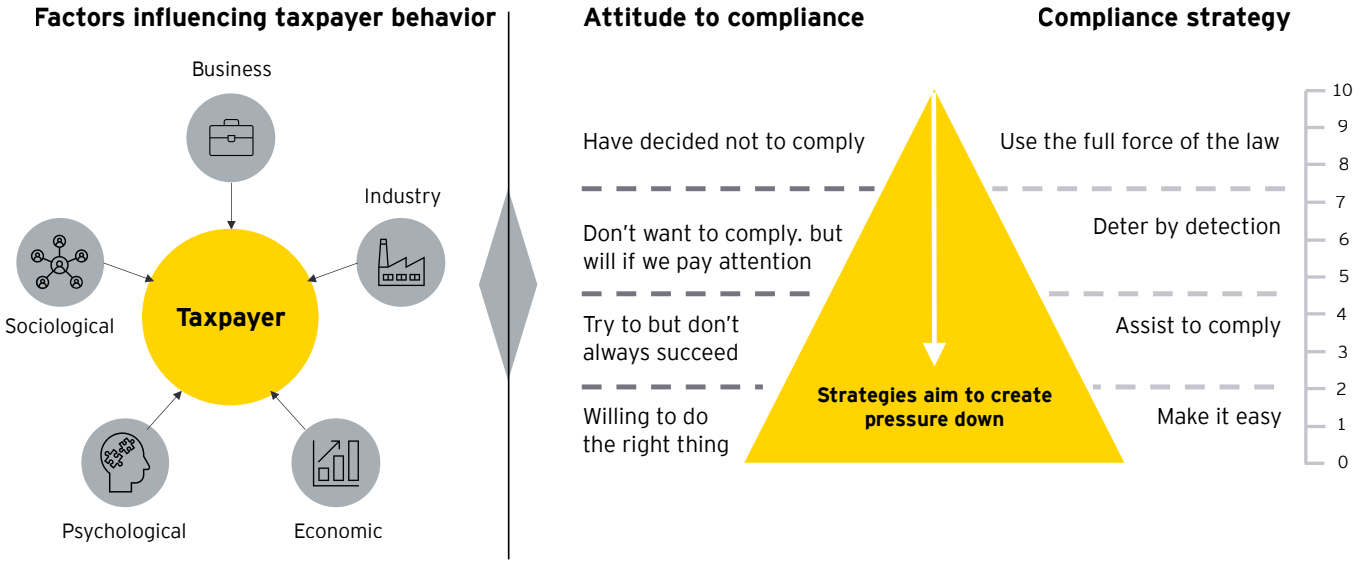
82 See for example: OECD (2004), "Compliance Risk Management: Managing and Improving Tax Compliance" (guidance note), OECD (2017), "Shining Light on the Shadow Economy: Opportunities and Threats".

- **Disengaged**. At the top of the compliance pyramid, there are people who intentionally and wittingly decide not to comply. They do not see sufficient benefits to act in accordance with the law, and they often do not recognize the role of the fiscal policy and the government. The compliance strategy proposed by the BISEP model for this group is to "use the full force of the law."
- **Resisters**. The second noncompliant group consists of taxpayers who view the tax system as a heavy burden and want to oppose it. However, they will comply if persuaded to do so or if their perspective is taken into account by the regulators. The recommended strategy in this case is to "deter by detection."
- **Triers**. This is the group of generally complaint taxpayers whose intentions are good, but they sometimes fail to comply mostly due to misunderstanding of their obligations. The compliance strategy in this case is to "assist to comply."
- **Supporters**. Finally, this is the compliant and committed group of taxpayers showing high tax morale and trust toward the tax administration. The recommended strategy for the tax administration is to make it easy for them to comply.

It is worth keeping in mind that through poorly designed policies, taxpayers can change their views and move up the pyramid. Moreover, an individual taxpayer may be classified in several different groups at once, depending on what the specific tax obligation relates to. In short, the model offers two standard approaches to increase tax compliance:

- Enforcement (supported by effective detection) targeted at deliberately noncompliant people
- Facilitation targeted mostly at those who want to do the right thing

Chart 19. The BISEP model: compliance strategies tailored to different attitudes toward compliance



Notes: The model was developed in conjunction with the Australian academic Dr. Valerie Braithwaite.
Source: OECD (2004), "Compliance Risk Management: Managing and Improving Tax Compliance"

4.2. Trust as an often-missing ingredient for successful reforms

The common way of thinking about reducing tax noncompliance concentrates on actions around strengthening enforcement (increasing the risk of getting caught and introducing more severe penalties) and facilitating compliance (reducing barriers related to time, complexity and financial cost of paying taxes and limiting opportunities for noncompliance). As we described at the beginning of this chapter, enforcement and facilitation are the two foundations of the BISEP model used by the OECD. While these two elements are crucial, some studies, including the recent World Bank report (2022),[83] stress the importance of yet another pillar of tax compliance: building taxpayers' trust, which translates into greater willingness to comply. As previously shown, our own analysis of the shadow economy concluded that government effectiveness is one of the most important factors contributing to the size of the shadow economy, especially in developing countries. Government effectiveness is linked to satisfaction with public goods and services, which is an important driver of trust toward public administration. In general, shadow economy may have a strong social component. In some countries, noncompliance behavior is both expected and accepted by people, so it is important to modify the prevailing narrative in this area among various groups of stakeholders.

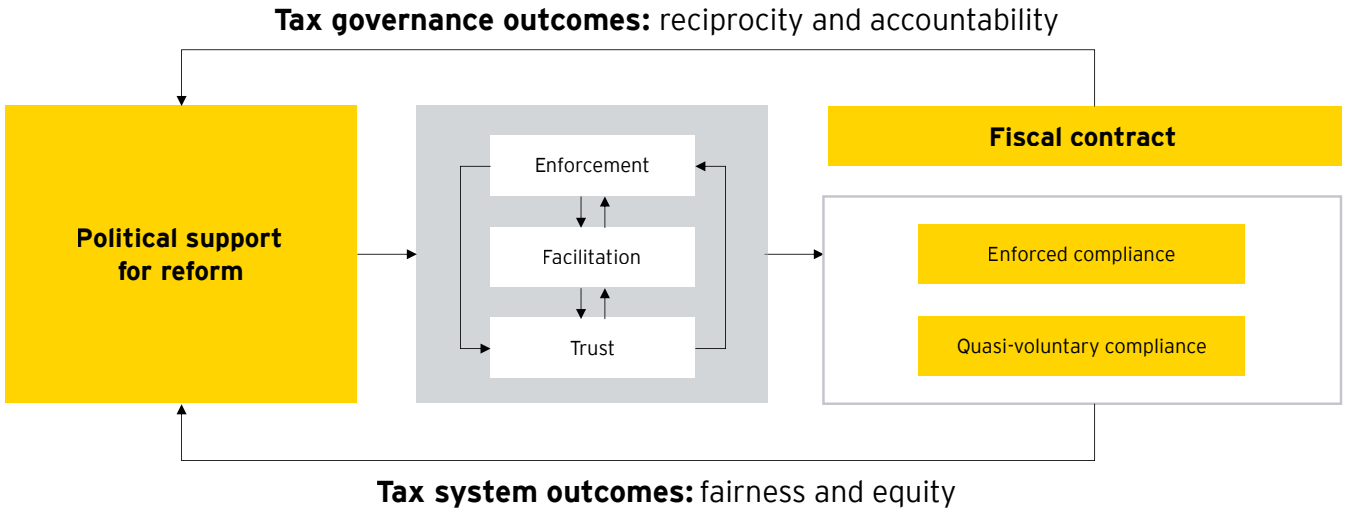
The book "Innovation in Tax Compliance: Building Trust, Navigating Politics, and Tailoring Reform" by the World Bank seeks an answer to the question of why many tax reforms introduced in low- and middle-income countries have failed to increase tax revenues. After analyzing numerous examples, the authors proposed a new model for successful reform — one that incorporates trust next to enforcement and facilitation measures (see Chart 20).

According to the authors of the report, trust in the government and the tax system is crucial for building political support for tax reforms, and it is driven by the following four elements:

- **Fairness of the tax system**. While the belief that the tax system is fair may mean different things for different people, it is crucial for all taxpayers to understand how the system works, to be treated with respect by tax collectors, to agree with the justification for penalties and to have the opportunity to assert their rights in the case of disputes with the tax administration.
- **Equity of the tax system** lies in the belief that everyone pays their share. It results both from how the tax liability is distributed among different taxpayers via tax rates and exemptions, but it is also closely related to the effectiveness of tax enforcement (willingness to pay taxes decreases if people see that many around them are evading taxes and are not facing any consequences).
- **Reciprocity** lies in the belief that taxes contribute to the provision of quality public goods and services (a foundation of the fiscal contract between the government and taxpayers).
- **Accountability** of government to taxpayers lies in the belief that taxpayers have a voice in deciding how tax revenues are spent and that they can punish those government officials who abuse their trust (e.g., via corruption).

83 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), "Innovations in Tax Compliance: Building Trust, Navigating Politics, and Tailoring Reform", Washington, DC: World Bank.

Chart 20. World Bank (2022) tax reform framework based on enforcement, facilitation and trust



Source: Word Bank (2022), "Innovations in Tax Compliance: Building Trust, Navigating Politics, and Tailoring Reform".

What has been done?

Building trust toward the government, tax system and fiscal policy can be an effective way of reducing the shadow economy and tax gap by increasing voluntary compliance, also defined as tax morale or "the intrinsic willingness to pay tax."[84] Emerging markets and developing economies, in particular, have a lot of room to improve the level of institutional maturity and quality linked to trust. Advanced economies can also benefit from strategies aimed at increasing tax morale of disengaged and resisting taxpayers and move them down the BISEP model pyramid. Below we present a few examples of what has been done by governments to raise the level of trust and tax morale, drawing mainly from the aforementioned World Bank report.[85]

1. Taxing and spending better

The most general answer is that tax administrations and governments may consider improvements in each of the four drivers of trust listed in the World Bank study: *fairness and equity of the tax system* as well as reciprocity and accountability linked to the way tax revenues are spent. There may be no easy fix, especially if many people experienced unfair treatment or poor quality of public services in the past. The institutional changes might be gradual (as it may not be possible to increase the quality of public goods without collecting enough tax revenues in the first place) but should go in the right direction. If people do not have any justification for why they pay taxes, all the other policies aimed at building trust may not be very effective in the long run.

2. Counteracting corruption and abuse among tax officials and public service providers

Contrary to the common belief that the poorest have a relatively low tax liability, research from developing countries shows the prevalence of so-called informal taxes among the lowest income groups. For instance, owners of small businesses, including market traders, face significant risk of harassment by tax officials demanding informal payments. Similarly, informal payments are often imposed in countries with underfunded public services, for example, in exchange for access to public health care or education. In consequence, a heavy burden on taxpayers imposed by state actors is not reflected in the amount of tax revenue collected, undermining trust in the system.

84 Definition by OECD (2019), Tax Morale What Drives People And Businesses To Pay Tax?

85 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), *op.cit.*

Reducing the scope of corruption can be achieved via internal audits (increasing detection of offenses committed by public officials), creating incentives for ethical conduct for tax officials and increasing transparency in processes of collecting taxes and spending tax revenues, for example, with the use of digital solutions.

Case study:

Frequent face-to-face interactions between tax officials and taxpayers increase the risk of corruption and collusion. An IMF study using survey data from 26 African countries concluded that replacing the need for such interactions with digital tools, such as e-government services, is effective in increasing taxpayers' trust in tax officials and reducing the perception that the tax administration is corrupted. Public trust in government officials can be undermined by intentional internet shutdowns that sometimes take place in the region.[86]

3. Educating on why and how to pay taxes

Educational campaigns about the importance of paying taxes have been used in many developing countries to increase tax morale and reduce informality. Current evidence suggests that the best programs are those tailored to address the specific needs of relatively narrow groups of taxpayers and those conducted in partnership with easily accessible and trusted institutions, such as schools, business organizations, civil society and religious organizations. Educating taxpayers on the benefits of paying taxes and the intricacies of the tax system may also serve as a good opportunity to discuss the challenges related to their tax obligations and the perceived quality of public administration.

Case study:

The effectiveness of a taxpayer education campaign was evaluated in the case of the program implemented by the Rwandan Revenue Authority.[87] The half-day training was targeted at new taxpayers and included basic instructions on how to pay taxes. The assessment was done with the use of survey data (1,000 randomly selected taxpayers, some of whom participated in the training) and administrative data on tax returns. The conclusions inspire optimism as to the effectiveness of such educational campaigns: Participation in the training increased tax knowledge and the probability to file tax returns and decreased perceived complexity of the tax system.

4. Increasing transparency about how tax revenues are spent

Providing online or mobile access to national budget reports, detailed information on public investments, and plans of local government initiatives is becoming a standard procedure in more and more countries. Open and easy access to public finance data gives the opportunity to monitor whether the government's promises are being fulfilled, increasing accountability of public administration. For example, in Nigeria, civil society platforms have been voluntarily created to analyze digital data on public finances. Transparency of public expenditures can also be improved via participatory budgeting (allowing taxpayers to directly choose specific goods and services funded by the portion of their taxes) and linking revenue to service delivery (successfully used for the provision of local services funded by local taxes, e.g., waste removal).

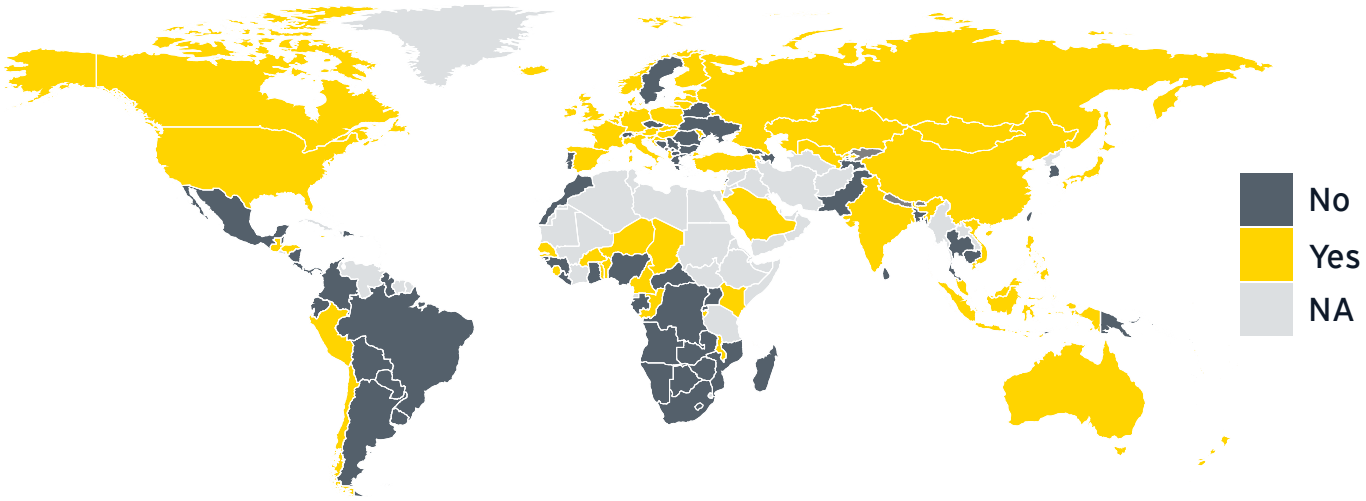
86 Ouedraogo, R., & Sy, A. N. (2020),"Can Digitalization Help Deter Corruption in Africa?" Washington DC: IMF.

87 Mascagni, G., F. Santoro, and D. Mukama (2019), "Teach to Comply? Evidence from a Taxpayer Education Programme in Rwanda.". Working Paper No. 91, International Centre for Tax and Development, Brighton, UK.

5. Influencing tax compliance decisions by tax nudges

The research in the field of psychology and behavioral economics gave rise to the use of so-called tax nudges, especially for the purpose of increasing PIT revenues. Tax nudges are short messages sent to taxpayers by tax administration (e.g., incorporated in already existing tax forms or via letters, emails or text messages), often linking tax payments with the provision of public goods or appealing to social norms in order to increase tax morale. To influence the behavior of taxpayers, tax nudges can also simply remind taxpayers of their obligations to pay taxes or can be written in a harsh tone, including the threat of audit (increasing perceived risk of being caught) or social shaming. The motivation for using tax nudges mostly lies in the ease and low cost of their implementation, while the evidence for their effectiveness has been mixed. In particular, their long-term effectiveness is being questioned, because a one-off intervention will possibly not change taxpayers' motivation in the long run, while constant exposure to this type of message can end up in taxpayers' desensitization to them. However, tax nudges are worth considering as in the short term they have shown positive results in many countries. Based on a meta-analysis of various types of tax nudges, those that appeal to elements of tax morale are more effective than simple reminders, leading to a 1.4 percentage point increase in compliance. Even more impactful are deterrence nudges, which inform taxpayers about enforcement actions and can further enhance compliance by an additional 3.2 percentage points.[88] Chart 21 shows economies where tax administrations reported using behavioral insight methodologies or techniques, as of 2020.

Chart 21. Tax administrations using behavioral insight methodologies or techniques, 2020



Source: International Survey on Revenue Administration (ISORA)

88 Antinyan, A.; Asatryan, Z. (2024). "Nudging for Tax Compliance: A Meta-Analysis.". *ZEW – Centre for European Economic Research Discussion Paper* No. 19-055.

Case study:

In experimental studies carried out by the World Bank in Poland, Latvia, Kosovo, Indonesia, Guatemala and Costa Rica, tax nudges have proved to be effective in increasing tax compliance, although different types of messages worked in different countries.[89]

In Costa Rica, tax nudges were sent to firms that did not file their income tax declarations and led to an increase in the filing rate by 20 percentage points within five weeks after the intervention. The most effective message included examples of third-party information (obtained from customers, suppliers and banks) that were used by the tax administration to verify firms' financial activities.

In Poland, behavioral messages were sent to people who submitted PIT declaration but were in arrears in paying the tax due. In this case, a hard-tone message emphasizing penalties turned out to be the most effective in inducing tax payments and increasing the amount paid (20.8% increase in the number of compliant taxpayers). Messages that tax revenues are used for the provision of public goods increased compliance among young people and the rural population.

89 World Bank (2021). "Behavioral Insights for Tax Compliance." Policy note, *World Bank*, Washington, DC.

4.3. Uneasy road toward enterprise formalization

Informality of enterprises (their lack of formalization) contributes to the committed component of the shadow economy. It is also the main source of informal employment as most informal employees work in unregistered companies.[90] Informal businesses are mostly micro and small enterprises, including a significant share of own account workers. On a macro scale, informality is linked to economic development, and the gap in business formalization is particularly large in emerging markets and developing economies. Informality is both the consequence of underdevelopment (associated with low productivity) as well as its source. Citing the recent World Bank report on the topic (2022),[91] "recognize informality as a phenomenon that reflects broad-based underdevelopment — rather than a challenge that can be considered in isolation. For that reason, measures to address informality need to be equally broad-based."

In 2021, the ILO published three thematic briefs[92] offering guidance toward enterprise formalization. Beyond the classical approach of combining facilitation and enforcement measures, the ILO acknowledged that in the case of "survivalist entrepreneurs" operating on the verge of poverty, formalization may not be feasible in the short term. Indeed, experience from Sub-Saharan Africa has shown that a significant one-time effort to register as many enterprises as possible is not cost-effective and can lead to bloated tax registers with many inactive payers.[93] Instead of forcing this specific group to register at all costs, governments can focus on enhancing a productivity level that will gradually translate into greater readiness to formalize. A similar conclusion was drawn by the recent IMF study on informal workforce (2021)[94] that said, "Improved access to and quality of education is probably the single most powerful way to lower informality."

Keeping that in mind, later in this section we will focus on the approaches used to formalize those enterprises that have the means to do so. The ILO advises to consider both costs and benefits for enterprises stemming from formalization while designing policies (see Chart 22). Costs include financial costs (e.g., taxes) that, according to our analysis, are the most important contributor to the shadow economy in advanced economies. Meanwhile, entry costs related to knowledge gaps and/or burdensome bureaucracy may be particularly important in developing countries. Businesses should be willing to formalize if those costs are outweighed by the benefits, such as gaining access to social security, formal financial markets and eliminating the risk of penalties for noncompliance, among others.

90 Gaarder, E., Doorn, J. & Department, I. (2021a), Enterprise formalization: an introduction, ILO.

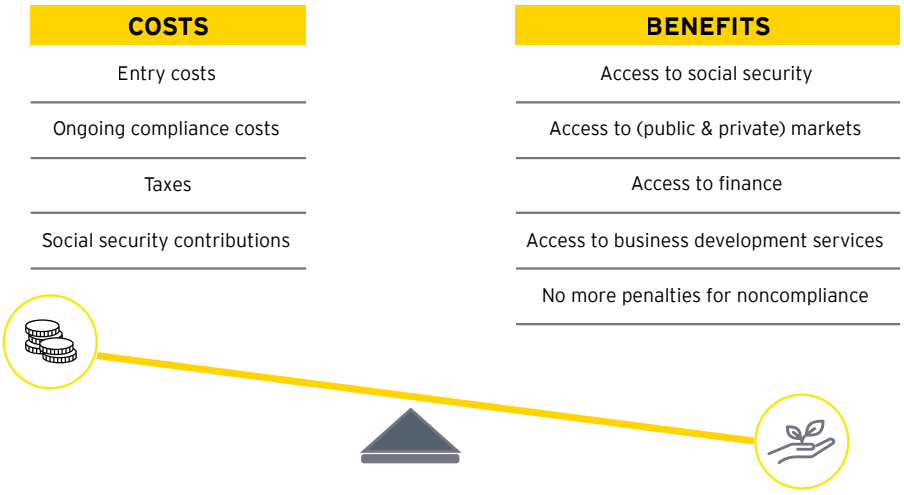
91 Ohnsorge, F., Yu, S., eds. (2022), The Long Shadow of Informality: Challenges and Policies. Washington, DC: World Bank.

92 (1) Gaarder, E., Doorn, J. (2021a), *op.cit.*, (2) Gaarder, E., Doorn, J. (2021b), Enterprise formalization: Simplifying and facilitating business start-up and compliance, ILO, (3) Gaarder, E., Doorn, J., Behrendt C., Nguyen Q. A., (2021), Enterprise formalization: Tailored registration, tax and social security requirements for MSEs, ILO.

93 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), *op.cit.*

94 Deléchat, C., Medina L., eds. (2021). The Global Informal Workforce: Priorities for Inclusive Growth. Washington, DC: IMF.

Chart 22. ILO (2021) cost-benefit approach toward business formalization



Source: Gaarder, E., Doorn, J., (2021), "Enterprise formalization: an introduction," ILO

What has been done?

The challenges related to enterprise formalization are particularly large in emerging markets and developing economies where the level of informality is widespread. However, no single measure can be recommended to reduce the level of informality in different countries. It requires a package of country-specific regulations and time for the intended changes to take effect. Initially, the costs of formalization policies will often outweigh revenues stemming from the broader tax base. To account for local specifics, before introducing any public policy aimed at reducing informality, it is worthwhile to first conduct field experiments (e.g., in a selected region of the country or selected sector of the economy) and quantitatively assess their results.

1 Cutting red tape with one-stop shops and e-government

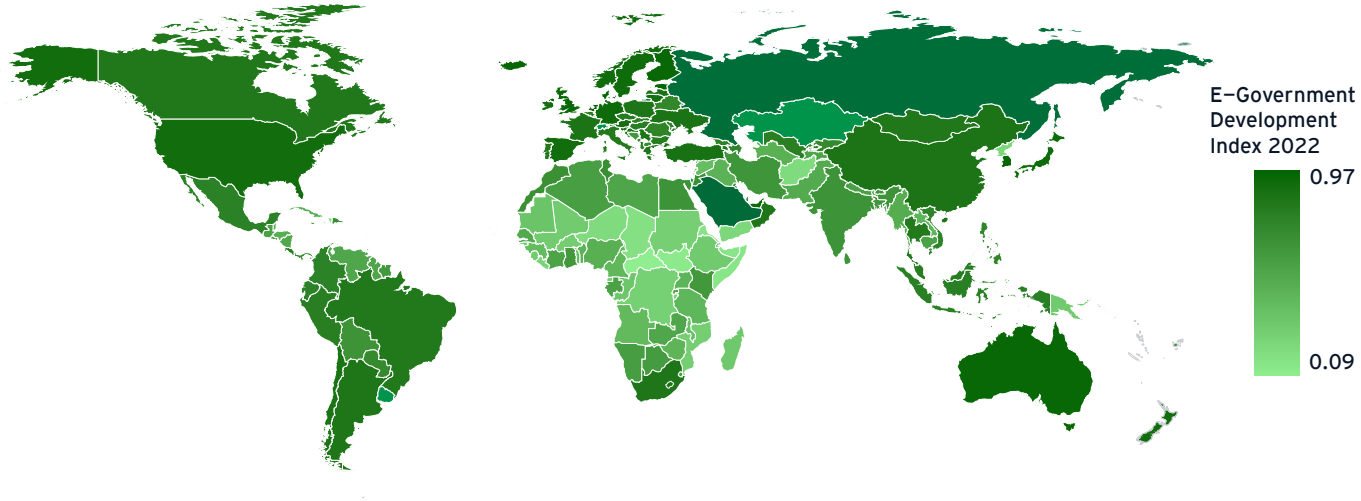
A good starting point for encouraging more businesses to formalize is to make the registration process faster and less burdensome. A common way of cutting red tape is providing businesses a single point in which all formalities can be completed, a so-called one-stop shop.[95] The very fact of designing one-stop shops forces public administrations to analyze business registration process in detail, which may result in simplifying procedures and combining similar, repetitive forms into one. Preferably, the business owner should be able to handle all matters with one official authorized by different governing bodies (tax administration, social security, etc.) to collect and pass on necessary data. Such points can offer not only business registration services but also all other kinds of interactions between businesses and the state, e.g., payment of social security benefits or financial assistance offered during the COVID-19 pandemic.

Thanks to digitization of processes related to business registration, such one-stop shops can be created online or take the form of mobile applications. Virtual one-stop shops save time and promote the use of electronic payments to the government, thereby enhancing financial inclusion, among other benefits of crowding out cash transactions. As we described in the previous section, replacing face-to-face interactions with e-government services may also lead to increased taxpayer trust in the tax administration and boost tax morale. As shown in Chart 23, in many economies, especially within Africa, South Asia and Southeast Asia, there is still a lot to improve in terms of development of e-government. It is important to adapt to the situation in a specific economy. For example, in Sub-Saharan Africa, mobile e-government services and mobile money accounts (see Chart 24) are much more promising than solutions relying on internet connectivity.[96]

95 Gaarder, E., Doorn, J. (2021b), *op. cit.*

96 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), *op.cit.*

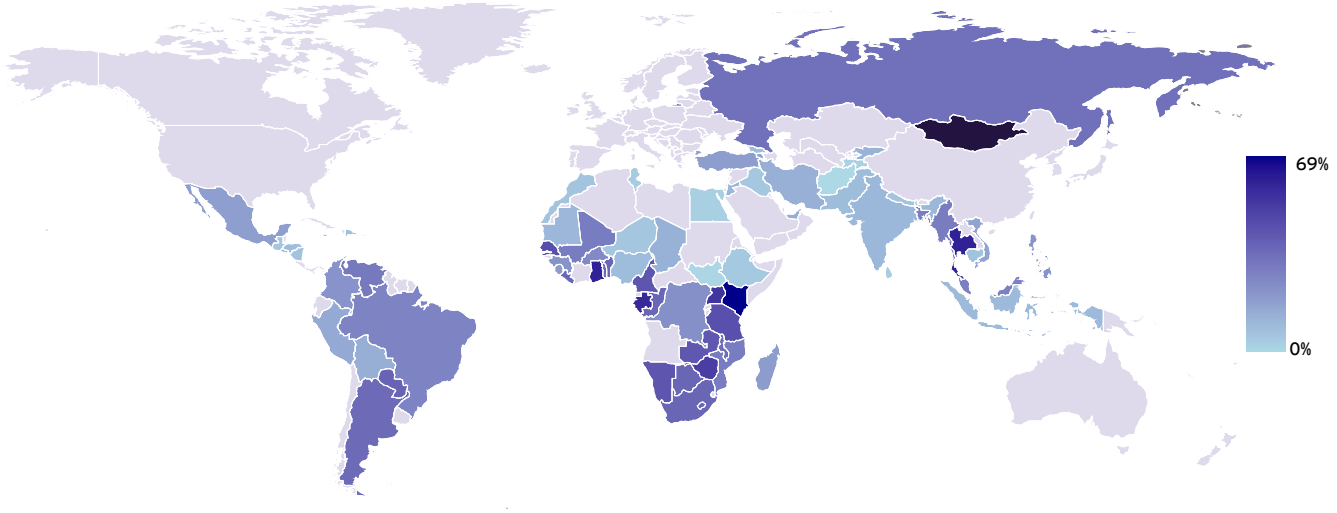
Chart 23. UN E-Government Development Index (EGDI) in 2022



Notes: The EGDI is a composite measure of three e-government dimensions: provision of online services, telecommunication connectivity and human capacity. The higher the index, the higher the level of e-government development in the economy.

Source: UN E-Government Knowledgebase

Chart 24. Mobile money account ownership (2021-22, percentage age 15+)



Source: The Global Findex Database 2021

2 Simplifying legal status and tax obligations for micro and small enterprises

Owners of informal businesses often lack the procedural knowledge and financial capacity needed to run a formal enterprise and meet the resulting reporting and financial requirements. To make things easier, tax administrations often offer those businesses simplified rules.[97] One possibility is to create entry-level legal status for micro and small enterprises that can be combined with exemptions from or (temporarily) lower taxes and social security contributions. For example, entry-level legal status for own-account workers below a certain turnover threshold was created in Morocco in 2015 and included simplified rules for starting and closing a business, exemption from VAT and some reporting requirements, and lower tax rates. Another used approach is to make taxes easier to understand and pay. In Argentina and Uruguay, income taxes and social security contributions were unified into one payment (monotributo). Presumptive taxes, for which the liability is estimated using proxies for income, are also sometimes used if it is very difficult to calculate tax base, e.g., in the case of agricultural workers.

3 Increasing benefits of formalization with financial development

Access to finance is one of the biggest benefits of enterprise formalization, as it helps companies to grow and increase productivity. Businesses operating in regions with an underdeveloped financial sector lose one of the crucial incentives to formalize. Policymakers can create favorable conditions for financial development by creating strong credit reporting and supervisory institutions, providing a reliable infrastructure for electronic transactions, promoting financial inclusion (e.g., by ensuring access to basic financial products at low or no cost or requiring electronic transfers of wages and social benefits) and stimulating competition among providers of financial services. Despite significant progress in the area of financial inclusion over recent years, the financial inclusion gap is still large in many parts of the world (see Chart 25).

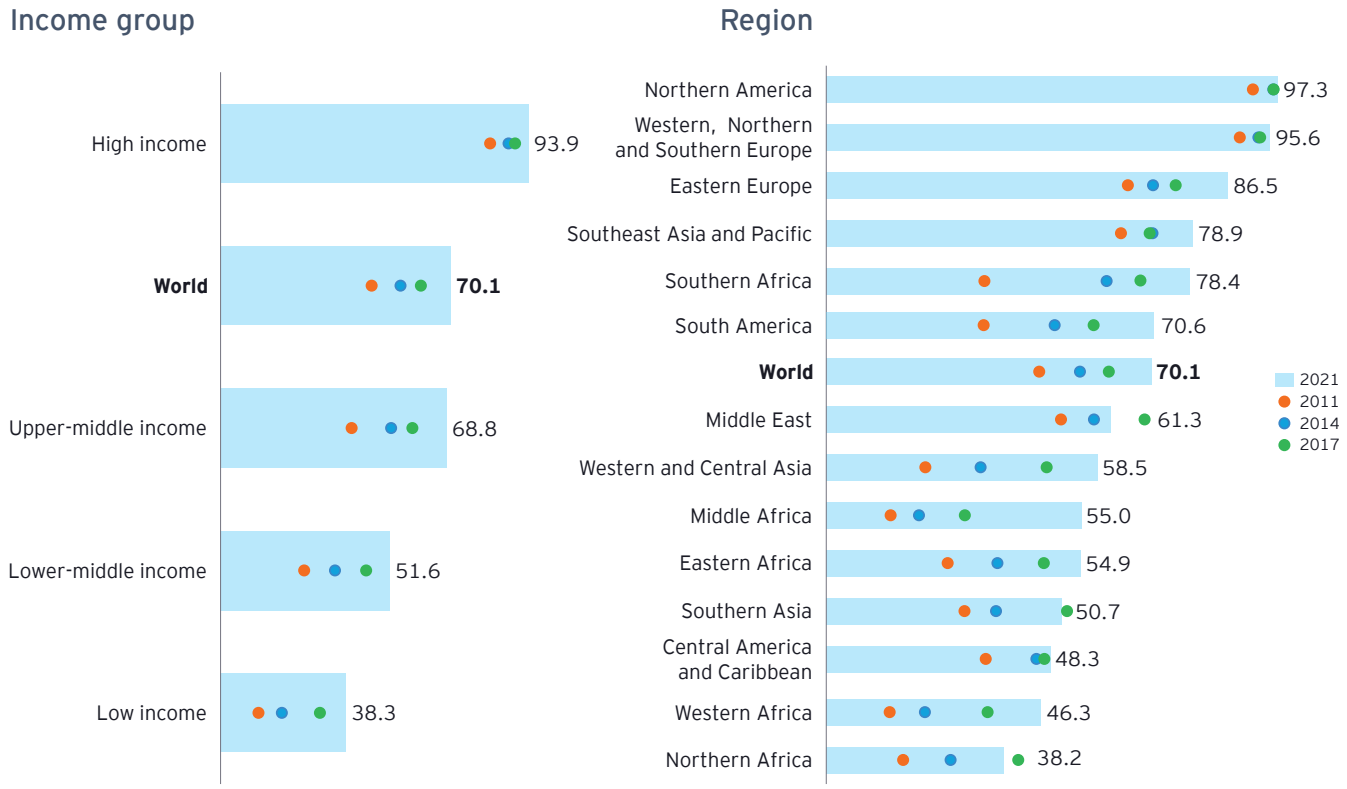
Case study:

The effectiveness of offering entry-level legal status (and accompanying training) in increasing enterprise formalization was studied in Benin using a randomized experiment framework.[98] The newly created entreprenant status offered free registration that took only one day, tax exemptions, access to formal financial services and the possibility of doing business with large domestic enterprises. The experiment showed that informal businesses were registering as entreprenants only if they were offered additional assistance from the tax officials. In the control group of firms that did not receive additional assistance, only 2% formalized over the course of the experiment (two years). In the group that received in-person visits during which the benefits of the program were explained and help for filling out required paperwork was offered, registration was 9.6 percentage points higher than in the control group. In the group that additionally received assistance in opening a business bank account after formalization, the increase in registration was 13 percentage points higher than in the control group. Finally, in the group that received the full package of assistance, including mediation services in the case of dispute with the tax administration, the increase in formalization was 16.3 percentage points higher than in the control group.

97 Gaarder, E., Doorn, J., Behrendt C., Nguyen Q. A. (2021), op. cit.

98 Benhassine, N., Mckenzie, D. J., Pouliquen, V., & Santini, M. (2016). Can enhancing the benefits of formalization induce informal firms to become formal? Experimental evidence from Benin, World Bank Policy Research Working Paper, (7900).

Chart 25. Account ownership (percentage age 15+) by income group and region of a country



Notes: See section A.7 for the regional aggregation of economies (in particular, Northern America includes only the US and Canada).

Source: The Global Findex Database 2021

Case study:

While various researchers have frequently noted the correlation between financial development and informality, a recent econometric study incorporating an instrumental variable framework on a large panel of countries has tried to establish a causal link (Capasso, Ohnsorge, Yu, 2022).[99] The results of the analysis show that the increase in access to bank services (measured by the number of commercial bank branches per 100,000 adults) leads to a decrease in the share of informal output in official GDP. Authors have chosen to focus on the access to bank services in their study, as informal enterprises are mostly small and rather interested in simpler forms and smaller amounts of financing that can be provided by commercial banks.

99 Capasso, S., Ohnsorge, F., & Yu, S. (2022). From Financial Development to Informality: A Causal Link, Policy Research Working Paper, World Bank.

4.4. Harnessing technology and advanced analytics to increase detection

Detection of noncompliant taxpayers and fraudulent transactions usually leads to application of severe penalties, strengthening the effectiveness of enforcement measures available to policymakers. Detection is also important in the context of identifying complicated techniques used by dishonest taxpayers so that the commonly used loopholes can be eliminated by legislators. Technology works on both fronts – it makes increasingly sophisticated tax fraud and tax evasion techniques possible but also serves as a powerful weapon to increase noncompliance detection. While keeping in mind other benefits stemming from technological advancement, such as previously mentioned facilitation achieved via e-government services and financial development, in this section we will describe how technology and advanced analytics are used to increase detection of high-risk taxpayers and combat fraud.

Today, it is generally accepted that efficient tax administration should rely, at least to some extent, on digital technology solutions, IT systems and data-driven analytics. While in advanced countries cost-effective innovative solutions are rather easily accessible, emerging markets and developing economies often face challenges related to technological reforms.[100] Those challenges include low technological capacity in those countries at the start or treating technology as an end in itself, resulting in its mismatch with specific goals of the tax administration and failure of overly ambitious projects. Again, those challenges can be addressed through a thorough analysis of the initial situation, setting clear goals to be achieved and a way of measuring progress, before deciding on implementation of technological reforms. In addition, based on our discussions with various experts that cooperate with tax administrations, many governments still under-exploit micro (taxpayer-level) data that is already at their disposal.

What has been done?

It is impossible to list all ways of how technology can help tax administrations detect unreported transactions and tax frauds. There are numerous approaches, but it is important to adapt policies to the level of technological development of the country. At the same time, it is worth remembering that tax benefits are just one of many reasons to promote digital transformation.

1 Mandating the use of electronic fiscal devices

Electronic fiscal devices (e.g., cash registers) are used to record every individual business-to-consumer transaction, regardless of the means of payment. The process of fiscalization is intended to provide a mechanism for tax administrations to supervise merchants' turnover in order to detect high-risk taxpayers. Mandating the use of electronic fiscal devices is sometimes accompanied with intensified fiscal controls and audits to strengthen enforcement. In addition, as obligation to possess fiscal devices institutes an additional financial and regulatory burden for businesses, there are ways to incentivize merchants to install the device, e.g., by (temporary) tax deduction following its activation or (partial) reimbursement of the cost of the device. Modern electronic fiscal devices are equipped with data recording technology, and in some cases, internet connectivity.[101] They are introduced to combat electronic sales suppression methods, i.e., illicit technological solutions (such as zappers and phantomware) that enable fraudulent modification of data saved on traditional cash registers in order to underreport income. Devices using data recording technology secure the sales data immediately after the transaction has occurred and can detect whether any electronic sales suppression

100 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), op.cit.

101 OECD. (2017). Technology Tools to Tackle Tax Evasion and Tax Fraud.

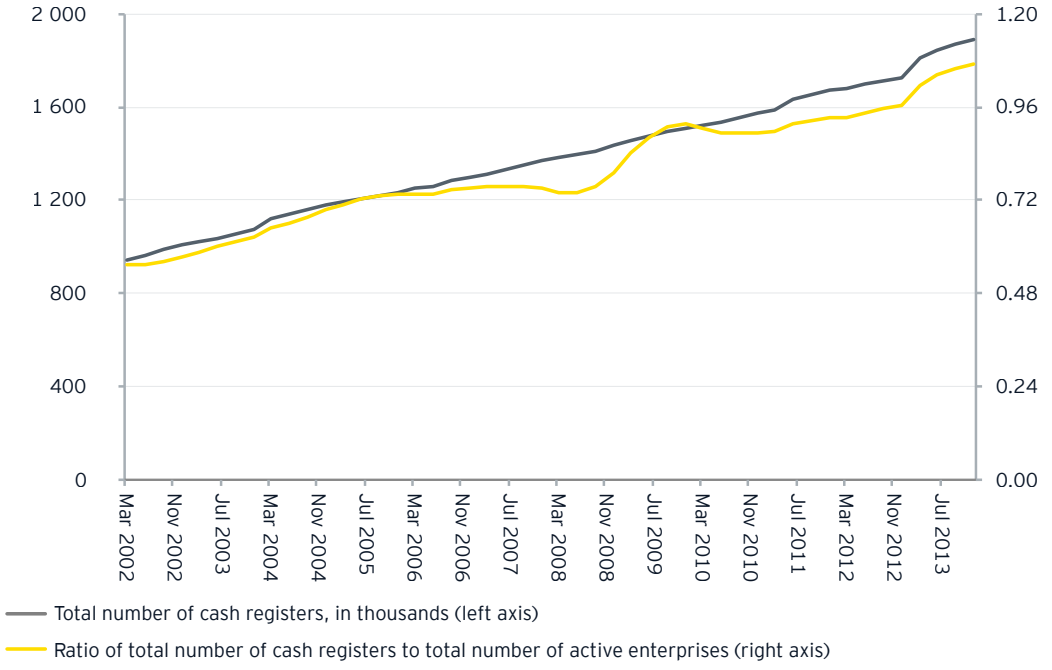
methods have been used. Online cash registers enable the delivery of individual transaction data on a real-time basis to the tax administration. In this way, every receipt is authorized by the tax office before being presented to the buyer. However, even with online cash registers, merchants can hide part of their income by not registering some transactions on the device.

In 2016, we investigated the effect of fiscalization in Poland. With the use of time-series econometric analysis, we estimated the impact of the number of cash registers on the size of the passive shadow economy.

The obtained estimates suggest that an increase in the ratio of the total number of cash registers to the total number of active enterprises by 0.1 leads, on average, to a decrease in the passive shadow economy in Poland by 0.3 percentage points of GDP.

To better understand the estimated size of the effect, in the fourth quarter of 2013, which was our latest available observation for this variable, the level of the applied fiscalization measure was equal to 1.07, which means that a rise by 0.1 would correspond to a 9.3% increase in the fiscalization level. In comparison, in the period from 2011 to 2013, the fiscalization level in Poland grew by about 19% (see Chart 26).

Chart 26. Number of cash registers in Poland in 2002–13



Source: EY analysis, Polish Ministry of Finance data on cash registers

Case studies:

Hungary mandated the use of online cash registers in 2014 in the retail and hospitality sectors. According to the information provided by the Hungarian tax administration, VAT revenues increased by 15% in 2014 in those sectors exceeding the costs of the project. In 2016, Hungary extended the obligation to the services sector as well as car and car parts dealers.[102] Among developing counties, electronic fiscal devices have been introduced, for example, in Tanzania, Ethiopia and Rwanda, with the most promising results observed in Rwanda (around 80% of VAT payers in Rwanda activated the devices within two years from the start of the project, increasing VAT payments by 5.4% on average).[103]

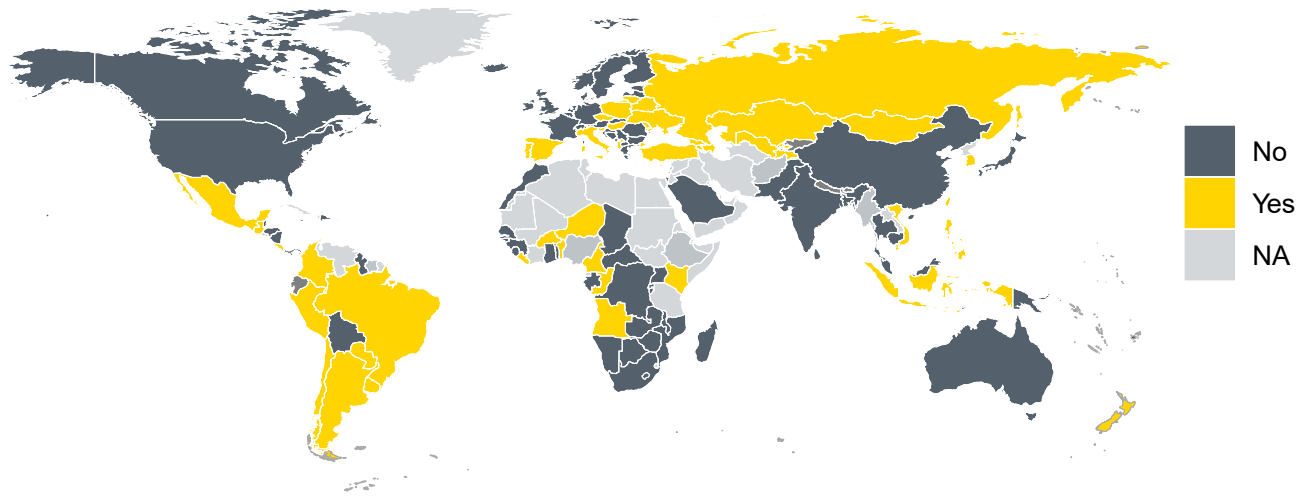
102 Op. cit.

103 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), op.cit.

2 Limiting overreporting of deductions with electronic invoicing

Apart from income underreporting, another common noncompliance mechanism relies on overreporting of deductions in tax returns with the use of false invoices (invoices not reflecting real transactions). More sophisticated VAT "carousel fraud" uses false invoices and "missing traders" to claim illegitimate VAT refunds related to cross-border transactions. The electronic invoicing system offers a technology solution used to replace existing paper invoices with their electronic equivalents. This can serve several purposes. First, e-invoices can incorporate the technology of digital signatures that ensure the authenticity of the seller. Second, fraudulent manipulation of the data is difficult as each change to the original invoice is recorded. Third, they can be transferred (in real time or at certain time intervals) to the tax administration, creating opportunities for advanced analytics, including automated matching of data for both parts of the transaction, to detect fraud. Finally, they may even discourage larger companies from doing business with informal enterprises that cannot issue e-invoices. Chart 27 presents economies where the tax administration introduced an electronic invoice mechanism for all or certain taxpayers, as of 2020. According to information collected by the OECD from the Mexican tax administration, the mandatory e-invoicing system in Mexico has led as many as 4.2 million micro enterprises to formalize.[104]

Chart 27. Tax administration requires all or certain taxpayers to use an electronic invoice mechanism for tax purposes, 2020



Source: International Survey on Revenue Administration (ISORA)

104 OECD. (2017). Technology Tools to Tackle Tax Evasion and Tax Fraud.

Case study:

The study by Heinemann and Stiller (2023)[105] investigated the effects of mandatory e-invoicing in Italy (that from January 2019 covered about 80% of taxable persons in the country) on the level of missing trader intra-community (MTIC) VAT fraud related to the EU bilateral trade agreements. To proxy the level of this cross-border VAT fraud, the authors calculated discrepancies between the level of export of a given product reported by the exporting country and the level of import of the same product reported by the importers (the trade gap). Using the difference-in-differences research framework, the effectiveness of Italian e-invoicing system was confirmed. According to the results of the study, introduction of generalized e-invoicing led to a decrease in the VAT revenue lost due to MTIC fraud in Italy by EUR600 million to EUR1 billion in 2019 compared to the annual running cost of a system amounting to EUR10 million.

3 Using advanced analytics to improve detection of high-risk taxpayers and transactions

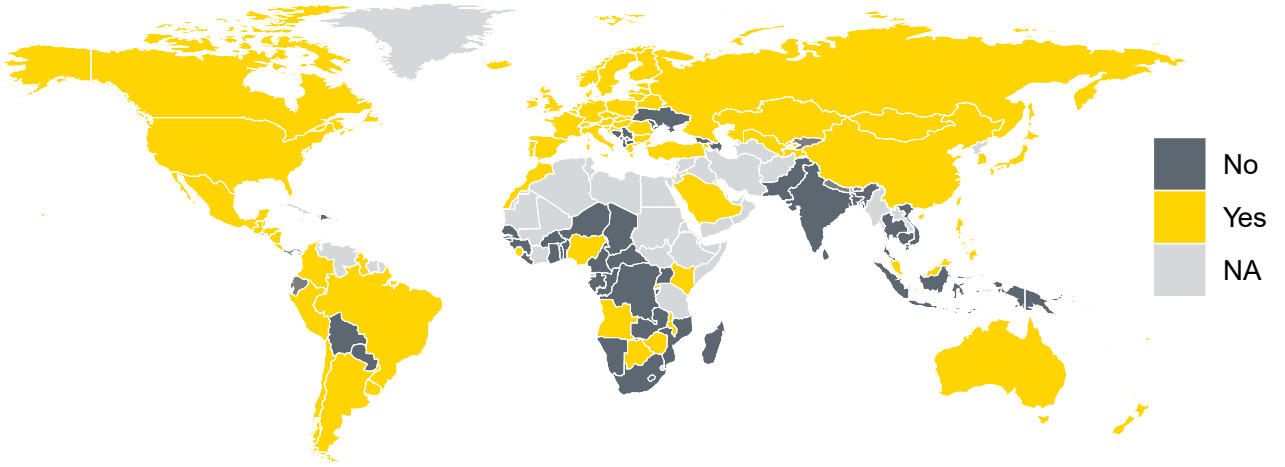
Technology is not only used to register and store the rapidly growing amount of data useful for tax administrations (coming from electronic fiscal devices, e-invoices, electronic and mobile payments, IoT sensors, etc.), but it also has given rise to increasingly automated ways of analyzing large data sets. For example, tax administrations successfully use machine learning models, artificial intelligence (AI) and text mining algorithms to improve their risk-scoring, i.e., the process of detection of high-risk taxpayers and subject them to tax audits. Those innovative digital solutions enable fast processing of large data sets (e.g., from tax returns), matching various data sources, making use of data in unusual formats, and continuously improving the effectiveness of the models using self-learning algorithms. More effective risk-based audits and other detection methods translate into increased revenues from taxes or penalties. However, the initial cost of their implementation, including the cost of technology and human capital, may be significant. Therefore, as the most sophisticated techniques are mostly used in advanced economies, in lower-income countries a starting point can be to replace the manual process of qualifying taxpayers for audits with simpler methods based on risk assessment and strengthening digital skills of analysts working for the tax administration.[106] Chart 28 presents economies where the tax administration reported using data science and AI tools, as of 2020. There is a visible gap in implementation of those methods between developing countries and advanced economies, with few examples of tax administrations benefiting from such solutions in Africa, South Asia and Southeast Asia.

105 Heinemann, M., & Stiller, W. (2023). Digitalization and Cross-Border Tax Fraud: Evidence from E-Invoicing in Italy. CESifo Working Paper No. 10227.

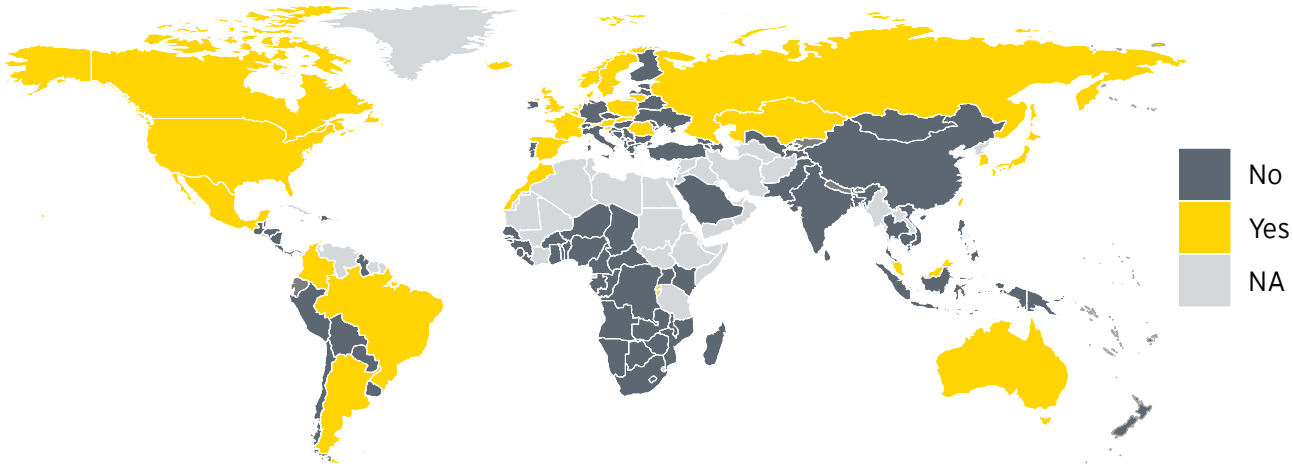
106 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), op.cit.

Chart 28. Tax administration implements and uses innovative technologies, 2020

A) Data science and/or analytics tools



B) AI, including machine learning



Source: International Survey on Revenue Administration (ISORA)

Case studies:[107]

In 2020, the Austrian tax administration managed to significantly improve the effectiveness of tax audits aimed at employed individuals. It incorporated several machine learning tools (decision trees, regression, balance scorecards, ensemble methods) to create real-time risk assessment of PIT declarations. The new model resulted in reducing the number of cases selected to audit by 40%, while increasing the effectiveness of the selection process as the hit rate (identification of cases subject to additional claims during audit) was doubled. Following the success of the project, it was decided to apply similar real-time risk assessment tools in the case of other taxpayers subject to PIT as well as VAT and CIT.

107 All three examples are based on the information provided by tax administrations in OECD (2022), Tax Administration 2022: Comparative Information on OECD and other Advanced and Emerging Economies, OECD Publishing, Paris.

In 2021, the National Revenue Agency in Bulgaria deployed a predictive model that automatically identifies likely missing traders responsible for VAT fraud with the use of extensive data on VAT transactions. The model was developed in cooperation with external advisors from academic institutions. The new model replaced the previous, much more labor-intensive procedure requiring risk-scoring followed by thorough investigation of suspected taxpayers. The new approach relying on advanced technology resulted in faster identification of missing traders (on average, the time of the activity of such a trader before being identified by the tax administration decreased by 15%) and increased probability of detection.

In France, the "Foncier Innovant" project allows the tax administration to analyze aerial photographs taken by the National Institute of Geographic and Forest Information with the use of AI to detect undeclared buildings and swimming pools subject to property taxes. The AI algorithm is able to identify such structures from photos and subsequently consult the data from tax declarations to verify whether appropriate local taxes have been paid. In 2022, the first experimental stage of the project was carried out in nine French departments focusing on detection of undeclared swimming pools. The results were promising, as about 20,000 undeclared swimming pools were identified, resulting in EUR10 million of additional revenues for municipalities concerned.[108]

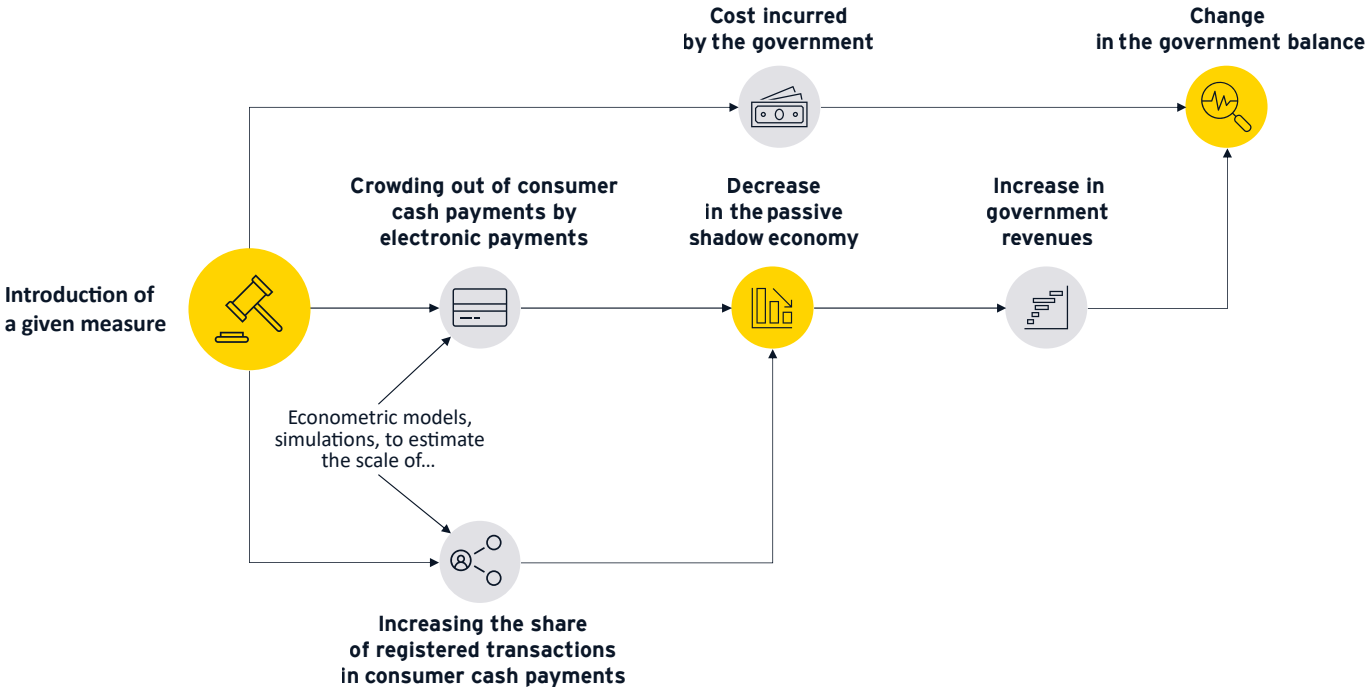
108 https://www.impots.gouv.fr/actualite/generalisation-du-foncier-innovant

4.5. Taking advantage of third-party information

Apart from the data provided by taxpayers directly and on their own behalf to the tax administration, financial activities and revenues of individuals or businesses are sometimes also collected from third parties. The third-party information is used by some governments to improve tax compliance by increasing the real and/or perceived risk of detection.

This happens primarily when the third party does not gain any benefit from providing incorrect information to the tax administration. For example, employees are less prone to underreport their income from work than self-employed people, because their employers are also obliged to file their tax returns as opposed to self-declaration of income by the self-employed. Likewise, a consumer who does not personally benefit from the seller's desire to conceal a transaction (as seen in the passive shadow economy, where the buyer is not involved in the seller's financial gains from evading VAT and income taxes, see section 2.1) can proactively request a receipt. This ensures that the transaction is recorded. Alternatively, the consumer can opt for an electronic payment method, which is traceable by the tax administration. EY Economic Analysis Team has analyzed many regulations stimulating this channel of the passive shadow economy reduction in various countries (see Chart 29 for the outline of our general approach).[109]

Chart 29. EY approach to the impact assessment of measures that promote registration of consumer transactions and the use of electronic payments to reduce the passive shadow economy



Source: EY analysis

109 Among the publicly available research, see e.g., EY (2019), Reducing the Shadow Economy in Albania Through Electronic Payments and related technical appendices.

What has been done?

There are various aspects of using third-party data. The mere awareness of the existence of such sources of information means that some dishonest taxpayers may feel more at risk of being subject to tax audits and, as a result, increase their tax payments. However, for the long-term effect, tax authorities actually use the data for improved detection. This is often facilitated with advanced methods for data matching and analysis that were described in section 4.4. Meanwhile, some developing countries have not implemented appropriate legal provisions allowing tax administrations to access private third-party data (e.g., from bank accounts).[110] On the one hand, this would expand the set of tools for building tax compliance. On the other hand, the previously mentioned low public trust in the tax administration may generate opposition to the introduction of any policies that may be perceived as violating the privacy of taxpayers or potentially lead to abuses of citizens by state officials. Therefore, special caution should be exercised when deciding on introduction of such measures.

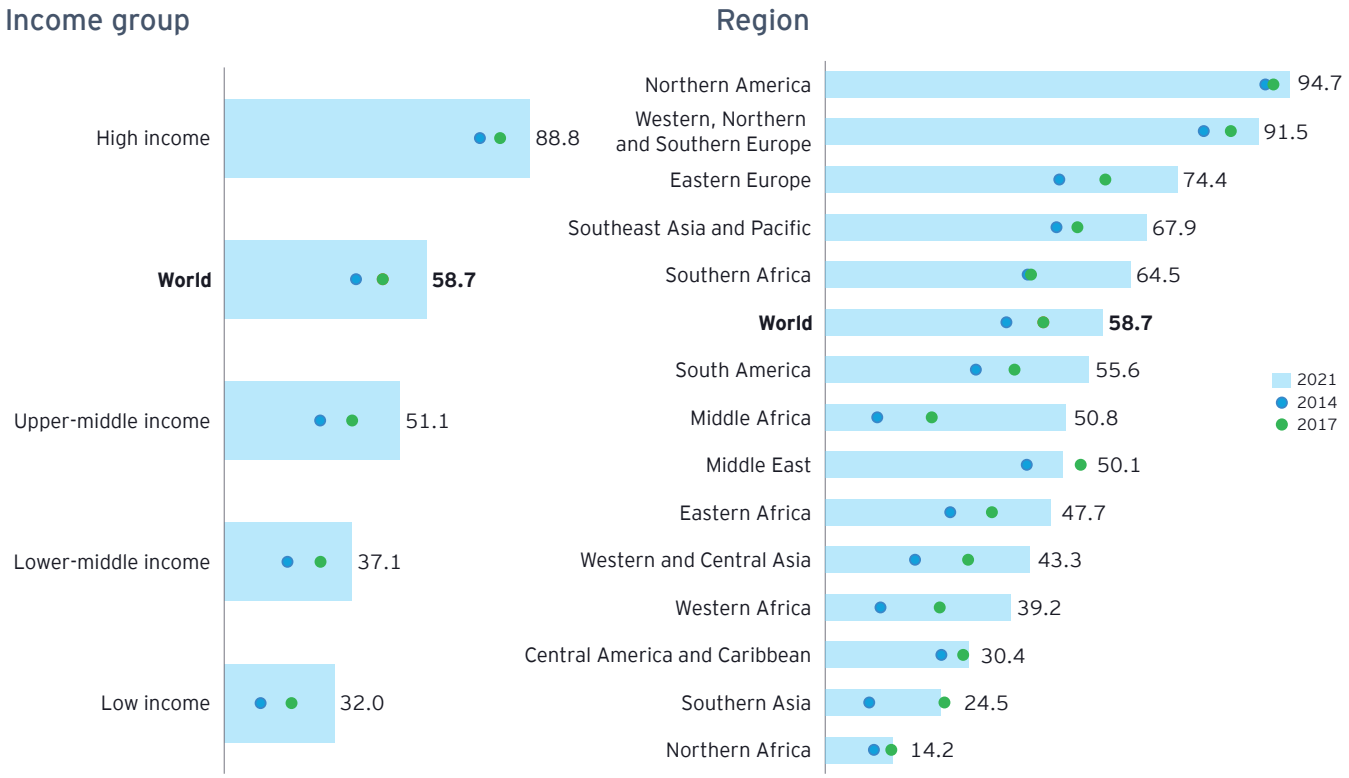
1 Promoting financial inclusion and the use of electronic payments

Electronic records of bank account balances and electronic payments offer a rich source of third-party data that the tax administration sometimes use to detect noncompliance. Provided that the tax administration can easily access such electronic records and knows how to use them to identify unreported transactions, using digital instead of cash payments by the buyer constitutes a strong imperative for the seller to register such a transaction and pay the resulting taxes. However, even though we globally observe the growing popularity of digital payments, very few countries aim to become completely cashless due to several benefits of using cash. For example, it provides privacy of transactions, immediate receipt of funds by the seller, no electricity or special devices are needed to make payments (therefore, it is available to the financially excluded population), and many believe that it allows for greater control of their spending amounts. At the same time, for more and more people, digital payments are becoming more convenient and secure, eliminating the need to carry large amounts of cash susceptible to pickpocketing and providing confirmation for each transaction that can be used during potential disputes.

One of the most important conclusions from our own studies on digital payments over the last decade is that guaranteeing a sufficient level of financial inclusion and an electronic payment acceptance network is crucial for the success of subsequent reforms promoting the use of digital payments. While in advanced economies digital payments were used by almost 90% of the adult population in 2021, in low-income countries this share was only around 30% (see Chart 30).

110 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), op.cit.

Chart 30. Made a digital payment in the last year (percentage age 15+) by income group and region



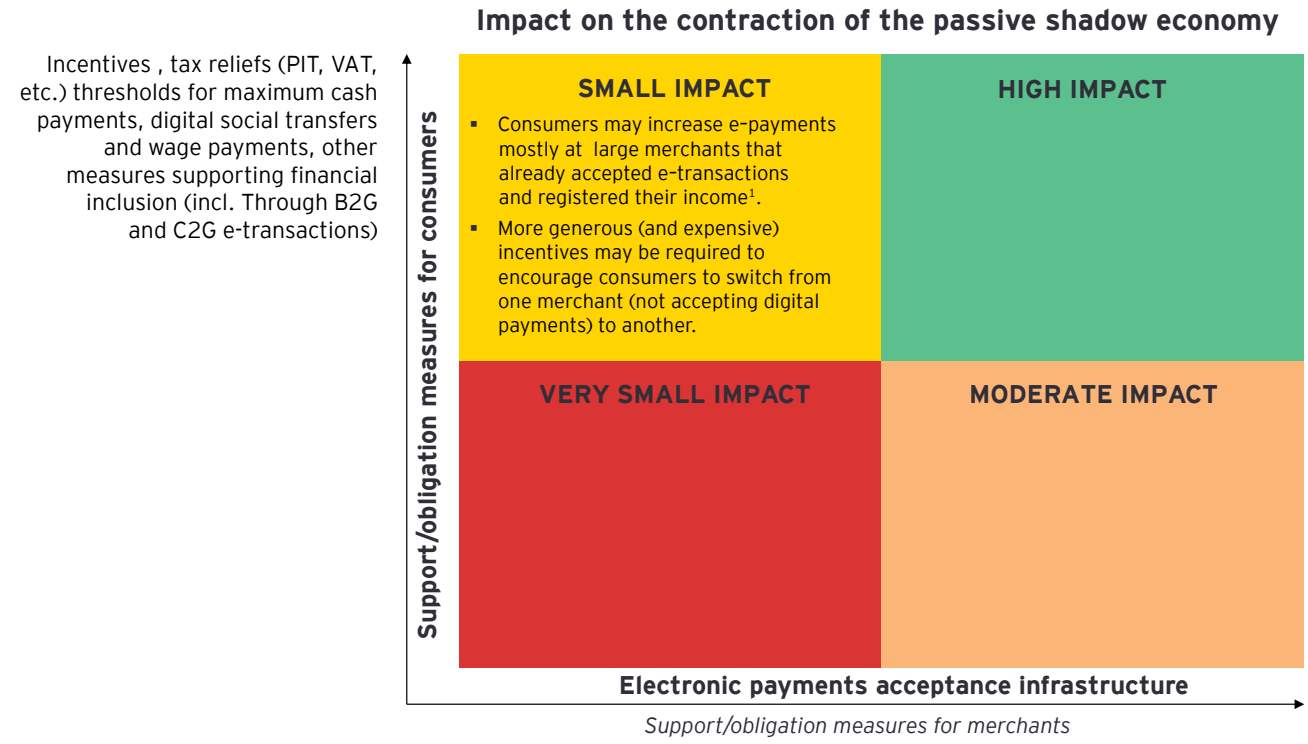
Notes: See section A.7 for the regional aggregation of economies (in particular, Northern America includes only the US and Canada).

Source: The Global Findex Database 2021

The policies that we have studied include those based on enforcement or obligation mechanisms (e.g., obligation to operate point of sale (POS) terminals by merchants, obligation to make electronic payments of wages and/or social security benefits, thresholds for maximum cash payments) as well as other measures focusing on providing incentives either to consumers or merchants (e.g., tax relief for making and/or accepting electronic payments). Incentives provided to consumers may have a limited impact if the payments acceptance network is not sufficiently developed, especially among less compliant enterprises (see Chart 31). Some initiatives did not bring the expected results. For example, according to the recent study of Brockmeyer and Saenz Somarriba (2022),[111] substantial VAT rebates for consumers introduced for debit and credit card payments in Uruguay resulted in a rise in the number and volume of electronic transactions but did not lead to an increase in VAT payments by retailers. First, to guarantee the cost effectiveness of such tax incentives, they should not be introduced too early, without ensuring the sufficient level of financial inclusion (access to electronic and/or mobile means of payments for consumers) and sufficient acceptance infrastructure among retailers that underreport their income. Second, the effects of promoting digital payments may initially be muted to the extent that some merchants respond to rising digital transactions by reducing the share of reported payments that they receive in cash. Finally, to reduce the costs of tax incentives for the regulator, they might be introduced only temporarily in order to change payment habits of consumers or can be awarded to digital payments in selected sectors with the highest share of unreported transactions.

111 Brockmeyer, A., Saenz Somarriba, M. (2022), Electronic Payment Technology and Tax Compliance: Evidence from Uruguay's Financial Inclusion Reform, Policy Research Working Paper Series 9947, The World Bank.

Chart 31. Combining various policies aimed at promoting electronic payments and building acceptance infrastructure: impact on the passive shadow economy



Source: EY analysis

Case studies:

An example of supporting the purchases of POS terminals (especially by small merchants) is the Cashless Poland Foundation, established in 2017 by several public and private entities in Poland. The foundation provides merchants that in the last 12 months were not accepting electronic payments with an opportunity to receive and use up to three POS terminals free of charge in the first year. After that period, or once the turnover registered on a given terminal in a given year exceeds PLN100,000, a monthly fee is collected. To participate in this program, some conditions have to be met, e.g., no surcharges for electronic payments are allowed, and the entrepreneurs can participate in the program only once. The program focuses on small and medium-size enterprises. The launch and development of the program was accompanied by a large media campaign with approximately 93% of entrepreneurs covered and up to 72% of entrepreneurs declaring that they had heard about the program.[112] Thanks to this initiative, over 600,000 POS terminals have been installed as of 2023, resulting in a substantial improvement in the acceptance network in Poland.[113]

In 2022, EY Economic Analysis Team conducted an analysis on the impact of the program on the passive shadow economy in Poland. Due to the growing popularity of cashless payments, some POS terminals would have appeared on the market even without the program. Taking this into account, we estimated such counterfactual scenario and calculated that without the program, the number of POS terminals in Poland at the end of 2021 would have been 23.3% lower. A larger number of POS terminals encourages the use of payment cards and linked bank accounts, increases the value of cashless transactions and reduces the passive shadow economy. We estimated that because of the increase in the number of POS terminals achieved by the program by the end of 2021, 1.3 million additional payment cards and 1.2 million individual bank accounts appeared in Poland. Without the program, the passive shadow economy in 2021 would have been higher by 0.3% of GDP (PLN8.7 billion) while tax revenues in Poland would have been lower by 0.04%-0.06% of GDP (PLN1.6 billion to PLN2.0 billion).[114] In total, in 2018-21, the program generated PLN3.9 billion to PLN5.0 billion of additional tax revenues, according to our estimates.

In 1999, South Korea introduced a program whereby consumers could deduct 10% of the amount paid through credit or debit cards (deduction rate) in excess of 10% of the person's total annual salary (deduction threshold) from the income tax base. If the value of the taxpayer's electronic transactions did not exceed the threshold of 10% of annual salary, the deduction was not applicable. To prevent excessive tax deductions, a deduction cap was set at KRW3 million or 10% of total labor income (depending on which amount was effectively lower). In the following years, the program was extended through inclusion of mobile transactions and cash payments for which electronically traceable cash receipts (ETCRs) were issued. The deduction rate has since been revised (increased or decreased) several times. As of 2017, it was set at 15% for credit card payments and 30% for debit card, mobile and ETCR payments and capped at the amount of KRW3 million or 20% of total labor income. The deduction threshold has also been elevated over time (reaching 25% as of 2017), thereby reducing the scale of the incentive.

All in all, the structure of the regulation allows the government to react (relatively) flexibly to a changing environment and to control the level of the incurred costs. Importantly, the Korean National Tax Service (NTS) succeeded in making the tax refund process easy and convenient by providing salary earners with prefilled data on their transactions eligible for deduction (credit and debit card companies are obliged to regularly report their payment data to the NTS). According to the study of Sung et al. (2017)[115] based on the analysis of microdata from the Korean Household Income and Expenditure Survey, the estimated net impact of the introduced tax incentive on PIT revenues in South Korea (accounting for an increase in the effective PIT rate for self-employed people due to a reduction of underreporting as well as a decrease in the effective PIT rate for wage and salary earners due to deductions of electronic payments) is positive – the net gain calculated for 2014 amounted to KRW1.4 trillion (4.2% of PIT revenues in 2014).

112 "Program Polska Bezgotówkowa" (2019), presentation from VII Cashless Congress in Poland, https://www.cashlesscongress.pl/wp-content/uploads/2019/04/Prezentacja-nr-2-_Program-Polska-Bezgot%C3%B3wkowa_.pdf

113 https://polskabezgotowkowa.pl/aktualnosci/600-tys-terminali-zainstalowanych-dzieki-fundacji-polska-bezgotowkowa/

114 This last result is based on the assumption that X% decrease in the value of consumer cash payments translates into X% decrease in the passive shadow economy which is supported by such transactions.

115 Sung M. J., Awasthi R., Lee H. C. (2017), "Can tax incentives for electronic payments reduce the shadow economy?: Korea's attempt to reduce underreporting in retail businesses", Policy Research working paper, no. WPS 7936, Washington, D.C. : World Bank Group.

2 Encouraging consumers to request receipts

Apart from conducting inspections aimed at detecting underreporting, regulators sometimes also encourage third parties, i.e., consumers, to demand fiscal receipts for each transaction. For this purpose, tax administrations run campaigns educating consumers about the obligations of companies and the benefits related to generating tax revenues (using the public goods argument). In addition, in some cases, they offer specific financial benefits to people asking for fiscal receipts. Such policies take the form of tax rebates similar to those offered for the use of electronic payments or so-called receipt lotteries. In the fiscal lottery scheme, consumers are provided with an incentive to ask for a receipt, as it may also serve as a free-of-charge ticket in lotteries, thereby giving its holder a chance to win attractive prizes (money, cars, etc.). In the longer perspective, those measures aim to get consumers used to asking for fiscal receipts. With the use of these kinds of policies, the regulator wants to stimulate registration of payments in sectors where the shadow economy may be more prevalent, e.g., by offering higher prizes or tax rebates for transactions at merchants in such sectors. Differentiating the value of benefits among sectors or offering them only in selected sectors can also control the costs of the regulation more flexibly and increase its efficiency in terms of additionally collected tax revenues.

Case study

A successful Nota Fiscal Paulista program encouraging consumers to ask for fiscal receipts while giving them the possibility to report noncomplaint sellers was introduced in 2007 in the state of São Paulo in Brazil. The effects of the program were assessed by Naritomi (2019).[116] The aim of the program was to reduce the level of VAT evasion attributed to the sale to the final consumer by benefiting from a similar self-enforcement mechanism of VAT that is used at the previous stages of the supply chain (in which companies applying for VAT refunds constitute a third-party source of information guaranteeing compliance).

To reach this goal, consumers were offered tax rebates (amounting to about 1% of the purchase value, on average) and participation in monthly lotteries (offering about 1.5 million cash prizes each month, on average) in exchange for ensuring that their business-to-consumer transactions were registered by the sellers. Participation in the program was convenient, as consumers only needed to give the cashier their Social Security Number while making the purchase. However, in order to receive lottery tickets (one ticket for every USD50 worth of purchases) and collect benefits, consumers needed to create an online account on the specially created platform. On the same platform, consumers could verify whether their transactions were properly recorded and, in the case of discrepancies, file complaints against specific sellers (in exchange they could even be awarded with part of the fines collected from noncomplaint businesses) while the businesses were notified of the complaint.

The author assessed the effects of the program using the difference-in-differences research design in which the performance of retailers (who should increase tax compliance after the introduction of Nota Fiscal Paulista) was compared with the performance of wholesalers (on which the program should have much less impact). According to the study, over four analyzed years, the program increased reported revenue in the retail sector by 21%. The increase in compliance was even stronger for small businesses and in the sectors with many different consumers (which increases the risk for the merchant that a consumer files a complaint). Despite the significant costs of the program offering financial rewards, it was estimated to have generated 9.3% net increase in tax revenues. The author of the research also provided evidence for the effectiveness of the system of consumers reporting irregularities to the tax administration — businesses were reporting 7% more receipts and 3% more revenues after being notified that the first complaint against them was filed.

116 Naritomi, J. (2019). Consumers as tax auditors. American Economic Review, 109(9), 3031-3072.

3 Making adjustments, where necessary, in a third-party reporting mechanism of VAT

In general, the mechanism for calculating VAT due in business-to-business (B2B) transactions, in which the supplier collects VAT from its business customer and reports it to the tax administration after deducting the refundable amount of input VAT, should lead to a fairly good level of compliance, as it provides for the third-party reporting across firms. However, the system is misused in certain types of VAT fraud, such as missing trader fraud, in which suppliers do not report the collected VAT and become untraceable, or carrousel fraud, in which suppliers use false invoices to claim the deductions or refund of VAT they did not pay. In the sectors most exposed to this type of organized fraud scheme, certain adjustments in the VAT system are sometimes introduced. For example, under the domestic reverse charge mechanism, the responsibility for reporting VAT to tax authorities in B2B transactions is shifted from the supplier to the customer, eliminating the risk of suppliers' frauds. EU Member States can apply the reverse charge mechanism for selected types of transactions, and many decide to do so.

A recent study on the MTIC fraud indicated that while the reverse charge mechanism largely reduces fraud in the importing country applying this policy, it also leads to shifting of fraud to other EU countries not covered by this measure.[117] Fraud shifting might be one of the reasons why so many EU countries decided to introduce this mechanism, implementing it in different years and gradually expanding the lists of products covered. Poland used a reverse charge mechanism to combat VAT fraud in particular goods and services (including steel products, basic metals, gold, jewelry, construction works, electronic processors and devices, heating fuels, waste and recyclable materials, car parts, and transfer of greenhouse gas emission allowances) before switching to a VAT split payment regime. Under the split payment, VAT is charged by the supplier under the normal rules, but the supplier cannot collect VAT paid by the customer without reporting it to the tax administration, as it is either directly transferred to the tax authorities or goes to a separate blocked VAT account.[118]

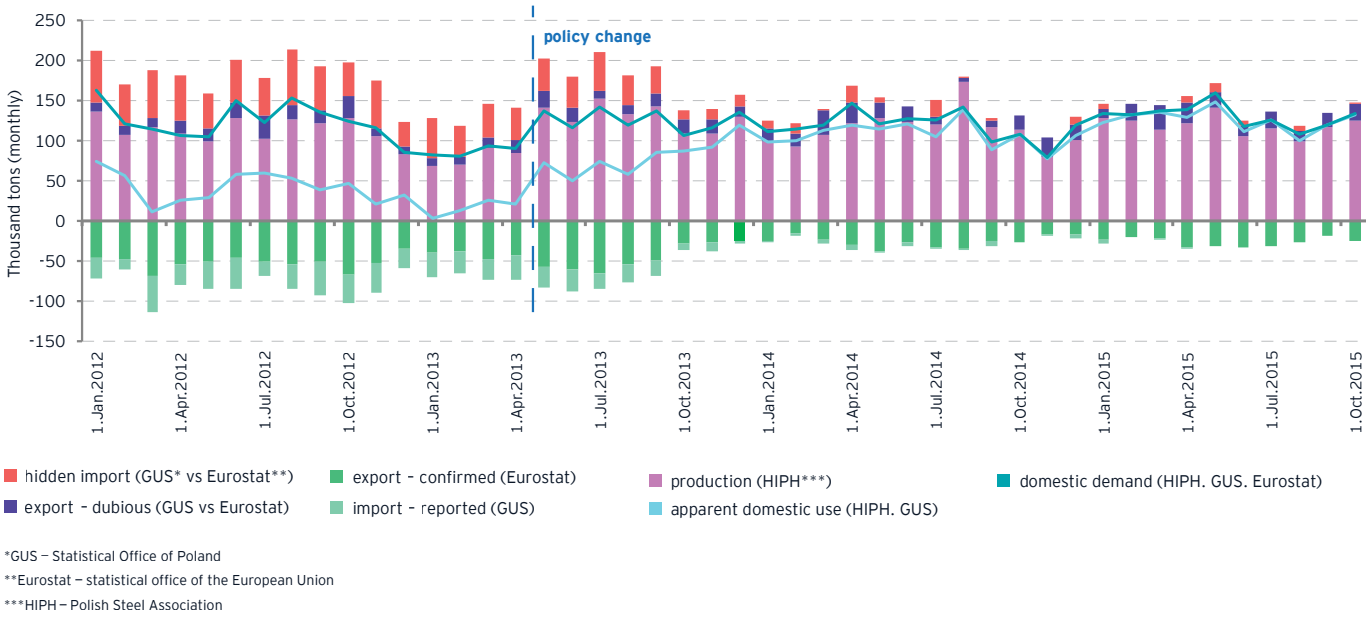
Case study

EY professionals supported the process aimed at counteracting VAT fraud in the steel products market in Poland with the introduction of a reverse charge mechanism in Q4 2013. In 2011–13, a remarkable expansion of the unreported trade of reinforcing bars occurred in Poland. This adversely affected the Polish iron and steel industry, which in turn resulted in reduced government revenues. The MTIC fraud mechanism was identified as the most important channel of unreported operations. Following our analyses and communication, the government responded by implementing a reverse charge mechanism for VAT as a preventive measure. We carried out a detailed quantification of the scale of the unregistered trade reduction as a result of the implementation of the reverse charge VAT in 2013 (we estimated this effect both before the implementation and after, when new data became available). We also ran an econometric and simulations analysis to estimate wider macroeconomic and fiscal effects of the introduced regulations. According to our results, after the introduction of the mechanism, the unreported trade in the steel sector considerably contracted, and the legal production increased (see Chart 32), which contributed to a revival in the sectors cooperating with the steel industry. The results of the EY professionals' analysis were presented by the Polish government to the European Commission as an illustration of measures undertaken under the EU Excessive Deficit Procedure.

117 Stiller, W., & Heinemann, M. (2019). Do more harm than good? The optional reverse charge mechanism against VAT fraud. Preprint on Research Gate.

118 Consumption Tax Trends 2020: VAT/GST and Excise Rates, Trends and Policy Issues," OECD (2020).

Chart 32. Estimated domestic demand and apparent domestic use of reinforcing bars in Poland



*GUS – Statistical Office of Poland
**Eurostat – statistical office of the European Union
***HIPH – Polish Steel Association

Source: EY analysis

4 Collecting third-party information from online platforms

Some part of unregistered transactions may leave a trace online, e.g., in applications associated with the sharing economy, e-commerce platforms or social media. Some tax administrations have already implemented measures aimed at collecting relevant data from such platforms and use it to improve detection. For example, as of July 2023 taxi travel and short-term accommodation platforms, such as Uber and Airbnb, are obliged to report transactions made through their platforms to the Australian Taxation Office under the Sharing Economy Reporting Regime.

As of July 2024, all other sharing economy platforms through which purchase transactions are made (e.g., food delivery) will enter the same scheme.[119] Tax administration in the UK developed a software that automatically filters social media and publicly available websites, including e-commerce, to identify unreported transactions.[120] The tool can also be used to monitor situations in specific business sectors or within a geographic region.[121]

119 https://www.ato.gov.au/Business/Third-party-reporting/Sharing-economy-reporting-regime/#PlatformsthatmustreportunderSERR.

120 PWC (2017), "What happens when the taxman gets superpowers? The disruptive impact of the Zero Cost of Control phenomenon on business".

121 OECD. (2017). Technology Tools to Tackle Tax Evasion and Tax Fraud.

4.6. Enhancing whole-of-government approaches and international cooperation

The whole-of-government approach refers to a close cooperation between different bodies of a government and public administration to increase the efficiency of processes and create a synergy that facilitates the achievement of a common goal. The two major elements forming the base for the whole-of-government approach are information sharing and compatibility of IT systems and data warehouses. The approach is also used to combat income underreporting, tax evasion and fraud, where tax administrations cooperate with other parts of the government and law enforcement agencies. Sharing data on high-risk taxpayers between different institutions enables its quick cross-validation and avoids duplicate actions. For example, thanks to rather simple verification, agencies can check whether a particular taxpayer receives remuneration while being registered as unemployed.

To combat a tax gap-related activity that goes beyond the single state level (e.g., offshore tax evasion), international cooperation is crucial. This comprises the on-request and automatic exchange of information. According to the OECD Global Forum on Transparency and Exchange of Information for Tax Purposes, on-request exchange of information refers to information about accounting records or bank statements received on a tax administration's request made to another tax authority. Automatic exchange of information provides for automatic sharing of detailed data on financial accounts held by foreigners. Each year, domestic jurisdictions gather information from banks, hedge funds and investment trusts to automatically exchange it with the tax administration in which a particular account owner is a taxpayer.[122] There exist numerous bilateral treaties on information exchange. While these remain important, multilateral agreements provide the richest source of data.

What has been done?

Information sharing is viewed by governments as crucial in enhancing cooperation between different actors at the national and multinational levels. Therefore, they try to reduce all potential barriers that could disrupt the exchange of data. This is done by synchronizing data warehouses and IT systems to enable efficient transfer of information. Apart from that, cooperation requires a harmonization of legal aspects and the commitment of all bodies engaged, clear and understandable targets, and a strong governance.[123]

122 https://www.oecd.org/tax/transparency/what-we-do/

123 OECD (2017). Shining Light on the Shadow Economy: Opportunities and Threats.

1 Joining forces of several state actors

The whole-of-government strategy of reducing the shadow economy and tax gap drives joint coordination of actions aimed at detection and prevention of tax crimes. In some cases, nongovernmental institutions, such as business organizations, are also involved in the process. Since it relies strongly on information exchange, it has to comply with laws and procedures, especially concerning data privacy and confidentiality.[124] In developing countries, exchange of information and data between different institutions can be initiated by implementing simple solutions, e.g., unification of the format of collected data. In advanced economies, there are examples of a close cooperation of different governing bodies. For instance, drawing from the report on labor market crime (i.e., "violations of the pay and working conditions, tax evasion and social security fraud")[125] prepared by agencies operating in different labor market areas, Norway prepared a strategy to tackle this problem via interinstitutional cooperation. The actions included establishing of joint centers of collaboration between public agencies, trade unions and employer associations, creating a national center of intelligence and analysis and establishing a special body to ensure confidentiality between agencies. The Finnish tax administration fights shadow economy through the Grey Economy Information Unit. This organization collects and shares data concerning the activities of taxpayers (individuals and enterprises) and their tax compliance, connections and financial status. Many authorities, including the Unemployment Insurance Fund, the Finnish Police, Customs and EU-Funding, have a legal right to access published data.

Meanwhile, in France, tax fraud is tackled collectively by the tax administration working with anti-fraud agencies, like Tracfin, which is a special unit to fight money laundering. The French tax administration also collaborates with the police; this cooperation resulted in the formation of a special unit pursuing tax criminals.[126]

2 Improving information sharing and efficiency of collaboration through digital transformation

Many countries pursue digitalization to facilitate interinstitutional data sharing as well as effective collection and use of third-party data to reduce the shadow economy and tax gaps. Initiatives undertaken include automation of processes and integration of IT systems to improve data collection, sharing and adoption of more flexible models for compliance and risk management. Examples of successful digitalization aimed at improving data sharing and collaboration among different agencies include Türkiye, which improved the collection of data coming from public and private units (including commercial banks) by employing digital tools, such as warehousing systems. Kenya's Digital Economy Blueprint is an attempt to combat the shadow economy through digital cooperation. Its actions involve digitalization of services for taxpayers, improvement of connectivity and technology infrastructure, as well as provision of legal and regulatory frameworks for data and consumer protection.[127] In Georgia, a data warehouse project was created to collect and sort information coming from the Revenue Service and other third-party sources. The program enables continuous assessment of taxpayers in terms of risk and tax returns.[128]

124 Brun, J. P., Gomez, A., Julien, R., Ndubai, J., Rao, S., & Soto, Y. (2022). Taxing crime: a whole-of-government approach to fighting corruption, money laundering, and tax crimes. World Bank Publications.

125 Samfunnsøkonomisk analyse (2017), "The size of labor market crime in Norway", online article: link.

126 All examples were taken from OECD (2017). Shining Light on the Shadow Economy: Opportunities and Threats.

127 Dom, Roel, Anna Custers, Stephen Davenport, and Wilson Prichard (2022), op.cit.

128 OECD (2022), Tax Administration 2022: Comparative Information on OECD and other Advanced and Emerging Economies, OECD Publishing, Paris.

3 Establishing international cooperation

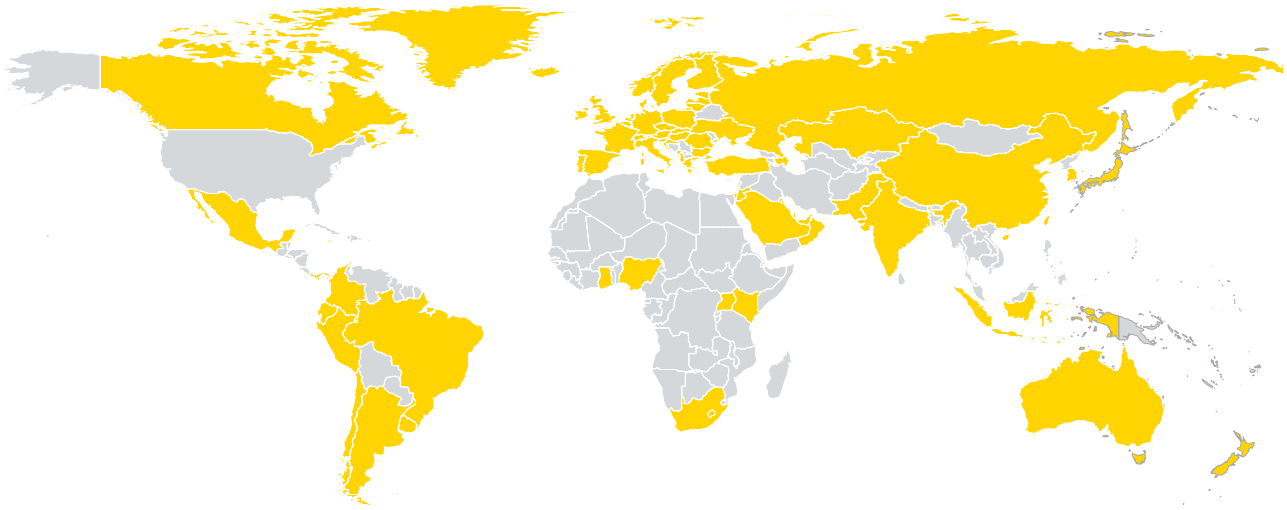
As globalization proceeds, tax evasion opportunities go beyond a state level. This includes allocation of money and investments to countries with beneficial tax rules (tax havens). To counter those actions, tax administrations in different countries, equipped with appropriate legal tools, are increasingly interested in cooperation. Data sharing agreements are established between two or more countries and through them participants commit to exchange data necessary to detect and chase tax crimes. There are also examples of regional cooperations. Focusing on more narrow areas allows identification of specific needs and barriers of countries from a specific region and, as a result, for better tailored policies.

Case studies

One of the major multilateral agreements on information exchange to combat tax evasion through tax havens is the Common Reporting Standard (CRS), designed by the OECD in 2014. The broad scope and country coverage (see Chart 33) makes the CRS the most universal model for the automatic exchange of information. Due to its multilateral character, it does not require negotiation of treaties on a country-by-country basis. In countries that participate in the CRS, domestic financial institutions collect detailed information on cross-border deposits and automatically exchange it. In situations where an account is owned indirectly, an investigation concerning the final owner is conducted. Casi, Spengel and Stage (2019)[129] analyzed the impact of the CRS implementation. The authors assessed the CRS's effectiveness in decreasing tax evasion from the Q4 2014 to Q3 2017 using the difference-in-differences method. They used the volume of cross-border deposits placed in tax havens as a proxy for tax evasion. A significant short-term reduction of 11.5% in foreign deposits held in tax havens was observed after the CRS implementation. As the US does not participate in the CRS (the US established the Foreign Account Tax Compliance Act, which obliges foreign institutions to share information on financial accounts held by the US residents outside the US), it potentially makes the US an attractive alternative to traditional tax havens. In the second part of the analysis, the authors investigated whether residents of EU and OECD countries relocated deposits to the US after the CRS implementation. The authors estimated an increase of about 10% of cross-border deposits on average in the US compared to other countries in the sample after the CRS enforcement. Thus, the CRS did not stop cross-border tax evasion entirely. The authors stressed that their study and its conclusions apply to individual tax evasion, rather than the use of tax havens for corporate tax planning.

129 Casi, E., Spengel, C., & Stage, B. M. (2020). Cross-border tax evasion after the common reporting standard: Game over?. Journal of Public Economics, 190, 104240.

Chart 33. Participants of the Common Reporting Standard as of 2023



Notes: Participants of the CRS marked in blue.
Source: EY analysis based on OECD reporting

Examples of this kind of cooperation are also present on the regional level (see Chart 34). The Africa Initiative, comprising 37 members, was created in 2014 with the purpose of strengthening African countries' capacity in exchange of information. Setting up operational units with proper resources and defining strategies for the exchange of information in tax audits are two examples of actions implemented by member states. According to an OECD report, in 2022, four countries (Kenya, South Africa, Tunisia and Uganda) identified additional revenues of about EUR76.6 million resulting from the exchange of information – the highest amount since the establishment of the Africa Initiative.[130]

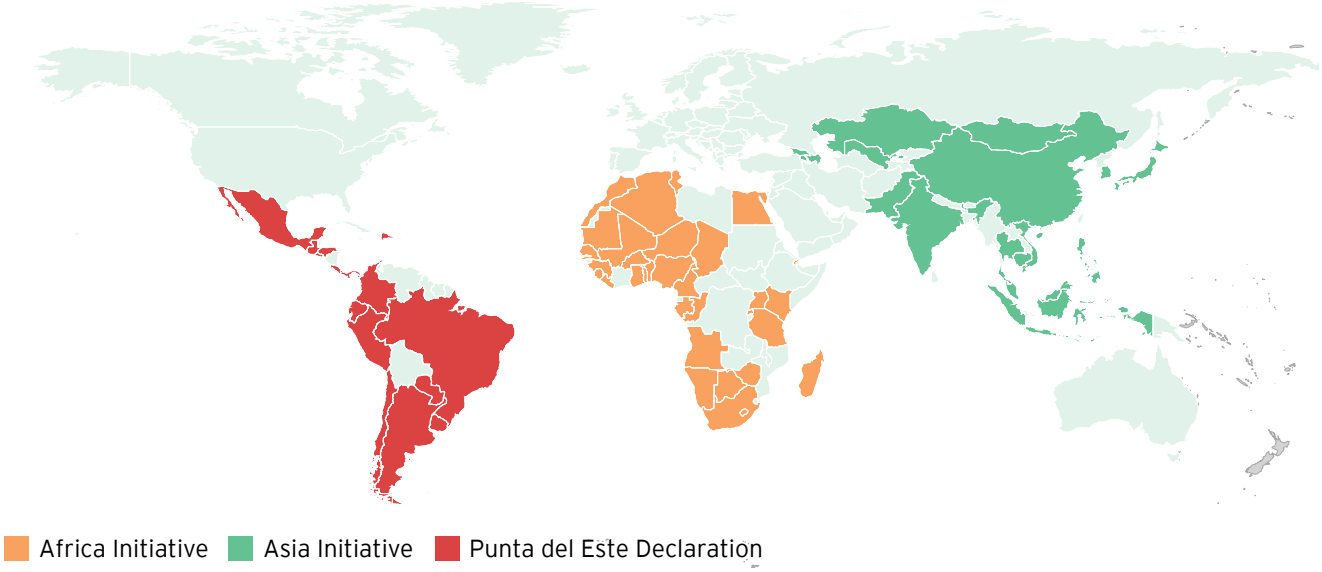
The Punta Del Este Declaration was signed in 2018 by 15 Latin American countries. By signing the declaration, those countries obliged to the exchange and use of information between tax administrations with the aim to improve the region's tax transparency. According to an OECD report, countries involved in this initiative have identified significant additional revenues by incorporating on-request and automatic exchange of information, offshore tax investigations and voluntary disclosure programs (EUR708 million in 2022); however, the benefits of these actions have been concentrated in countries with more mature institutions and more efficient enforcement measures.[131] In 2022, a similar cooperation was created in Asia – the Asia Initiative Declaration among 22 economies.[132]

130 OECD (2023), Tax Transparency in Africa 2023: Africa Initiative Progress Report, Global Forum on Transparency and Exchange of Information for Tax Purposes, OECD, Paris.

131 OECD (2023), Tax Transparency in Latin America 2023: Punta del Este Declaration Progress Report, Global Forum on Transparency and Exchange of Information for Tax Purposes, OECD, Paris.

132 OECD (2023), Tax Transparency in Asia 2023: Asia Initiative Progress Report, Global Forum on Transparency and Exchange of Information for Tax Purposes, OECD, Paris.

Chart 34. Regional cooperations for cross-border exchange of information



Source: EY analysis based on OECD reporting

4.7. Policy insights

There are three broad categories of actions aimed at reducing the shadow economy and tax gap:

Building trust

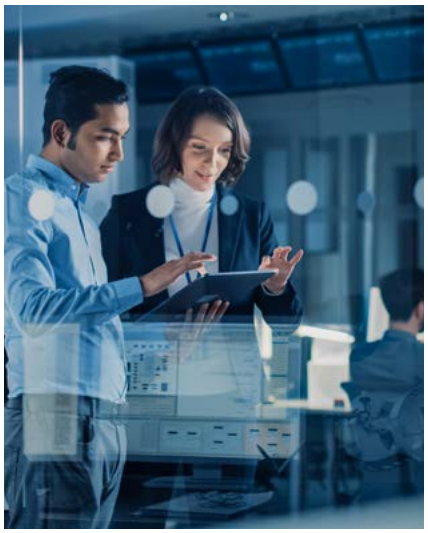
Increasing tax morale or taxpayers' belief that complying is the right thing to do.

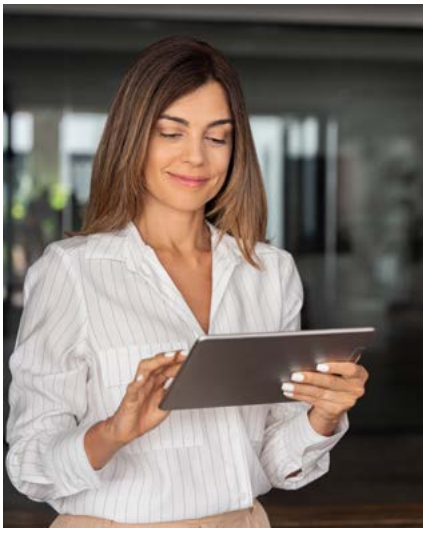
Facilitation

Making it easier for taxpayers to pay taxes and comply with regulations.

Enforcement

Increasing the risk of detection and/or severity of penalties for noncompliance.





Those actions are most effective when the right tools are applied. In general, tax administrations use or consider using advanced technological solutions, new data sources (e.g., third-party information) as well as interinstitutional and international cooperation while designing treatment strategies. Most importantly, it might be essential for an effective policy strategy aimed at reducing the shadow economy and tax gap to correspond to the scale and sources of those problems in a given country.

According to our analysis, the shadow economy is particularly large in emerging markets and developing countries where, aside from the non-monetary shadow economy (household production of goods for own final use), it is mostly associated with low government effectiveness[133] and large informality (unregistered businesses and employment). Progress is very much needed in terms of financial inclusion, digitalization and education on why and how to pay taxes. Moreover, tax administrations often expand the scope of data collection and experiment with more advanced risk analytics to improve detection. Importantly, policies intended to reduce the informal economy must be approached with caution, as informal activities frequently serve as a safety net for the poor. However, in this case there are some policies available that can help in the gradual transition toward formality by increasing labor productivity, e.g., improving access to and quality of public education and health care. Those investments may not provide immediate fiscal benefits, but they should prove profitable in the longer term, with benefits going far beyond the reduction of the shadow economy and tax gap.

133 As approximated by the World Bank's indicator in this area.

Our results indicate that, on average, high taxation is the main driver of the shadow economy in advanced economies. Some noncompliant taxpayers simply do not register (part of) the transactions that they make in cash while others use sophisticated tax frauds or transfer money to tax havens (other sources of the tax gap). Third-party information, including traces of electronic payments, and technological solutions such as electronic invoices and online cash registers are used in preventing and/or increasing detection of hidden transactions and frauds. Still, some improvements can be considered in terms of facilitation measures (e.g., simplifying the tax system and reducing bureaucracy) and building trust (e.g., using participatory budgeting to include taxpayers in the process of public spending decisions).

The considered actions may include both long-term strategies (e.g., for formalizing enterprises and enhancing institutional quality) and short-term initiatives (e.g., improvements in analytics for detection, third-party information and international cooperation). The latter may often bring smaller but quicker gains.

In our view, a good first step for any tax administration is to measure the size of the shadow economy and other sources of the tax gap. Then, it might be pivotal to identify the main sources of the problem in order to select those policies that best suit the local context. Before introducing any costly policies, it may be worth conducting field experiments in a selected region of the country or sector of the economy and quantitatively assess their results. Moreover, additional research and insights on tax noncompliance, e.g., in sectors or regions, enable more precise targeting of measures. It is also useful to run dedicated surveys, interviews and general dialogue with consumers and businesses to better understand potential motivations and mechanisms of noncompliance as well as check their assessment of considered policy solutions. Such evidence-based approaches to cost-benefit analysis should help policymakers in achieving positive results from both social and fiscal perspectives.

Technical appendix

The technical appendix includes further details for our analysis. It is divided into sections that contain the following information:

Steps in our approach

1

We show a decomposition of the total economy (GDP) within the currency demand approach (CDA) as well as steps and assumptions for translating the results of the econometric model into shadow economy estimates.

We present types of used data, data sources and variable categories as well as include a large table with all the considered factors in our shadow economy model.

2

Data set and considered factors

Data preparation

3

We describe some additional operations on our data (e.g., related to outliers and interpolations).

We discuss a selection of the applied estimator (econometric method of estimation of unknown parameters).

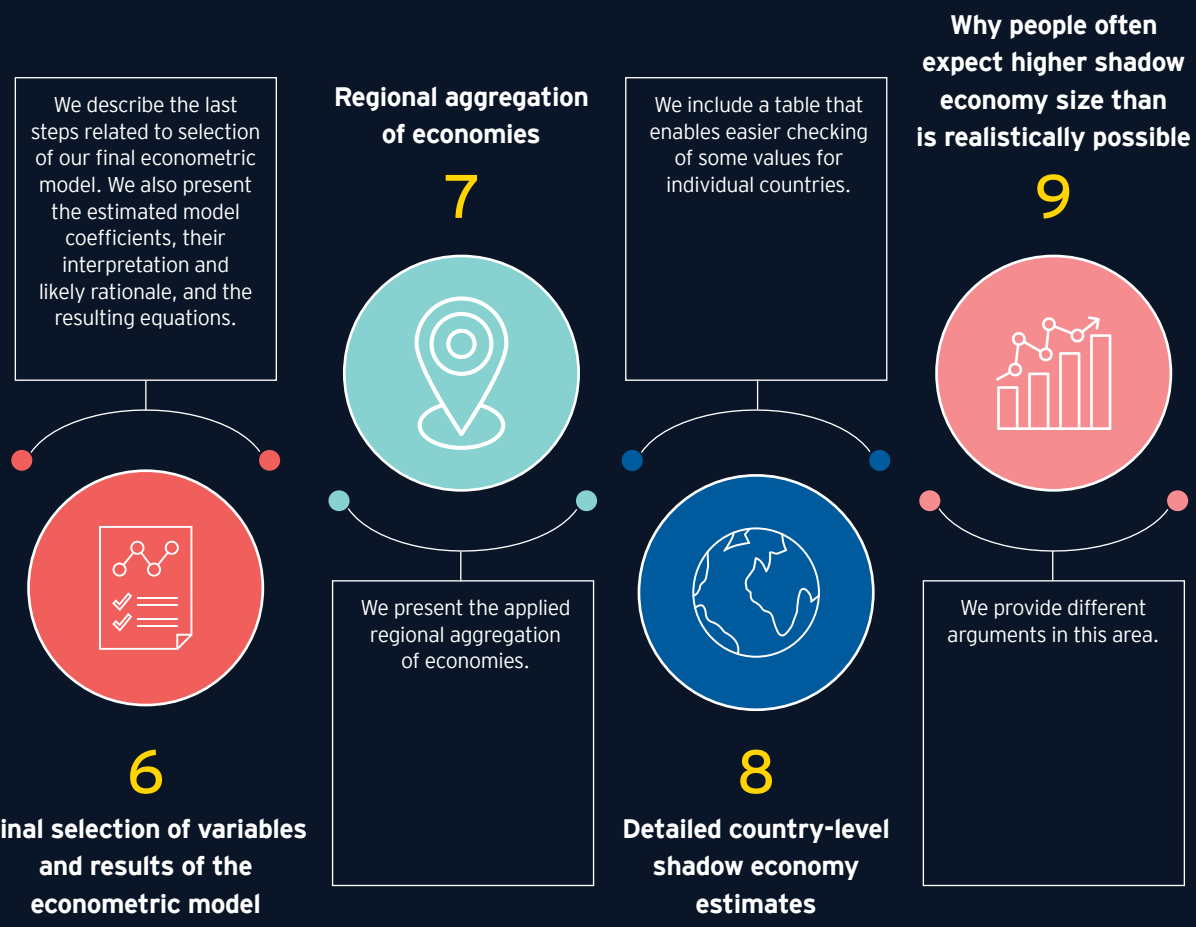
4

Method for estimation of the econometric model

Initial selection of variables

5

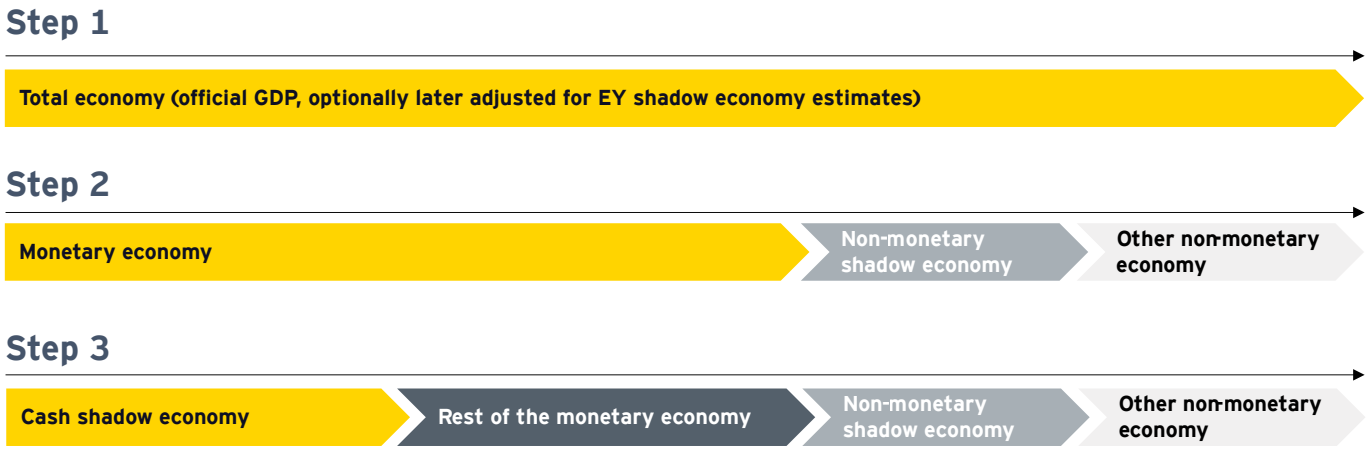
We explain our application of Bayesian model averaging (BMA) techniques to make the selection of explanatory variables in the model as objective as possible.


We describe the last steps related to selection of our final econometric model. We also present the estimated model coefficients, their interpretation and likely rationale, and the resulting equations.
6
Final selection of variables and results of the econometric model
Regional aggregation of economies
7
We present the applied regional aggregation of economies.
We include a table that enables easier checking of some values for individual countries.
8
Detailed country-level shadow economy estimates
Why people often expect higher shadow economy size than is realistically possible
9
We provide different arguments in this area.

A.1. Steps in our approach

Our approach consists of three steps decomposing the total economy into different components presented in Figure 4 and an additional step related to estimation of lost government revenues, all described below.

Figure 4. Decomposition of the total economy into shadow and registered components



Note: The proportions of the areas above do not reflect the proportions of different components of the total economy.

Source: EY analysis

Step 1

Determine the relationship between total economy and official GDP

When we conduct an analysis for a single country, we start with official GDP figures ($Y_{i,t}^{OFFICIAL}$ for country i in period t). We check whether information on the shadow (non-observed) economy estimates included in GDP figures of the statistical office is available. If it is, and we conclude that such estimates account for all relevant aspects of the shadow economy, we can later calculate the total economy size (total GDP, $Y_{i,t}^{TOTAL}$) by adjusting official GDP for the difference between our and the statistical office's shadow economy estimates. If it is not the case, we may assume, for simplicity, that the shadow economy included in the official GDP is equal to our estimate. To make analysis of many different countries in this report manageable, we have made such assumptions. This step is later needed to interpret our results as a percentage of official GDP, since our methodology returns outcomes as a percentage of total GDP.

Step 2

Split total economy into monetary and non-monetary components

We split the total economy into monetary ($Y_{i,t}^{MONETARY,TOTAL}$), i.e., payment-based, and non-monetary activities by estimating the latter. The non-monetary economy includes two components: (1) imputed rents of owner-occupiers that could be found in statistical offices' data sets and (2) household production of goods for own final use (non-monetary shadow economy, $Y_{i,t}^{NMSE}$, mainly related to agriculture). Sometimes the value of (2) is also available at the statistical office. Otherwise, we estimate it based on the role of agriculture in the economy and results of Blades (1975), who analyzed its link with the non-monetary shadow economy in various countries (for details see EY (2019)).[134] Unfortunately, to our best knowledge, no newer data is publicly available in this area. Potential future cooperation with an international institution that can encourage many statistical offices to share such data would allow us to improve our approach to estimation of the non-monetary shadow economy component.

134 EY (2019), op. cit.

Step 3

Estimate the cash shadow economy: CDA

In Step 3, we first focus on measuring the share of the monetary (cash) shadow economy in total monetary economy ($\frac{Y_{i,t}^{CASH,SHADOW}}{Y_{i,t}^{MONETARY,TOTAL}}$).

Inspired by the existing and our CDA research, we propose a modified approach. We distinguish the following substeps:

Substep 3.1. Estimation of the CDA model

The first substep is an econometric estimation of the currency demand equation:

$$CASH\_M1_{i,t} = \alpha_i + \boldsymbol{\beta}_{i,t}^{(1)} \boldsymbol{x}_{1,i,t} + \boldsymbol{\beta}_{i,t}^{(2)} \boldsymbol{x}_{2,i,t} + \varepsilon_{it} \quad (1)$$

where i represents the analyzed country and t stands for the analyzed time. In this equation, the explained (dependent) variable is the share of currency in circulation (cash) in the M1 monetary aggregate (total transactional money, including cash and overnight deposits). To explain its variation, we use two groups of explanatory variables:

Cash shadow economy determinants ($\mathbf{x}_1$). They mostly affect the willingness of agents to operate in the shadow economy (e.g., state of labor market, institutional indicators, taxation) and through this channel impact the dependent variable.

Control variables ($\mathbf{x}_2$). These variables, after controlling for the influence of $\mathbf{x}_1$ should not (directly) impact the shadow economy but may still have influence on the dependent variable. They are related to the level of the economic development, monetary conditions, etc.

$\boldsymbol{\beta}_{i,t}^{(1)}$ and $\boldsymbol{\beta}_{i,t}^{(2)}$ represent vectors of the regression coefficients (they may also include interactions with real GDP per capita to account for their conditionality on the development level). Finally, ε_{it} is the error term. Additionally, we include the individual effects, α_i, which represent time-invariant unobservable country characteristics that affect the demand for cash in each country.

The construction of the coefficients $\boldsymbol{\beta}_{i,t}^{(1)}$ and $\boldsymbol{\beta}_{i,t}^{(2)}$ reflects country heterogeneity, which is crucial when using data for many countries. Individual effects (α_i) are estimated as fixed effects. Panel data makes it possible to incorporate such effects that can represent constant unobservable cultural factors.

We consider a wide range of potential explanatory variables from the two groups discussed above. Our preferred approach to the selection of variables and assessment of their impact is based on the frequentist and/or BMA procedure in which a wide array of variants of equation (1) is estimated using the Panel Corrected Standard Errors (PCSE) method,[135] with different combinations of considered variables.

Substep 3.2. Using the CDA model to measure shadow economy–related cash

In the second substep, we set the values of $\boldsymbol{x}_1$ vector in equation (1) at their "best" (benchmark) observable levels for the countries in the sample (e.g., the lowest unemployment rate) and estimate the theoretical value of the explained variable in the case of the lowest possible cash shadow economy.

The difference between the fitted value from the model (i) calculated on the basis of the factual values of $\mathbf{x}_1$ in the given country and (ii) calculated on the basis of the best (benchmark) values of $\mathbf{x}_1$ in the sample may be interpreted as the share of cash related to cash shadow economy transactions in the M1 aggregate ($\frac{C_{i,t}^{SHADOW}}{M1_{i,t}}$). Given the observed stock of the M1 aggregate for a given country and period, the obtained difference allows us to calculate the amount of cash attributable to the cash shadow economy ($C_{i,t}^{SHADOW}$).

135 The method is robust to: contemporaneous correlation of error terms between panel units, serial correlation of order 1 of the error term (a common serial correlation coefficients for all the panels is selected) as well as to heteroskedasticity.

Substep 3.3. Conversion of the shadow cash into the cash shadow economy

In the third substep, we estimate the size of the cash shadow economy.[136] First, we assume that the velocity of money in the cash shadow economy is equal to the velocity of money in the overall monetary economy:

$$\frac{Y_{i,t}^{MONETARY,TOTAL}}{M1_{i,t}} = \frac{Y_{i,t}^{CASH,SHADOW}}{C_{i,t}^{SHADOW}} \quad (2)$$

where $Y_{i,t}^{MONETARY,TOTAL}$ and $Y_{i,t}^{CASH,SHADOW}$ denote the monetary output in the total and shadow economy, respectively; $C_{i,t}^{SHADOW}$ stands for the amount of cash used for settling transactions in the cash shadow economy and M1_(i,t) is the M1 total transactional money.

We transform equation (2) to estimate the share of the cash shadow economy output in the total monetary output (including the cash shadow economy) without knowing the exact value of the velocity of money:

$$\frac{Y_{i,t}^{CASH,SHADOW}}{Y_{i,t}^{MONETARY,TOTAL}} = \frac{C_{i,t}^{SHADOW}}{M1_{i,t}} \quad (3)$$

Note that $\frac{C_{i,t}^{SHADOW}}{M1_{i,t}}$ is the endpoint of substep 3.2. However, it is only related to those economic activities that include monetary transactions. To obtain the estimate of the total shadow economy $Y_{i,t}^{TOTAL,SHADOW}$ (as a share in total economy $Y_{i,t}^{TOTAL}$), we use the following formula:

$$\frac{Y_{i,t}^{TOTAL,SHADOW}}{Y_{i,t}^{TOTAL}} = \frac{Y_{i,t}^{CASH,SHADOW}}{Y_{i,t}^{MONETARY,TOTAL}} \times \frac{Y_{i,t}^{MONETARY,TOTAL}}{Y_{i,t}^{TOTAL}} + \frac{Y_{i,t}^{NMSE}}{Y_{i,t}^{TOTAL}} \quad (4)$$

in which $\frac{Y_{i,t}^{MONETARY,TOTAL}}{Y_{i,t}^{TOTAL}}$ is the output of Step 2 and the $Y_{i,t}^{NMSE}$ is the non-monetary shadow economy (NMSE) estimated earlier. In our shadow economy analyses focusing on a particular country (not the case of this report), we make one more final step if the statistical office's estimate of the non-observed economy in the total economy is available. To express our results in terms of a percentage of official GDP, we conduct the following calculation:

$$\frac{Y_{i,t}^{TOTAL,SHADOW}}{Y_{i,t}^{OFFICIAL}} = \frac{Y_{i,t}^{TOTAL,SHADOW}}{Y_{i,t}^{TOTAL}} \times \frac{Y_{i,t}^{TOTAL}}{Y_{i,t}^{OFFICIAL}} \quad (5)$$

in which $\frac{Y_{i,t}^{OFFICIAL}}{Y_{i,t}^{TOTAL}}$ is the result of Step 1.

136 The size of the cash shadow economy corresponds to the part of monetary output / monetary GDP that is generated in the shadow economy.

A.2. Data set and considered factors

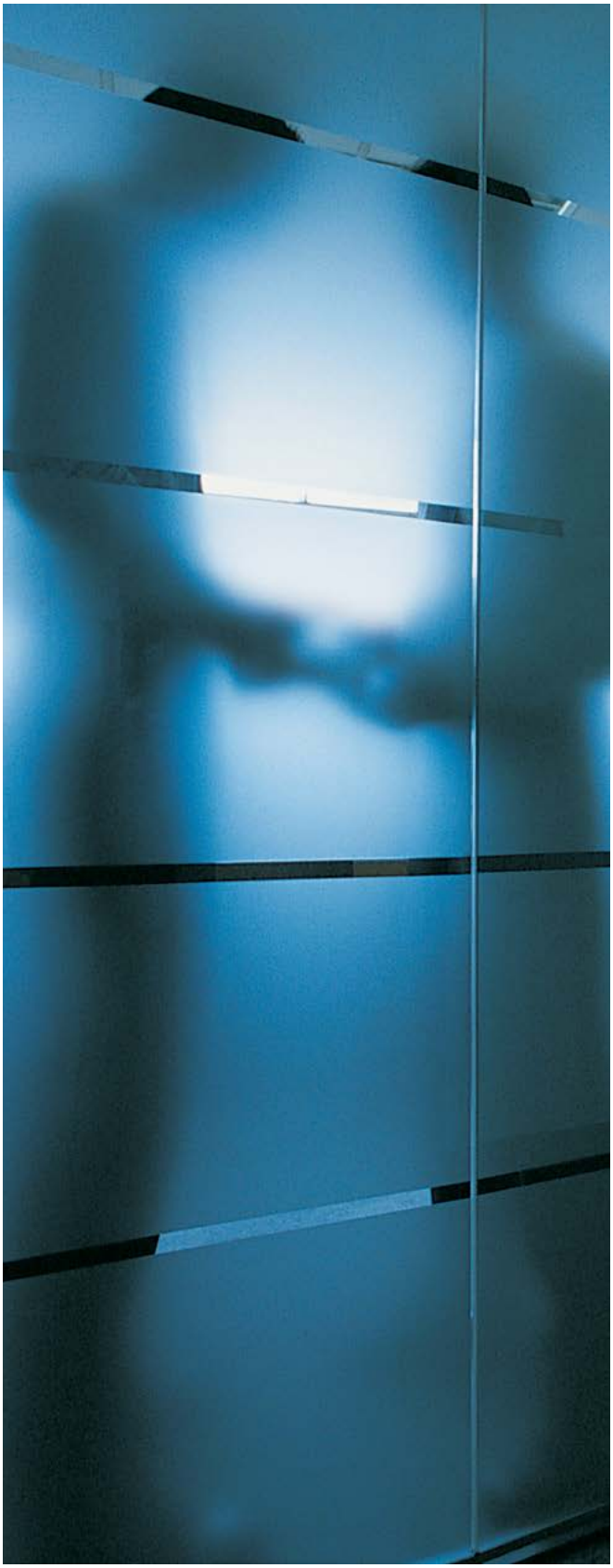
First, we provide key information on the prepared data set and factors that we have considered.

- **Type of data.** The data consists of various countries observed over different years (panel data set). Due to the availability of data, we decided to focus on 1996–2020. We analyzed data for 187 countries, but on account of data gaps, we have 101 countries in the final estimation sample.[137] Yet, at the later stage of analysis, we collected new data points and made certain assumptions when the data was missing to obtain the results for an additional 34 countries as well as to cover the years 2021–23. Finally, we removed four countries from our results due to their outlying values of shadow economy estimates. For the sake of completeness, timeliness and transparency, we show our shadow economy estimates in the report for 2000–23. Due to the required data structure, our analysis does not consider factors accessible only for a few years, a relatively low number of countries or factors only at the individual or sectoral level.
- **Data sources.** We used only publicly available data. The main sources of the information included the IMF, World Bank, Fraser Institute, ILO and Tax Foundation. Research projects and institutions from which we at least initially collected or considered some variables covered include the World Values Survey, European Central Bank, International Bank for Settlements, Global Findex Database, Oxford Economics, Transparency International, World Health Organization and national central banks.
- **Variable categories.** The first category is the explained variable (share of the currency in circulation in the M1 monetary aggregate) that under certain conditions approximates the level and changes in the cash shadow economy. As already mentioned, the explanatory variables can be divided into shadow economy determinants and other control variables. While testing whether the given explanatory variable is statistically significant in the econometric model is an empirical question, the assignment of the variable to the shadow or control variable category is the decision of the researcher based on theory and other studies. For example, besides the effects related to the shadow economy, there is no simple way to explain the impact of tax or public governance quality on the currency demand. On the other hand, control variables do not impact the shadow economy but may have other influence on the currency in circulation, e.g., through economic/technological development or changes in monetary conditions. For the convenience of initial listing of variables, we introduced some additional subcategories for shadow economy determinants – like labor market/business cycle, institutional/regulatory and taxation.
- **Alternative variables.** For various areas, we often considered more than one variable (source). The final selection was based on the number of observations and empirical analysis.

137 At a later stage of analysis, we decided to exclude four countries from the data set.

- **Initial exclusions from the analysis.** Most often we excluded variables due to data gaps or the fact that some underlying research – like the Doing Business report – was discontinued. The same problem applies to the number of payment cards and other factors from the electronic payment system group of variables (something between shadow economy determinants and control variables). Although such factors could bring some value to our analysis, we finally chose not to include them due to the low data availability (only after 2004 and for a limited number of countries).[138]

More information about our data set can be found in Table 3 below. It contains information about all variables considered in our shadow economy model and to which group a given variable belongs. It consists also of variable description and data source. You can also find there an explained decision about excluding some variables already at the initial phase of the analysis, numbers of observations, countries and years available. We also included additional comments to link some of our macroeconomic variables with publicly available forecasts (e.g., from the IMF).



138 Another potential issue with such variables in the currency demand framework is simultaneity, i.e. the fact that they may not only influence the dependent variable but also, to some extent, be impacted by changes in this variable that have some other sources.

Technical appendix

Table 3. Information about variables considered in the shadow economy model

Group of variables for our analysis	Name of the variable	Description	Decision to exclude from the model after initial analysis	Additional comments	Number of observations	Number of years	Latest year available	Earliest year available	Number of countries (with any data point)	Sources	Hyperlinks
Dependent (explained) variable	CASH_M1	Share of the currency in circulation in the M1 monetary aggregate (currency in circulation + transferable deposits), %. Numerator's data series: Currency Outside Depository Corporations (from Depository Corporations data table) or – in case of missing data – Currency Outside Banking Institutions (from Non-Standardized Presentation data table). Denominator's data series: M1 or sum of data on Transferable Deposits and Currency from the same tables.			3283	27	2021	1995	149	International Monetary Fund	https://data.imf.org/?sk=B83F71E8-61E3-4CF1-8CF3-D7FE04D0930&sid=1390030341854
Shadow economy determinant: labour market / business cycle	*NON_EMPLOYED*	The share of unemployed and economically inactive in the total population aged 15–64, %.		Non-employed share was calculated as 1-employed share.	5017	*27*	*2021*	*1995*	*186*	International Labour Organization, own calculations	https://www.ilo.org/shinyapps/bulkexplorer53/?lang=en&id=EMP_2EMP_SEX_AGE_NB_A
Shadow economy determinant: labour market / business cycle	*UNEMP*	Unemployment rate, % of total labor force (economically active population)		The same definition as "unemployment rate" (percent of total labor force) in the IMF, for which there are publicly available forecasts.	5049	*27*	*2021*	*1995*	*187*	World Bank – modeled ILO estimate	https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS
Shadow economy determinant: labour market / role of small and specific entities	*SELF_EMPLOYED*	The ratio of the total number of self-employed (employers, own-account workers, members of producers' cooperatives, and contributing family workers) to the population aged 15–64, %.			5022	*27*	*2021*	*1995*	*186*	International Labour Organization, own calculations	https://www.ilo.org/shinyapps/bulkexplorer53/?lang=en&id=EMP_2EMP_SEX_AGE_NB_A
Shadow economy determinant: labour market / role of small and specific entities	*FAMILY_WORK*	The ratio of the total number of contributing family workers to the population aged 15–64, %. Contributing family workers are own-account workers in the market-oriented business that is conducted by a related person who lives in the same household.			5022	*27*	*2021*	*1995*	*186*	International Labour Organization, own calculations	
Shadow economy determinant: labour market / role of small and specific entities	*OWN_ACCOUNT_WORK*	The ratio of the total number of own-account workers to the population aged 15–65, %.			5022	*27*	*2021*	*1995*	*186*	International Labour Organization, own calculations	
Shadow economy determinant: institutional / regulatory	*CONTROL_OF_CORRUPTION*	The value of the indicator measuring the control of corruption from the Worldwide Governance Indicators. It ranges from approximately –2.5 (low control of corruption) to 2.5 (high control of corruption). It reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.			4564	*23*	*2021*	*1996*	*203*	World Bank – Worldwide Governance Indicators	https://databank.worldbank.org/source/worldwide-governance-indicators/preview/on#

Technical appendix

Group of variables for our analysis	Name of the variable	Description	Decision to exclude from the model after initial analysis	Additional comments	Number of observations	Number of years	Latest year available	Earliest year available	Number of countries (with any data point)	Sources	Hyperlinks
Shadow economy determinant: institutional / regulatory	*GOV_ EFFECTIVENESS*	The value of the indicator measuring the government effectiveness from the Worldwide Governance Indicators. It ranges from approximately -2.5 (low government effectiveness) to 2.5 (high government effectiveness). It reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.			4540	*23*	*2021*	*1996*	*203*	World Bank - Worldwide Governance Indicators	
Shadow economy determinant: institutional / regulatory	*POLITICAL*	The value of the indicator measuring the political stability and absence of violence/terrorism from the Worldwide Governance Indicators. It ranges from approximately -2.5 (weak political stability and a greater presence of violence/terrorism) to 2.5 (strong political stability and lower presence of violence/terrorism). Political Stability and Absence of Violence/ Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.			4615	*23*	*2021*	*1996*	*205*	World Bank - Worldwide Governance Indicators	
Shadow economy determinant: institutional / regulatory	*REGULATORY*	The value of the indicator measuring the regulatory quality from the Worldwide Governance Indicators. It ranges from approximately -2.5 (low regulatory quality) to 2.5 (high regulatory quality). It reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.			4542	*23*	*2021*	*1996*	*203*	World Bank - Worldwide Governance Indicators	
Shadow economy determinant: institutional / regulatory	*RULE_OF_LAW*	The value of the indicator measuring the rule of law from the Worldwide Governance Indicators. It ranges from approximately -2.5 (weak rule of law) to 2.5 (strong rule of law). It reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.			4654	*23*	*2021*	*1996*	*205*	World Bank - Worldwide Governance Indicators	

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Group of variables for our analysis	Name of the variable	Description	Decision to exclude from the model after initial analysis	Additional comments	Number of observations	Number of years	Latest year available	Earliest year available	Number of countries (with any data point)	Sources	Hyperlinks
Shadow economy determinant: institutional / regulatory	*VOICE_AND_ ACCOUNTABILITY*	The value of the indicator measuring the voice and accountability from the Worldwide Governance Indicators. It ranges from approximately -2.5 (fewer rights) to 2.5 (more rights). It reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.			4648	*23*	*2021*	*1996*	*205*	World Bank – Worldwide Governance Indicators	
Shadow economy determinant: institutional / regulatory	*INDEPENDENCE*	Judicial independence, index with values from 0 (worst) to 10 (best)		2A; the first source of this component is from the Global Competitiveness Report question: "Is the judiciary in your country independent from political influences of members of government, citizens, or firms? No—heavily influenced (= 1) or Yes—entirely independent (= 7)". The question's wording has varied slightly over the years. All variables from the Global Competitiveness Report were converted from the original 1-to-7 scale to a zero-to-10. The second source is a collection of questions from the V-Dem dataset, namely: Judicial Purges, Government Attacks on the Judiciary, Court Packing, High Court Independence, and Low Court Independence. Each of the V-Dem variables is individually rated using the formula (Vi − Vmin) / (Vmax − Vmin) multiplied by 10. For Judicial Purges, Government Attacks on the Judiciary, High Court Independence, and Low Court Independence, Vmax and Vmin were set at 4.0 and 0, respectively. For Court Packing, Vmax and Vmin were set at 3.0 and 0, respectively. All five scores are then averaged.	3548	*22*	*2020*	*1995*	*164*	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=3
Shadow economy determinant: institutional / regulatory	*COURTS*	Impartial courts, index with values from 0 (worst) to 10 (best)		2B; The first source of this component is the Global Competitiveness Report question: "The legal framework in your country for private businesses to settle disputes and challenge the legality of government actions and/or regulations is inefficient and subject to manipulation (= 1) or is efficient and follows a clear, neutral process (= 7)". The question's wording has varied slightly over the years. The second source of this component is Judicial Corrupt Decision from the V-Dem dataset. The rating is equal to: (Vi − Vmin) / (Vmax − Vmin) multiplied by 10. The Vi is the country's Judicial Corrupt Decisions Score, while the Vmax and Vmin were set at 4.0 and 0, respectively.	3548	*22*	*2020*	*1995*	*164*	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=4
Shadow economy determinant: institutional / regulatory	*PROPERTY_RIGHTS*	*Protection of property rights, index with values from 0 (worst) to 10 (best)*		2C; The first source of this component is the Global Competitiveness Report question: "Property rights, including over financial assets, are poorly defined and not protected by law (= 1) or are clearly defined and well protected by law (= 7)". The second source is Property Rights and Rule-Based Governance from Country Policy and Institutional Assessment data from the World Bank. This has been scaled to the Legal System and Property Rights data via regression. The final number is the average of whichever of these two sources are available.	3511	*22*	*2020*	*1995*	*164*	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=5

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Shadow economy determinant: institutional / regulatory	*INTEGRITY*	Integrity of the legal system, index with values from 0 (worst) to 10 (best)		2E; The first source of this component is the International Country Risk Guide Political Risk Component I for Law and Order: "Two measures comprising one risk component. Each sub-component equals half of the total. The 'law' sub-component assesses the strength and impartiality of the legal system, and the 'order' subcomponent assesses popular observance of the law". The second source is Judicial Accountability, Compliance with the High Court, Judicial Review, Transparent Laws with Predictable Enforcement, and Access to Justice for Men from the V-Dem dataset. (An adjustment for the area as a whole is made later to account uniformly for gender disparities.) Each of the V-Dem variables is individually rated using the formula (Vi – Vmin) / (Vmax – Vmin) multiplied by 10. Vi is the country's V-Dem score according to V-Dem, and Vmax and Vmin were set at 4.0 and 0, respectively. The five measures from V-Dem are then averaged. The final number is the average of whichever of the two sources are available.	3541	*22*	*2020*	*1995*	*164*	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=6
Shadow economy determinant: institutional / regulatory	*CONTRACTS_ ENFORCEMENT*	Legal enforcement of contracts, index with values from 0 (worst) to 10 (best)		2F; This first source of this component is the World Bank's Doing Business estimates for the time and money required to collect a debt. The debt is assumed to equal 200% of the country's per-capita income where the plaintiff has complied with the contract and judicial judgment is rendered in his favor. Zero-to-10 ratings were constructed for (1) the time cost (measured in number of calendar days required from the moment the lawsuit is filed until payment); and (2) the monetary cost of the case (measured as a percentage of the debt). These two ratings were then averaged to arrive at the final rating for this component. The formula used to calculate the zero-to-10 ratings was: (Vmax – Vi) / (Vmax – Vmin) multiplied by 10. Vi represents the time or money cost value. The values for Vmax and Vmin were set at 725 days and 82.3% (1.5 standard deviations above average in 2005) and 62 days (1.5 standard deviations below average in 2005) and 0%, respectively. Countries with values outside the range from Vmax to Vmin received ratings of either zero or 10, accordingly. The second source of this component is Enforcement of Contracts from the Historical Ratings Research Package by Business Environment Risk Intelligence. The formula used to calculate the zero-to-10 ratings was: (Vi – Vmin) / (Vmax – Vmin) multiplied by 10. Vi represents the component value. The values for Vmax and Vmin were set at 4 and zero, which corresponds to the range of the variable. The final number is the average of whichever of these two sources are available.	3514	22	2020	1995	163	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=7

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Shadow economy determinant: institutional / regulatory	*PROTECTIVE_ GOVERNMENT*	Legal System & Property Rights, index with values from 0 (worst) to 10 (best)		2; the nine components in this area (A. Judicial independence, B. Impartial courts, C. Protection of property rights, D. Military interference in rule of law and politics, E. Integrity of the legal system, F. Legal enforcement of contracts, G. Regulatory costs of the sale of real property, H. Reliability of police, I. Business costs of crime, J. Gender Disparity Adjustment) are indicators of how effectively the protective functions of government are performed	3548	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=8
Shadow economy determinant: institutional / regulatory	*HIRING*	Hiring regulations and minimum wage, index with values from 0 (worst) to 10 (best)		5Bi; This sub-component is based on the "Employing Workers" section of the World Bank's Doing Business and uses the following components: (1) whether fixed-term contracts are prohibited for permanent tasks; (2) the maximum cumulative duration of fixed-term contracts; and (3) the ratio of the minimum wage for a trainee or first-time employee to the average value added per worker. An economy is assigned a score of 1 if fixed-term contracts are prohibited for permanent tasks and a score of 0 if they can be used for any task. A score of 1 is assigned if the maximum cumulative duration of fixed-term contracts is less than 3 years; 0.5 if it is 3 years or more but less than 5 years; and 0 if fixed-term contracts can last 5 years or more. Finally, a score of 1 is assigned if the ratio of the minimum wage to the average value added per worker is 0.75 or more; 0.67 for a ratio of 0.50 or more but less than 0.75; 0.33 for a ratio of 0.25 or more but less than 0.50; and 0 for a ratio of less than 0.25.	3040	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=9
Shadow economy determinant: institutional / regulatory	*HIRING_FIRING*	Hiring and firing regulations, index with values from 0 (worst) to 10 (best)		5Bii; This sub-component is based on the Global Competitiveness Report question: "The hiring and firing of workers is impeded by regulations (= 1) or flexibly determined by employers (= 7)". The question's wording has varied over the years.	2814	22	2020	1995	161	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=10
Shadow economy determinant: institutional / regulatory	*LABOR_MARKET*	Labor market regulations, index with values from 0 (worst) to 10 (best)		5B; The labor-market component (5B) is designed to measure the extent to which these restraints upon economic freedom are present. In order to earn high marks in the component rating regulation of the labor market, a country must allow market forces to determine wages and establish the conditions of hiring and firing, and refrain from the use of conscription.	3072	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=11
Shadow economy determinant: institutional / regulatory	*ADMINISTRATIVE*	Administrative requirements, index with values from 0 (worst) to 10 (best)		5Ci; This sub-component is based on the Global Competitiveness Report question: "Complying with administrative requirements (permits, regulations, reporting) issued by the government in your country is (1 = burdensome, 7 = not burdensome)". The question's wording has varied slightly over the years.	2729	21	2020	2000	161	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=12

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Shadow economy determinant: institutional / regulatory	*REGULATORY_ BURDEN*	Regulatory Burden, index with values from 0 (worst) to 10 (best)		5Cii; This sub-component is based on the "Regulatory Burden Risk Ratings" from IHS Markit, which measures "the risk that normal business operations become more costly due to the regulatory environment. This includes regulatory compliance and bureaucratic inefficiency and/or opacity. Regulatory burdens vary across sectors so scoring should give greater weight to sectors contributing the most to the economy". The raw scores range, roughly, from 0 to 7, with higher values indicating greater risk. The formula used to calculate the zero-to-10 ratings was: (Vmax − Vi) / (Vmax − Vmin) multiplied by 10. Vi is the country's Regulatory Burden rating, while the Vmax and Vmin were set at 5 and 0.5, respectively. These ratings were first published for 2014, and the 2014 ratings were used for 2012-2013.	2857	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=13
Shadow economy determinant: institutional / regulatory	*STARTING_A_ BUSINESS*	Starting a business, index with values from 0 (worst) to 10 (best)		5Ciii; This sub-component is based on the World Bank's Doing Business data on the amount of time and money it takes to start a new limited-liability business. Countries where it takes longer or is more costly to start a new business are given lower ratings. Zero-to-10 ratings were constructed for three variables: (1) time (measured in days) necessary to comply with regulations when starting a limited liability company; (2) money costs of the fees paid to regulatory authorities (measured as a share of per-capita income); and (3) minimum capital requirements, that is, funds that must be deposited into a company bank account (measured as a share of per-capita income). These three ratings were then averaged to arrive at the final rating for this sub-component. The formula used to calculate the zeroto-10 ratings was: (Vmax − Vi) / (Vmax − Vmin) multiplied by 10. Vi represents the variable value. The values for Vmax and Vmin were set at 104 days, 317%, and 1,017% (1.5 standard deviations above average in 2005) and 0 days, 0%, and 0%, respectively. Countries with values outside the Vmax and Vmin range received ratings of either zero or 10, accordingly.	3051	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=14
Shadow economy determinant: institutional / regulatory	*PUBLIC_ ADMINISTRATION*	Impartial Public Administration, index with values from 0 (worst) to 10 (best)		5Civ; This sub-component is based on the "Rigorous and Impartial Public Administration" data from the V-Dem dataset. If nepotism, cronyism, and discrimination are widespread in the application of public administration, countries receive a lower score. The rating for this component is designed to mirror the actual distribution of the raw data but on a zero-to-10 scale. The rating is equal to: (Vi − Vmin) / (Vmax − Vmin) multiplied by 10. The Vi is the country's impartial administration score, while the Vmax and Vmin were set at 4.0 and 0, respectively.	3481	*22*	*2020*	*1995*	*161*	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=15

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Shadow economy determinant: institutional / regulatory	*LICENSING_ RESTRICTIONS*	Licensing restrictions, index with values from 0 (worst) to 10 (best)		5Cv; This sub-component is based on the World Bank's Doing Business data on the time in days and monetary costs required to obtain a license to construct a standard warehouse. Zero-to-10 ratings were constructed for (1) the time cost (measured in number of calendar days required to obtain a license) and (2) the monetary cost of obtaining the license (measured as a share of per-capita income). These two ratings were then averaged to arrive at the final rating for this sub-component. The formula used to calculate the zero-to-10 ratings was: (Vmax − Vi) / (Vmax − Vmin) multiplied by 10. Vi represents the time or money cost value. The values for Vmax and Vmin were set at 363 days and 2,763% (1.5 standard deviations above the average in 2005) and 56 days (1.5 standard deviations below the average in 2005) and 0%, respectively. Countries with values outside the Vmax and Vmin range received ratings of either zero or 10, accordingly.	2514	17	2020	2004	162	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=16
Shadow economy determinant: institutional / regulatory	*BUSINESS_ REGULATIONS*	Business regulations, index with values from 0 (worst) to 10 (best)		5C; The sub-components of 5C are designed to identify the extent to which regulations and bureaucratic procedures restrain entry and reduce competition. In order to score high in this portion of the index, countries must allow markets to determine prices and refrain from regulatory activities that retard entry into business and increase the cost of producing products. They also must refrain from "playing favorites," that is, from using their power to extract financial payments and reward some businesses at the expense of others.	3079	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=17
Shadow economy determinant: institutional / regulatory	*REGULATION*	Regulation, index with values from 0 (worst) to 10 (best)		5; The fifth area of the index focuses on regulatory restraints that limit the freedom of exchange in credit, labor, and product markets.	3216	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=18
Shadow economy determinant: institutional / regulatory	*CORRUPTION*	Corruption Perceptions Index; level of corruption ranges from 0 (highly corrupt) to 100 (no corruption)	rather exclude, low number of observations		1749	10	2021	2012	179	Transparency International	https://www.transparency.org/en/cpi/2022
Shadow economy determinant: institutional / regulatory	*APP_TRUST_ GOVERN*		rather exclude, low number of observations	Different variants considered: interpolation with naive forecast, interpolation with dynamic forecast and interpolation without forecast	1580	27	2021	1995	109	World Values Survey	https://www.worldvaluessurvey.org/WVSContents.jsp
Shadow economy determinant: institutional / regulatory	*APP_GOVERN_RESP*		rather exclude, low number of observations	Different variants considered: interpolation with naive forecast, interpolation with dynamic forecast and interpolation without forecast	1580	27	2021	1995	109	World Values Survey	
Shadow economy determinant: institutional / regulatory	*APP_AVOID_FARE*		rather exclude, low number of observations	Different variants considered: interpolation with naive forecast, interpolation with dynamic forecast and interpolation without forecast	1580	27	2021	1995	109	World Values Survey	

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Shadow economy determinant: institutional / regulatory	*APP_CHEAT_TAX*		rather exclude, low number of observations	Different variants considered: interpolation with naive forecast, interpolation with dynamic forecast and interpolation without forecast	1580	27	2021	1995	109	World Values Survey	
Shadow economy determinant: institutional / regulatory	*APP_DEMOCRATIC*		rather exclude, low number of observations	Different variants considered: interpolation with naive forecast, interpolation with dynamic forecast and interpolation without forecast	1580	27	2021	1995	109	World Values Survey	
Shadow economy determinant: taxation	*TAX_REVENUE*	Tax revenue, % of GDP		The year 2021 for all countries & data for Spain (1995–2020), Kazakhstan 2005–2009, Kiribati 2010, Madagascar 1995–1996, Senegal 2019–2020 and Kyrgyz 2013 were calculated on the basis of dynamics obtained from IMF data; data for Kuwait (2001–2015), Japan (1995–2020) were taken directly from IMF data.	3048	27	2021	1995	155	World Bank – International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates, own calculations based on data from the International Monetary Fund	Government Finance Statistics (GFS), Revenue: https://data.imf.org/?sk=a0867067-d23c-4ebc-ad23-d3b015045405&sId=1435757954964
Shadow economy determinant: taxation	*TAXES_GOODS_AND_SERVICES*	Taxes on goods and services, % of value added of industry and services		The year 2021 & data for Spain 1995–2017, Kazakhstan 2005–2009, Senegal 2019–2020 and Trinidad&Tobago 1995–2000 were calculated on the basis of dynamics obtained from IMF and WB data; calculated as the share of Taxes on goods and services (domestic currency) in the sum of Industry (including construction), value added (current LCU) and Services, value added (current LCU); data for Japan (1995–2020) were taken directly from IMF data	2907	27	2021	1995	151	World Bank – International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD value added estimates, own calculations based on data from the International Monetary Fund and World Bank national accounts data, and OECD National Accounts data files.	https://data.imf.org/?sk=a0867067-d23c-4ebc-ad23-d3b015045405&sId=1435757954964
Shadow economy determinant: taxation	*TAXES_INCOME_PROFITS_GAINS*	Taxes on income, profits and capital gains, % of GDP		Calculated as the % share of Taxes on income, profits and capital gains (current LCU) in the GDP (current LCU); the year 2021 & data for Spain 1995–2016, Kazakhstan 2005–2009, Kiribati 2010, Kyrgyz 2013, Senegal 2019–2020, West Bank and Gaza 2019–2010 and Trinidad&Tobago 1995–2000 were calculated on the basis of dynamics obtained from IMF data; data for Japan (1995–2020) were taken directly from IMF data	2954	27	2021	1995	152	World Bank – International Monetary Fund, Government Finance Statistics Yearbook and data files	
Shadow economy determinant: taxation	*VAT*	Standard VAT/GST rate, %		For two or more different values, the mean was taken	3599	27	2021	1995	178	International Monetary Fund	https://www.imf.org/external/np/fad/tpaf/pages/vat.htm; https://www.vatlive.com/; https://www.imf.org/external/np/fad/tpaf/files/VAT_historic_rates.xlsx
Shadow economy determinant: taxation	*CIT*	Corporate Income Tax (CIT) rate, %			4970	28	2022	1995	211	Tax Foundation	https://taxfoundation.org/publications/corporate-tax-rates-around-the-world/
Shadow economy determinant: taxation	*PIT*	Personal Income Tax (PIT) rate, %			2976	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	
Shadow economy determinant: taxation	*PIT_INCOME*	Top marginal income tax rate, %		1Di; Countries with higher marginal tax rates that take effect at lower income thresholds received lower ratings based on the matrix available here: https://www.fraserinstitute.org/sites/default/files/uploaded/2022/economic-freedom-of-the-world-2022-appendix.pdf The income threshold data were converted from local currency to 1982/1984 US dollars (using beginning-of-year exchange rates and the US Consumer Price Index).	2976	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=0

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Shadow economy determinant: taxation	*PIT_PAYROLL*	Top marginal income and payroll tax rate, %		1Dii; Countries with higher marginal income and payroll (wage) tax rates that take effect at lower income thresholds received lower ratings based on the matrix available here: https://www.fraserinstitute.org/sites/default/files/uploaded/2022/economic-freedom-of-the-world-2022-appendix.pdf The income threshold data were converted from local currency to 1983 US dollars (using beginning-of-year exchange rates and the US Consumer Price Index).	2787	22	2020	1995	161	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=1
Shadow economy determinant: taxation	*PIT_BOTH*	Top marginal tax rate, %		1D; this component is based on the top marginal income tax rate (1Di) and the top marginal income and payroll tax rate (1Dii) and the income threshold at which these rates begin to apply. These two sub-components are averaged to calculate the top marginal tax rate (1D).	2976	22	2020	1995	164	Economic Freedom of the World, Fraser Institute	https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=2
Shadow economy determinant: taxation	*TAX_RATES*	Average rate of VAT and CIT, %			3333	22	2020	1995	178	see sources for VAT and CIT rates	
Shadow economy determinant: taxation	*TAX_TIME*	Time to prepare and pay taxes in hours	exclude, the reasearch project and data was discontinued		2677	15	2019	2005	189	World Bank – Doing Business project	https://data.worldbank.org/indicator/IC.TAX.DURS
Partly shadow economy determinant, partly control variable: payment card system / financial inclusion	*CARDS*			Data for the end of the period	1627	18	2021	2004	137	European Central Bank, International Monetary Fund, International Bank for Settlements, national central banks	https://sdw.ecb.europa.eu/browseTable.do?org.apache.struts.taglib.html.TOKEN=6ab720d6adb4e6c43c02c84b6d69153d&df=true&ec=&dc=&oc=&pb=&rc=&DATASET=0&removeItem=&removedItemList=&mergeFilter=&activeTab=PSS&showHide=&REF_AREA.93=AT&REF_AREA.93=BE&REF_AREA.93=BG&REF_AREA.93=CY&REF_AREA.93=CZ&REF_AREA.93=DO&REF_AREA.93=DE&REF_AREA.93=DK&REF_AREA.93=EE&REF_AREA.93=ES&REF_AREA.93=FI&REF_AREA.93=FR&REF_AREA.93=GR&REF_AREA.93=HR&REF_AREA.93=HU&REF_AREA.93=IE&REF_AREA.93=IT&REF_AREA.93=LT&REF_AREA.93=LU&REF_AREA.93=LV&REF_AREA.93=MT&REF_AREA.93=NL&REF_AREA.93=PL&REF_AREA.93=PT&REF_AREA.93=RO&REF_AREA.93=SE&REF_AREA.93=SI&REF_AREA.93=SK&PSS_INFO_TYPE.93=S101&PSS_INSTRUMENT.93=I12&MAX_DOWNLOAD_SERIES=500&SERIES_MAX_NUM=50&node=9689709&legendPub=published
Partly shadow economy determinant, partly control variable: payment card system / financial inclusion	*ACCOUNT*	Account, % age 15+	rather exclude, low number of observations	Data available for 2011, 2014, 2017, 2021, data interpolation was made for the remaining years	1467	11	2021	2011	160	Global Findex Database, own calculations	https://www.worldbank.org/en/publication/globalfindex/Data
Partly shadow economy determinant, partly control variable: payment card system / financial inclusion	*OWNING_CARDS*	Owns a debit or credit card, % age 15+	rather exclude, low number of observations	Data available for 2011, 2014, 2017, 2021, data interpolation was made for the remaining years	1467	11	2021	2011	160	Global Findex Database, own calculations	

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Partly shadow economy determinant, partly control variable: payment card system / financial inclusion	*USING_CARDS*	Used a debit or credit card, % age 15+	rather exclude, low number of observations	Data available for 2011, 2014, 2017, 2021, data interpolation was made for the remaining years	867	8	2021	2014	135	Global Findex Database, own calculations	
Partly shadow economy determinant, partly control variable: payment card system / financial inclusion	*DIGITAL_PAYMENT*	Made a digital payment, % age 15+	rather exclude, low number of observations	Data available for 2011, 2014, 2017, 2021, data interpolation was made for the remaining years	1037	8	2021	2014	155	Global Findex Database, own calculations	
Control variable and for interactions with selected shadow economy determinants (to show differences in the determinants' impact depending on the country's development level)	*GDP_PER_CAPITA*	GDP per capita based on purchasing power parity (PPP), thousands of constant 2017 international dollars		The same definition as "Gross domestic product per capita, constant prices" (purchasing power parity; 2017 international dollar) in the IMF, for which there are publicly available forecasts.	5084	27	2021	1995	194	World Bank – International Comparison Program, World Development Indicators database, Eurostat-OECD PPP Programme.	https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD?end=2021&start=2004
Control variable	*DEPOSIT_ INTEREST_RATE*		rather exclude, data not available for some European countries for which most other variables are available		3402	27	2021	1995	150	International Monetary Fund	Financial, Interest Rates, Deposit, Percent per annum: https://data.imf.org/?sk=B83F71E8-61E3-4CF1-8CF3-6D7FE04D0930&sId=1390030341854
Control variable	*R_DEPOSIT_ INTEREST_RATE*	Real deposit rate, i.e. households deposit rate per annum adjusted by yoy CPI inflation rate, in %	rather exclude, data not available for some European countries for which most other variables are available	Calculated as (1+DEPOSIT_INTEREST_ RATE)/(1+CPI_RATE) – 1; in our database to obtain the appropiate units: ((1+DEPOSIT_ INTEREST_RATE/100)/(1+CPI_RATE/100) – 1)*100	3135	27	2021	1995	138	International Monetary Fund, own calculations	-
Control variable	*CPI_RATE*	Inflation, consumer price index, % year-on-year		The same definition as "Inflation, average consumer prices" (percent change) in the IMF, for which there are publicly available forecasts.	4998	27	2021	1995	186	Oxford Economics	https://data.oxfordeconomics.com/render-app
Control variable	*CREDIT_GDP*	Domestic credit to private sector, % of GDP			3963	26	2020	1995	185	World Bank – International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates.	https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS
Control variable	*FIN_DEV*	Financial development index, aggregate of financial institutions, financial depth and financial market development indices. It ranges from 0 to 1, 1=best development			4680	26	2020	1995	180	International Monetary Fund – Svirydzenka (2016)	https://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B&sId=1481126573525
Control variable	*URBAN_ POPULATION*	The share of urban population in the total population, %			5805	27	2021	1995	215	World Bank – United Nations Population Division. World Urbanization Prospects: 2018 Revision	https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

Technical appendix

Group of variables for our analysis	Name of the variable	Description	Decision to exclude from the model after initial analysis	Additional comments	Number of observations	Number of years	Latest year available	Earliest year available	Number of countries (with any data point)	Sources	Hyperlinks
Control variable	*AGRI_GDP*	Agriculture, forestry, and fishing value added, % of GDP			5112	27	2021	1995	204	World Bank national accounts data, and OECD National Accounts data files	https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS
Control variable	*INDUSTRY_GDP*	Industry (including construction) value added, % of GDP			5098	27	2021	1995	205	World Bank national accounts data, and OECD National Accounts data files	https://data.worldbank.org/indicator/NV.IND.TOTL.ZS
Control variable	*SERVICES_GDP*	Services value added, % of GDP			5005	27	2021	1995	202	World Bank national accounts data, and OECD National Accounts data files	https://data.worldbank.org/indicator/NV.SRV.TOTL.ZS
Control variable	*AGRI_EMPLOYMENT*	The share of people employed in agriculture in the overall employment, %			4675	25	2019	1995	187	World Bank – modeled ILO estimate	https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS
Control variable	*INTERNET_ACCESS*	The share of population with Internet access, %			5092	27	2021	1995	213	World Bank – International Telecommunication Union	https://data.worldbank.org/indicator/IT.NET.USER.ZS
Control variable	*DUMMY_IND*	Binary variable controlling for the effect of demonetization in India in 2016		2016=1	6293	29	2022	1995	217	Own elaboration	-
Control variable	*DUMMY_ROU*	Binary variable controlling for the credit boom in Romania starting in 2007		2007-2010=1	6293	29	2022	1995	217	Own elaboration	-
Shadow economy determinant / control variable: sociodemographic	*YOUNG*	Share of people aged 15-34 in the working age population (15-64), %			5751 (over the period 1995-2021)	72	2021	1950	213	United Nations	https://population.un.org/wpp/Download/Standard/MostUsed/
Shadow economy determinant / control variable: sociodemographic	*EDUCATION*	considered various variables related to the number of finished school years, educational attainment, etc.	exclude, data not available after 2019 and/or missing for many countries		not available (excluded after initial analysis)	not available (excluded after initial analysis)	not available (excluded after initial analysis)	not available (excluded after initial analysis)	not available (excluded after initial analysis)	Various sources considered, for example, Penn World Table (Human Capital Index), Unesco	https://www.rug.nl/ggdc/productivity/pwt/?lang=en http://data.uis.unesco.org/index.aspx?queryid=3803
Shadow economy determinant / control variable: sociodemographic	*POVERTY_WORK*	Working poverty rate (employed living below US$1.90 PPP), % of employed		For developed economies there is no data in the ILO database, but it can be assumed that all the observations are equal to 0.	6109	32	2022	1991	188	International Labor Organization	https://ilostat.ilo.org/topics/working-poverty/
Shadow economy determinant / control variable: sociodemographic	*MIGRATION*	Net migration rate (number of immigrants minus number of emigrants in a given year), per 1,000 population		Data on migration stock would be better but there are issues with such data (see MIGRATION_STOCK)	5751 (over the period 1995-2021)	72	2021	1950	213	United Nations (similar/the same data as on https://www.migrationdataportal.org/)	https://population.un.org/wpp/Download/Standard/MostUsed/
Shadow economy determinant / control variable: sociodemographic	*MIGRATION_STOCK*	Number (or "stock") of international migrants, per 1,000 population	exclude: (1) data on migrants stock (cumulative number of migrants) widely available only for 5-year intervals, while data for our model needs to be available at the annual frequency, (2) there are significant differences in definitions of such data between countries		not available (excluded after initial analysis)	not available (excluded after initial analysis)	not available (excluded after initial analysis)	not available (excluded after initial analysis)	not available (excluded after initial analysis)	United Nations (similar/the same data as on https://www.migrationdataportal.org/)	https://www.un.org/development/desa/pd/content/international-migrant-stock

Technical appendix

Group of variables for our analysis	Name of the variable	Description	Decision to exclude from the model after initial analysis	Additional comments	Number of observations	Number of years	Latest year available	Earliest year available	Number of countries (with any data point)	Sources	Hyperlinks
Shadow economy determinant / control variable: sociodemographic	*LIFE_EXP*	Life expectancy at birth, total (years)		In our opinion this variable is better than the variable related to deaths at birth, since it captures health outcomes (including death rates) for the whole age distribution.	5540	27	2021	1995	212	World Bank (United Nations)	https://data.worldbank.org/indicator/SP.DYN.LE00.IN
Shadow economy determinant / control variable: sociodemographic	*HOSPITAL_BEDS*	Hospital beds, per 1,000 people	exclude, data not available in many cases, especially for more recent time periods		3099	27	2019	1995	178	World Health Organization	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/hospital-beds-(per-10-000-population)
Shadow economy determinant: labour market / business cycle	*GDP_GROWTH*	Gross domestic product, constant prices, percentage change from previous year		Similar aspect (plus level of income) is already included in the GDP_PER_CAPITA variable.	5145 (over the period 1995-2021)	47	2022	1980	196	International Monetary Fund	https://www.imf.org/en/Publications/WEO/weo-database/2022/October
Shadow economy determinant / control variable: other	*IMPORTS*	Volume of imports of goods and services, % change from previous year		Since we analyse determinants of currency in circulation used for transactions of residents, considering imports (rather than exports) seem to make more sense. Theoretically, instead of (a) volume of imports (percent change, y/y) it may make more sense to consider (b) imports (% of GDP), because (b) captures not only the dynamics of imports but also their relative role in the economy ((b) could also be forecasted with publicly available sources).	4588 (over the period 1995-2021)	47	2021	1980	178	International Monetary Fund	https://www.imf.org/en/Publications/WEO/weo-database/2022/October

Source: EY

A.3. Data preparation

Apart from some basic operations described in the table with our data set (e.g., dividing some variables by GDP or population size to make them comparable between countries and over time), we also took additional measures to increase the sample size and improve the data set quality:

- **Currency in circulation for the eurozone.** We decomposed the cash in circulation in the whole eurozone into the values for each of the euro area members (such estimates are not publicly available).[139] It was done to increase the number of countries in the estimation sample. The decomposition was based on the value of cash withdrawals from ATMs in each euro area member state collected from the European Central Bank database. We assumed that the shares of euro area members in such withdrawals in the eurozone are the same as their shares in the currency in circulation in the euro area.
- **Interpolations.** When, for the given variable and country, values were missing between periods with available data points, we used simple interpolation techniques to complete the time series (e.g., Worldwide Governance Indicators data did not include observations for 1995, 1997, 1999 and 2000, and for the last three of them, such an approach allowed us to estimate the missing values).
- **Outliers.** We corrected or cleaned some outliers in the data. One of the errors identified in the original data source was incorrect units for Belarus and Zambia in the data of Currency Outside Banking Institutions (used to create the dependent variable CASH_M1). We have also removed doubtful observations for Romania in 1995 for the variable CREDIT_GDP.
- **Countries selection.** After an initial investigation, we dropped specific countries from the analysis (the list of countries and reasons are in the footnote).[140] Finally, we generated a common sample (a fixed set of countries and periods) to effectively compare the models with different sets of variables (otherwise changes in the obtained results would be a mix of the variables' impact and changes in the sample composition resulting from the selection of different variables).

139 Among the public data we can find a variable with such a name, but it was calculated as countries' shares in the European Central Bank's capital. In such data all the eurozone members show exactly the same percent growth of currency in circulation over time, despite the fact that the actual trends in this area could be different among them.

140 We excluded countries with substantial amount of missing data or questionable/outlying data (due to wars, high inflation, low quality of data collection or very specific conditions in the given country): Afghanistan, Angola, American Samoa, Andorra, Antigua and Barbuda, Aruba, Bahrain, Barbados, Belize, Bermuda, Bolivia, Brunei Darussalam, Bhutan, Cambodia, Cayman Islands, Central African Republic, Channel Islands, Congo, Dem. Rep., Comoros, Cuba, Curacao, Djibouti, Dominica, Ecuador, Egypt, Arab Rep., Equatorial Guinea, Eritrea, Ethiopia, Faroe Islands, Fiji, French Polynesia, Gibraltar, Greenland, Grenada, Guam, Guinea-Bissau, Iran, Iraq, Isle of Man, Kiribati, Kosovo, Kyrgyz Republic, Liberia, Liechtenstein, Maldives, Marshall Islands, Micronesia, Monaco, Mongolia, Namibia, Nicaragua, Northern Mariana Islands, New Caledonia, Nauru, Qatar, Palau, People's Republic of Korea, Puerto Rico, Rwanda, Samoa, Sao Tome and Principe, San Marino, Saudi Arabia, Seychelles, Sint Maarten (Dutch part), Solomon Islands, Somalia, South Sudan, St. Kitts and Nevis, St. Lucia, St. Martin, St. Vincent and the Grenadines, Syrian Arab Republic, Timor-Leste, Tonga, Turks and Caicos Islands, Turkmenistan, Tuvalu, United Arab Emirates, Uzbekistan, West Bank and Gaza, Vanuatu, Venezuela, Virgin Islands (U.S.), Yemen (Rep.), Zimbabwe.

A.4. Method for estimation of the econometric model

Even for a given set of variables, there are different econometric methods of estimation (so-called estimators) of unknown parameters that describe the relationship between the explanatory and explained variables (coefficients) as well as the measure of their uncertainty or variability (standard errors). The choice of the estimator should be based on various characteristics of the analyzed data set that are discussed below. In general, such characteristics have been similar for different combinations of variables considered in our analysis. Therefore, we first chose the estimator based on a few initial sets of variables and then applied the same rule of estimating the coefficients to a different set of variables.[141]

Having a ready set of data, we performed a series of statistical tests. First, we verified whether there was a problem of heteroskedasticity (i.e., we can observe changes in the variance of errors from the model across different countries) on the basis of a likelihood ratio test, where we compared the likelihood of the model estimated using a feasible generalized least squares (FGLS) estimator that takes into account heteroskedasticity with a simple least squares model. The results showed that the heteroskedasticity is an issue. Second, we performed a serial correlation test[142] that showed that autocorrelation (i.e., correlation of errors from the model) is also present. Those results indicated that we must use the family of FGLS estimators that take into account presence of heteroskedasticity and autocorrelation. Third, we performed the Hausmann test that concluded that we should account for fixed effects (i.e., binary variables representing each country that take into account specific characteristics of each country included in the panel data set).

Finally, we chose a PCSE estimator, as it accounts for the heteroskedasticity and autocorrelation, produces stable results (regarding exclusion of random countries or changes in the specification) and provides reliable evaluation of standard errors of each parameter.[143] We selected a panel-specific autocorrelation structure option (psar1) that identifies that there is first-order autocorrelation and its coefficients are specific to each country.

The tool that we used to conduct the investigation of the currency demand and the shadow economy is Stata software,[144] as it is well-designed for the econometric analysis of panel data. In particular, it has a well-programmed function for estimation of the model's coefficients with the PCSE estimator. For the part related to the selection of the variables (BMA analysis), which will be described in the next subsection, we used the R software,[145] as it is faster and better suited to this type of analysis.

141 In practice, while conducting the econometric analysis, we looked also at some additional estimators to observe the robustness of our analysis to a different choice of estimator.

142 See Drukker, D. M. (2003), Testing for serial correlation in linear panel-data models. Stata Journal 3, pp. 168-177.

143 For a discussion of a selection of the estimator for panel data setting see: Reed W.R. & Ye H. (2011), Which panel data estimator should I use?, Applied Economics, 43:8, pp. 985-1000.

144 For the estimation we used version Stata/IC 16.0 for Windows (64-bit x84-64).

145 R version 3.5.3.

A.5. Initial selection of variables

In a preliminary part of the analysis, we apply the BMA procedure, in which CDA model variants are estimated using the PCSE method, with different combinations of variables from Table 4 (for their detailed description see Table 3). The goal of this procedure is to estimate the posterior inclusion probability (PIP) of each variable,[146] a measure indicating which variables should be included in the model.

The total number of combinations of models is equal to 2^k, where k is the number of considered variables. Since we have a preliminary list of more than 40 variables (after excluding some variables for which not enough data is available), we had to use some additional assumptions to further decrease the number of analyzed models. As such we divided variables into groups consisting of variables that represent similar concepts of shadow economy determinants:

- Worldwide Governance Indicators (WGI) that measure general level of institutional quality.
- Other institutional and regulatory indicators.
- Labor market structure indicators.
- Business cycle indicators.
- Taxation level indicators.
- Other social factors that can affect the shadow economy development.

We assumed that, in each analyzed model there can only be one variable from each of the groups. This assumption decreased substantially the number of potential combinations. Moreover, we also assumed that in each model there must be at least one shadow economy determinant and one control variable (measuring the demand for cash used in legal transactions). We observed that some variables kept very low levels of PIP, so we excluded them in the initial iterations of the BMA analysis. The overall number of models analyzed in the final iteration of the BMA analysis amounted to 737,152 models. In addition to this, we also imposed sign restrictions on each shadow economy determinant. For example, an increase in the institutional quality measure should decrease the shadow economy level. As a result, each WGI variable should have a minus sign (–). If there is a plus sign (+) in the analyzed model, it indicates a problem regarding estimation (e.g., due to omitting important variables in the specification, the so-called "omitted variable bias") and, therefore, we excluded such model from the analysis in the "restricted" variant of the BMA analysis.

146 For BMA application in the context of shadow economy estimation see: Dybka et al. (2022), op. cit.

Table 4. Summary of the BMA analysis

Variable name	PIP	PIP (sign restrictions)
Worldwide Governance Indicators		
GOV_EFFECTIVENESS	30.4%	52.9%
REGULATORY	10.7%	14.0%
CONTROL_OF_CORRUPTION	9.7%	13.1%
VOICE_AND_ACCOUNTABILITY	8.9%	10.7%
POLITICAL	8.9%	7.1%
RULE_OF_LAW	21.9%	0.0%
Probability that a variable from this group should be included		97.8%
Other institutional and regulatory indicators		
INTEGRITY	50.4%	43.7%
COURTS	24.4%	27.5%
CONTRACTS_ENFORCEMENT*	23.1%	0.2%
BUSINESS_REGULATIONS*	0.0%	0.0%
LABOR_MARKET_REGULATIONS*	0.0%	0.0%
REGULATORY_BURDEN*	54.1%	0.0%
Probability that a variable from this group should be included		71.43%
Labor market structure indicators		
FAMILY_WORK	100.0%	100.0%
SELF_EMPLOYED*	0.1%	0.1%
OWN_ACCOUNT_WORK*	0.0%	0.0%
Probability that a variable from this group should be included		100.0%
Business cycle indicators		
UNEMP	75.3%	74.8%
NON_EMPLOYED	22.8%	24.4%
GDP_GROWTH	1.0%	0.5%
Probability that a variable from this group should be included		99.6%
Taxation level indicators		
CIT	13.1%	64.4%
VAT	3.7%	17.0%

Variable name	PIP	PIP (sign restrictions)
PIT	2.0%	9.3%
TAXES_INCOME_PROFITS_GAINS	1.5%	1.8%
TAXES_GOODS_AND_SERVICES	78.2%	0.0%
Probability that a variable from this group should be included		92.5%
Other social factors		
MIGRATION_NET	54.1%	50.4%
YOUNG_LABOR_FORCE	29.5%	37.6%
LIFE_EXPECTANCY	5.0%	6.2%
POVERTY_WORK	6.5%	0.1%
Probability that a variable from this group should be included		94.3%
Control variables		
GDP_PER_CAPITA	100.0%	100.0%
INTERNET_ACCESS	100.0%	100.0%
AGRI_GDP	98.9%	96.1%
CPI_RATE	85.9%	86.0%
IMPORTS	54.0%	60.3%
CREDIT_GDP	57.8%	52.4%
URBAN_POPULATION	52.9%	51.8%
GDP_PER_CAPITA_squared	48.1%	48.1%

*Notes: *We have conducted two iterations of the BMA analysis, as we have reached such a large number of potential models that we were unable to evaluate them all at once. After the first BMA iteration, we removed variables that had a very low PIP or had a wrong sign, and then we ran an additional BMA iteration where we added some new variables (e.g., "Other social factors group"). We denote variables removed after the first BMA iteration with an asterisk (*).*

Source: EY analysis

The sum of inclusion probabilities of variables in most of the groups of shadow economy determinants is above 90%, presenting strong evidence that a variable from the group should be present in the final model. In the case of the Other institutional and regulatory indicators group, the probability is over 70%, which still presents some evidence[147] that a variable from that group should be considered in the final model.

Among the WGI, the GOV_EFFECTIVENESS variable has the highest PIP and should be considered in the final model.[148] Moreover, the INTEGRITY variable is the best candidate for the final model from the other institutional and regulatory indicators group, whereas FAMILY_WORK should be used as a variable measuring the structure of the labor market (i.e., the share of potentially vulnerable workers) and the UNEMP should be viewed as the variable measuring the effects of a business cycle (also general state of the labor market) on the shadow economy.

In the case of taxation level indicators, the case is less clear. To begin with, it would be best to have a tax variable that summarizes average monetary gains from not reporting economic activity in different countries, accounting for various kinds of taxes, applicable rates, deductions, structure of the economy, etc. Unfortunately, such data is not available for as many countries and time periods as needed in our case. Next, the effective rates (i.e., variables based on the value of actually collected taxes) often have a wrong sign in the BMA (due to potential endogeneity issues). TAXES_GOODS_AND_SERVICES (measuring the income from VAT and sales tax to the value-added ratio) has a PIP equal to 0 after imposing a restriction that its sign should be positive (i.e., higher taxes mean higher shadow economy level). Moreover, the TAXES_INCOME_PROFITS_GAINS variable measuring the ratio of CIT (and other entrepreneurial income taxes) to value added also has a low PIP value. As a result, we conclude that the nominal rates should be considered in the final model, where the CIT rate has the highest PIP.

147 For a discussion on the interpretation of PIP see e.g. Bierut B.K., Dybka P., (2021) Increase versus transformation of exports through technological and institutional innovation: Evidence from Bayesian model averaging, Economic Modelling, Vol. 99, 105501, https://doi.org/10.1016/j.econmod.2021.105501.

148 After in-depth analysis we decided that adding GOV_EFFECTIVENESS variable does not generate substantial issues in the model and therefore inclusion of this variable outweighs potential problems related to its construction.

The World Bank's worldwide governance indicators (WGI) are generated using the Unobserved Components Model (UCM) as a weighted average of selected indicators related to given area of governance. The WGI measures are created in such a way that for each year the mean value is 0. As a result, using such data in a panel data setting can lead to the so-called cross-sectional dependence, meaning the time series for different countries are correlated due to exclusion of a common factor. The existence of such a problem would lead to biased estimates of the model.

Cross sectional dependency would be prevalent in the case that the average value of selected governance measure in each year would differ to a significant extent (e.g. due to a presence of a common trend). It is worth noting that on the WGI website we read: To gain insights into trends in global averages of governance it is necessary to consult the data from the underlying sources. Over the past several years we have documented that global averages of individual data sources show no clear pattern of systematic improvements or declines. This observation can be used to justify our choice of units for the WGI where the world average is constant over time. This indicates that centering of the WGI data in 0 for each year should not create cross-sectional dependency. Moreover, Handoyo (2023) analyses the underlying WGI data sources and provides additional evidence that the changes in the observed means over the 2012-2022 period are not significant. For the government effectiveness the change over the 10 years is approximately 2%.

A potential consequence of the omission of a common factor for panel units might potentially result in cross-sectional dependence, with a potential resulting inconsistency of estimates. The use of an adequate estimator, such as Common Correlated Effects (CCE), is not feasible with a large-N limited-T panel like ours but given that the omitted mean is a possibly strong factor affecting the entire sample, we attempted to account for this by using periodic dummies (for 4-year windows to economize on degrees of freedom). The results are similar to the baseline model, confirming that the trend in the government effectiveness indicator's mean is weak, at most.

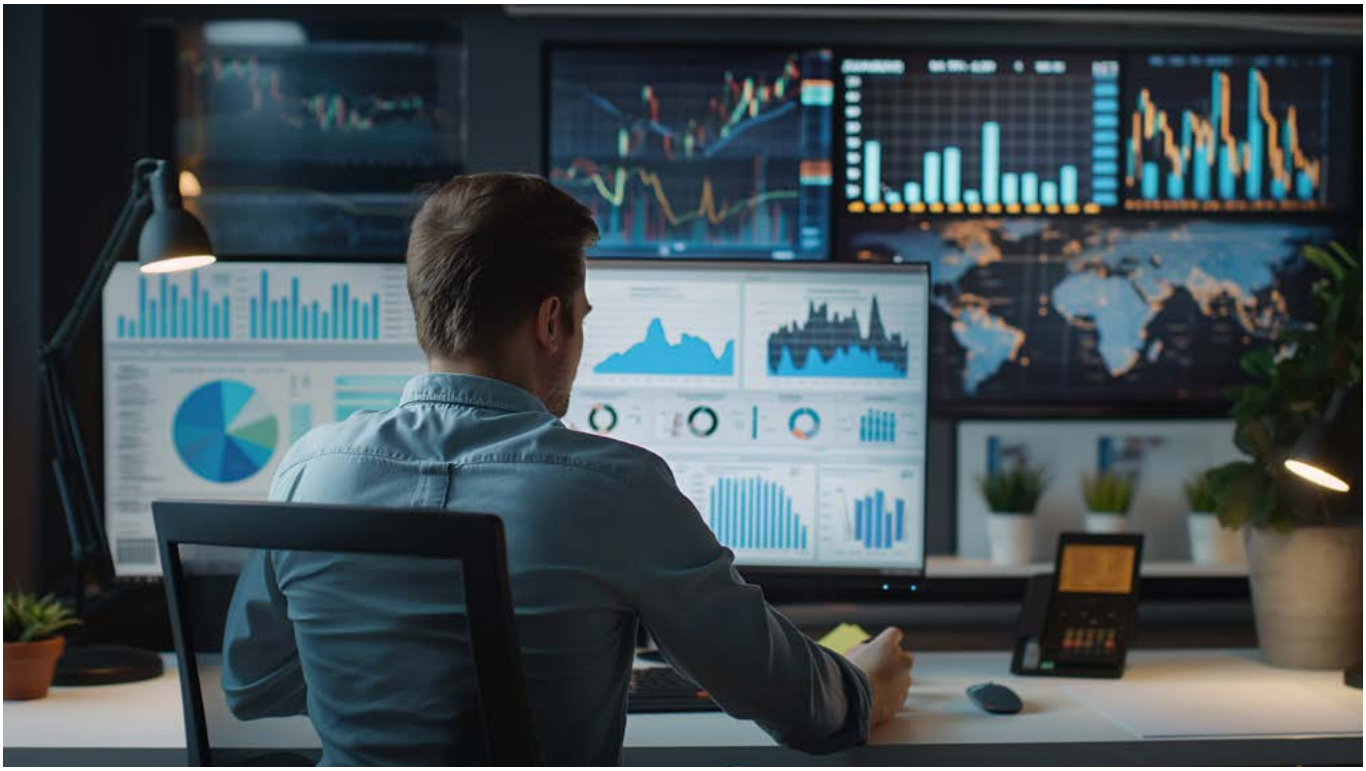
As a result, we concluded that even though the government effectiveness indicator is centered in 0 for each period, such transformation has a limited impact on the obtained results. Taking into account a vast array of countries included in the WGI database and the importance of the institutions for the shadow economy (confirmed by the results of the Bayesian model averaging) we believe that the use of government effectiveness measure is justified.

Since VAT also shows relatively high (compared to other tax variables) inclusion probabilities, we consider a simple average of CIT and VAT nominal rates in the final model. After obtaining valuable comments to the draft version of our study, we made a choice to exclude the available PIT rate from this average and our model.[149] Potential improvement of the tax variable and testing its impact on the shadow economy is an important area for further research for our team (unfortunately, this will be likely possible only for the limited number of countries).

The last group includes other types of social variables that can affect the shadow economy. In this group, one demographic factor, the net migration ratio and the share of young people (15–34) in the working age population (15–64) have the largest PIP and should also be considered in the final model (they were eventually removed as they were not statistically significant).

In the case of the so-called control variables (that account for factors affecting demand for cash that are not related to the shadow economy), we did not impose any restrictions. Obtained results indicate that the most likely candidates for the final model include GDP_PER_CAPITA, INTERNET_ACCESS, AGRI_GDP and CPI_RATE. For all control variables except the squared GDP_PER_CAPITA, the PIP was above 50%, indicating there exists weak evidence that such variables should be considered in the final model.

To our best knowledge, such thorough analysis of variables in the currency demand model has not been previously done in the economic literature by other researchers.



149 The main reason for that was the fact data on PIT rates available for many countries and time periods represents the top marginal rate, which does not necessarily reflect the tax rate that is crucial for decision on hiding economic activity, as these are relatively often made by low-income businesses and individuals. Therefore, the top marginal PIT rate may be of limited relevance in predicting the propensity to hide economic activity. The exclusion of the PIT rate has had a small impact on our estimates and all the qualitative conclusions remain robust. This change is also the source of small differences in shadow economy estimates for Bulgaria in this study versus our dedicated report for this country (see EY (2023), op. cit.).

A.6. Final selection of variables and results of the econometric model

The CDA is based on the econometric model, for which two crucial components are the estimation method and selection of variables.

First, even for a given set of variables, there are different econometric methods of estimation (so-called estimators) of unknown parameters that describe the relationship between the explanatory and explained variables (coefficients) as well as measure their uncertainty or variability (standard errors). Our final choice of the PCSE estimator is explained in section A.4.

Second, our innovation and significant improvement in comparison with standard CDA models includes a long list of considered factors and our approach to initial selection of variables from that list. We applied a BMA procedure in which hundreds of thousands of CDA model variants were estimated, with different combinations of potential variables. The goal of this was to obtain the ranking indicator showing likelihood of variables inclusion in the "true" model. This part of the analysis is described in section A.5.

The choice of the final specification (set of variables) was made according to the method from general-to-specific.[150] Based on the results from BMA, we specified the general model containing all the variables worth further consideration. Afterward, we tested different specifications, and we swapped variables within one group from BMA if their choice was ambiguous. Wealso checked whether obtained signs of coefficients were in line with theory and other research. Next, we removed the variables that were statistically insignificant and/or had wrong signs in the stepwise manner. The list of variables included in the final version of the model along with the principal information is presented in Table 5. Table 6 contains coefficients of the selected econometric model, related standard errors and some additional statistics.

150 General-to-specific is a modeling strategy in econometrics that involves starting with a general model that includes a large number of potential explanatory variables and then using a stepwise approach to systematically narrow down the set of variables to the most significant ones that best explain the variation in the dependent variable.

Table 5. Variables included in the final econometric model of the currency demand

Group of variables for our analysis	Name of the variable	Description and source
Dependent (explained) variable	CASH_M1	Share of the currency in circulation in the M1 monetary aggregate (currency in circulation + transferable deposits), %. Numerator's data series: Currency Outside Depository Corporations (from Depository Corporations data table) or – in case of missing data – Currency Outside Banking Institutions (from Non-Standardized Presentation data table). Denominator's data series: M1 or sum of data on Transferable Deposits and Currency from the same tables. *Source: International Monetary Fund*
Shadow economy determinant: institutional/ regulatory	GOV_ EFFECTIVENESS	The value of the indicator measuring government effectiveness from the WGI. It ranges from approximately -2.5 (low government effectiveness) to 2.5 (high government effectiveness). It reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. *Source: World Bank – Worldwide Governance Indicators*
Shadow economy determinant: institutional/ regulatory	INTEGRITY	Integrity of the legal system, index with values from 0 (worst) to 10 (best) The first source is the International Country Risk Guide Political Risk Component I for Law and Order: "Two measures comprising one risk component. Each sub-component equals half of the total. The 'law' sub-component assesses the strength and impartiality of the legal system, and the 'order' subcomponent assesses popular observance of the law." The second source is Judicial Accountability, Compliance with the High Court, Judicial Review, Transparent Laws with Predictable Enforcement, and Access to Justice for Men from the V-Dem data set. (An adjustment for the area as a whole is made later to account uniformly for gender disparities.) Each of the V-Dem variables is individually rated using the formula (Vi – Vmin) / (Vmax – Vmin) multiplied by 10. Vi is the country's V-Dem score according to V-Dem, and Vmax and Vmin were set at 4.0 and 0, respectively. The five measures from V-Dem are then averaged. The final number is the average of whichever of the two sources is available. Source: Economic Freedom of the World, Fraser Institute
Shadow economy determinant: labor market/ role of small and specific entities	FAMILY_WORK	The ratio of the total number of contributing family workers to the population age 15-64, %. Contributing family workers are own-account workers in the market-oriented business that is conducted by a related person who lives in the same household. *Source: International Labour Organization, own calculations*
Shadow economy determinant: business cycle	UNEMP	Unemployment rate, percentage of total labor force (economically active population). The same definition as "unemployment rate" (percentage of total labor force) in the IMF, for which there are publicly available forecasts. *Source: World Bank – modeled ILO estimate*
Shadow economy determinant: taxation	TAX_RATES	Average of standard VAT and CIT rate, % *Source: VAT – International Monetary Fund, CIT – Tax Foundation*

Group of variables for our analysis	Name of the variable	Description and source
Control variable and for interactions with selected shadow economy determinants (to show differences in the determinants' impact depending on the country's development level	GDP_PER_ CAPITA	GDP per capita based on PPP, thousands of constant 2017 international dollars The same definition as "Gross domestic product per capita, constant prices" (purchasing power parity; 2017 international dollar) in the IMF, for which there are publicly available forecasts. *Source: World Bank – International Comparison Program, World Development Indicators database, Eurostat–OECD PPP Programme*
Control variable	URBAN_POPULATION	The share of urban population in the total population, % *Source: World Bank – United Nations Population Division, World Urbanization Prospects: 2018 Revision*
Control variable	CREDIT_GDP	Domestic credit to private sector, percentage of GDP *Source: World Bank – International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates*
Control variable	INTERNET_ACCESS	The share of the population with internet access, % *Source: World Bank – International Telecommunication Union*
Control variable	DUMMY_IND	Binary variable controlling for the effect of demonetization in India in 2016, 2016=1 *Source: EY analysis*
Control variable	DUMMY_ROU	Binary variable controlling for the credit boom in Romania starting in 2007, 2007–10=1 *Source: EY analysis*

Source: EY analysis

Table 6. Coefficients in the final econometric model of the currency demand

	Dependent variable: CASH_M1	
		PCSE_psar1
Shadow economy determinants	GOV_EFFECTIVENESS	-4.3906***
		(1.240)
	GOV_EFFECTIVENESS_interacted	0.1028***
		(0.032)
	INTEGRITY	-0.5121
		(0.347)
	FAMILY_WORK	0.8770***
		(0.148)
	UNEMP	0.3459***
		(0.127)
	UNEMP_interacted	-0.0076**
		(0.003)
	TAX_RATES	0.2698***
		(0.087)
Control variables	GDP_PER_CAPITA	-0.2764***
		(0.078)
	URBAN_POPULATION	-0.3293***
		(0.077)
	CREDIT_GDP	0.0191**
		(0.008)
	INTERNET_ACCESS	-0.0980***
		(0.022)
	DUMMY_IND	-18.8679***
		(2.099)
	DUMMY_ROU	-9.5041***
		(1.640)
	constant	65.1923***
		(8.555)
	Observations	1638
	Groups	101

*Notes: Standard errors in parentheses. P-values marked with asterisks: *p<0.1, ** p<0.05, ***p<0.01.*[151] *Groups = number of countries included in the sample. While INTEGRITY variable is not statistically significant in this model, it is very close to this and was significant in many other considered specifications. It was also suggested by our Bayesian model averaging approach. For these reasons and to avoid the omitted variable bias, we decided to leave this factor in the final model.*

Source: EY analysis

151 The p-value is a statistical measure used in econometrics to determine the strength of the evidence supporting a particular relationship between variables. It is a number between 0 and 1 that represents the likelihood of observing the given data or more extreme data, assuming that there is no relationship between the variables. In simplified approach, holding other things equal, the variables with lower p-values are "better".

Since the explained variable (CASH_M1) is not only related to the shadow economy determinants but also to non-shadow economy-related processes (e.g., shifting cash into deposits due to various macroeconomic and technological conditions), we needed to decide (based on other research and theory) which variables are (1) shadow economy determinants and (2) control variables. According to our best understanding, the first group should include the following factors: GOV_EFFECTIVENESS, INTEGRITY, FAMILY_WORK, UNEMP and TAX_RATES.

The remaining variables belong to the second group.[152] To control for potential differences in the impact of factors at different levels of development, we tested interaction terms with GDP_PER_CAPITA and included in the final model the ones that were statistically significant.

With the results obtained, we can calculate the theoretical value of the dependent variable CASH_M1 in the country i in the period (year) t (see section A.1 for more details). The formula is as follows:

$$
\begin{aligned}
&CASH\_M1_{i,t} \\
&= \left(-4.3906 + 0.1028 * GDP\_PER\_CAPITA_{i,t}\right) * GOV\_EFFECTIVENESS_{i,t} - 0.5121 \\
&* INTEGRITY_{i,t} + 0.8770 * FAMILY\_WORK_{i,t} + \left(0.3459 - 0.0076 * GDP\_PER\_CAPITA_{i,t}\right) \\
&* UNEMP_{i,t} + 0.2698 * TAX\_RATES_{i,t} - 0.2764 * GDP\_PER\_CAPITA_{i,t} - 0.3293 \\
&* URBAN\_POPULATION_{i,t} + 0.0191 * CREDIT\_GDP_{i,t} - 0.0980 * INTERNET\_ACCESS_{i,t} \\
&- 18.8679 * DUMMY\_IND_{i,t} - 9.5041 * DUMMY\_ROU_{i,t} + FIXED\_EFFECT_{i,t} + 62.1923
\end{aligned}
$$

DUMMY_IND and DUMMY_ROU are dummy variables controlling for specific observations for India and Romania, so for other countries, their values are equal to zero.

Fixed effects are country-level individual effects, which represent time-invariant unobservable country characteristics that affect the shadow cash to M1 ratio in each country.

152 Worth explaining is the assignment of GDP_PER_CAPITA to the control group. There are a few reasons for this. First, it is quite common approach in other currency demand research. Second, while the development of the economy can affect the role of electronic payments (e.g., through better payments infrastructure), they serve to large extent for registered transactions and only a part of additional cashless payments crowds out unregistered transactions. Third, one can argue that a large part of GDP_PER_CAPITA and shadow economy negative correlation is due to other related factors that accompany or often proceed the economic development such as improvements in government effectiveness and other aspects of public policy. Since they are among our shadow economy determinants, the economic development impact should be already adjusted for their influence in our model and, thus, mostly related to registered cash transactions. Fourth, GDP_PER_CAPITA could be moderating the impact of shadow economy determinants. For instance, in countries where the general level of development is high, a one percentage point increase in unemployment can lead to a lower increase in the shadow economy compared to the less affluent economies (e.g., there could be more alternative legal sources of income in case of losing job). As a result, we have included in the model the so-called interaction terms between the GDP and shadow economy determinants that account for the diminishing (with economic development) scale of the shadow economy determinants effect.

Crucially, we can obtain the ratio of the shadow cash (cash in circulation related to shadow economy determinants) to the M1 estimate for the given country and time period from the following formula:

$$
\begin{aligned}
&SHADOW\_CASH\_M1_{i,t} \\
&= \left(-4.3906 + 0.1028 * GDP\_PER\_CAPITA_{i,t}\right) \\
&* \left(GOV\_EFFECTIVENESS_{i,t} - MAX(GOV\_EFFECTIVENESS)\right) - 0.5121 \\
&* \left(INTEGRITY_{i,t} - MAX(INTEGRITY)\right) + 0.8770 * (FAMILY\_WORK_{i,t} \\
&- MIN(FAMILY\_WORK)\Big) + \left(0.3459 - 0.0076 * GDP\_PER\_CAPITA_{i,t}\right) \\
&* \left(UNEMP_{i,t} - MIN\left(UNEMP_{i,t}\right)\right) + 0.2698 * \left(TAX\_RATES_{i,t} - MIN(TAX\_RATES)\right)
\end{aligned}
$$

In the equation above, we include only the shadow economy determinants. To estimate their contribution to the shadow cash, we calculate the difference between their values for the given country and the benchmarks included in our sample. The benchmarks are the "best values" of the shadow economy determinants present in our sample of different countries and time periods (minimum (maximum) value in case of variables that increase (decrease) the shadow economy). If a given variable reached the level of the benchmark in the analyzed country, its contribution to the shadow would be equal to zero.

With some additional assumptions and operations, the ratio of shadow cash to M1 could be further translated into the share of the cash shadow economy in the total economy (GDP) (for details, see section A.1).

The estimated coefficients in the econometric model should be interpreted in the way described in Table 7.

Table 7. Interpretation of the coefficients in the final econometric model

Name of the variable	Variable interpretation
GOV_EFFECTIVENESS	Due to inclusion of the interaction term, the effect of GOV_EFFECTIVENESS is different across countries and for a given country over time (if its income level changes). For example, in the country where the GDP_PER_CAPITA equals 10 (thousands of international PPP dollars in constant 2017 prices), an increase in GOV_EFFECTIVENESS by 1 unit is associated with 3.4 (= 4.4-10*0.103) percentage point (pp) decrease in the shadow cash to M1 ratio. On average for all analyzed countries in 2023, an increase in GOV_EFFECTIVENESS by 1 unit is associated with 2.12 pp decrease in the shadow cash to M1 ratio, which is equivalent to a decrease in shadow economy by 1.84% of GDP.
INTEGRITY	An increase in INTEGRITY by 1 unit is associated on average with a 0.51 pp decrease in the shadow cash to M1 ratio, which is equivalent to a decrease in shadow economy by 0.46% of GDP.
FAMILY_WORK	An increase in FAMILY_WORK by 1 percentage point is related on average with a 0.88 pp growth in the shadow cash to M1 ratio, which is equivalent to an increase in shadow economy by 0.78% of GDP.
UNEMP	Due to inclusion of the interaction term, the effect of UNEMP is different across the countries and for a given country over time (if its income level changes). For example, in the country where the GDP per capita equals 10 (thousands of international PPP dollars in constant 2017 prices) an increase in unemployment rate by 1 percentage point is associated with a 0.27 (= 0.35-10*0.008) pp increase in the shadow cash to M1 ratio. On average for all analyzed countries in 2023, an increase in unemployment rate by 1 pp is associated with a 0.17 pp decrease in the shadow cash to M1 ratio, which is equivalent to a decrease in shadow economy by 0.15% of GDP.
TAX_RATES	An increase in TAX_RATES by 1 pp is associated on average with a 0.27 pp increase in the shadow cash to M1 ratio, which is equivalent to an increase in shadow economy by 0.24% of GDP.

Source: EY analysis

We can see that the signs of the obtained estimates for the shadow economy variables are in accordance with the theory and/or other research:

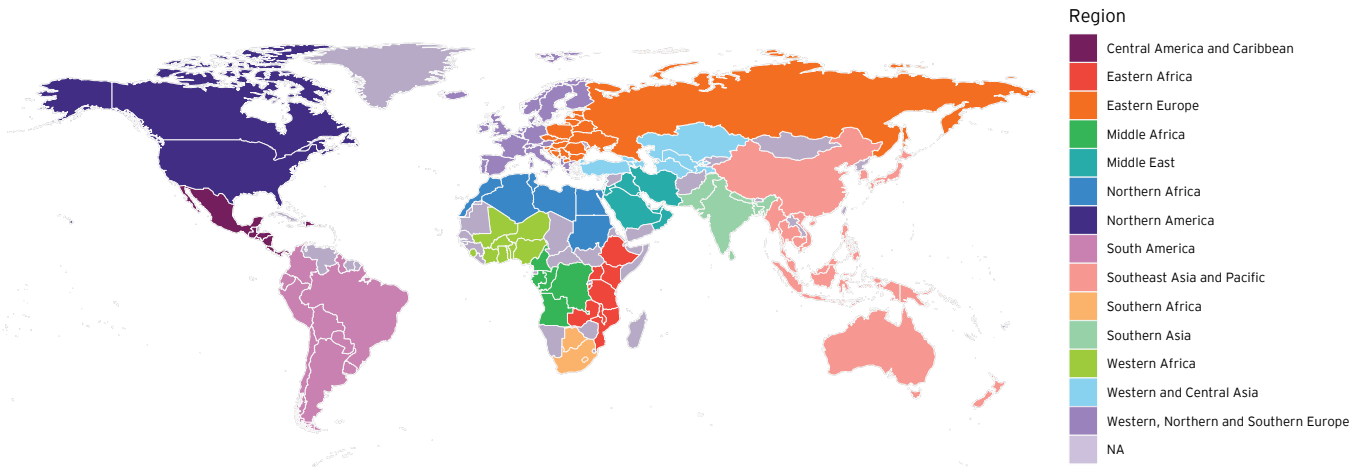
- Higher values of GOV_EFFECTIVENESS and INTEGRITY have a limiting effect on the shadow economy, likely through their multichannel impact on taxpayers' behavior and attitudes.
- Elevated FAMILY_WORK levels reflect the popularity of specific relations on the labor market that likely support activity in the shadow economy.
- Increased UNEMP captures the worst situation on the labor market, resulting from the business cycle, which may encourage people to increase their unregistered activity.
- Higher TAX_RATES increase the costs and stimulate avoidance of reported business operations. Yet, a growth in tax rates, despite leading to some expansion of the shadow economy, is still likely to increase collected tax revenues (net effect depends on both changes in the shadow economy and non-shadow-economy activity due to the higher rates). In theory, especially in the long term, additional government revenues may support government effectiveness and integrity (such potential link is not captured by our model).
- Finally, in our model, the impact of GOV_ EFFECTIVENESS and UNEMP declines with the economic development level. For joblessness in higher-income countries, it could be linked with lower incentives or opportunities to engage in unregistered activity despite turbulences on the labor market, e.g., due to more accumulated savings and wealth, more available social security, better options to borrow money, etc. For improvements in GOV_EFFECTIVENESS, their impact on the shadow economy may be lower in more developed countries, e.g., due to the structural differences in the economy (e.g., higher role of large enterprises that are less likely to not report their operations) or the fact that more affluent people are less interested in risky behavior.

We also tested in our model so-called time effects for 2020 (and 2021, in some cases) — during the COVID-19 pandemic. Yet, at least for the average cash demand and shadow economy in the analyzed sample of countries, these years were not significantly different than the other years (after controlling for the level of variables included in our model).

A.7. Regional aggregation of economies

Figure 5 below presents the regional aggregation of economies applied in our analysis. It is based on the approach applied in some data and analyses of the IMF[153], with a few regions further aggregated to limit the number of investigated units. Economies marked with "NA" have not been covered by our shadow economy estimates.

Figure 5. Regional aggregation of economies



Source: EY analysis

153 See e.g., the IMF's data on VAT rates: https://www.imf.org/external/np/fad/tpaf/files/vat_substandard_rates.xlsx.

A.8. Detailed country-level shadow economy estimates

Below we present our country-level shadow economy estimates from section 3.2 in the table that enables easier checking of exact values for individual countries.

Table 8. Shadow economy by countries (percentage of GDP), level in 2023 and changes over time

Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23	Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23
Albania	27.8	-11.3	-6.2	-1.6	Latvia	9.3	-10.0	-1.4	-0.2
Algeria	24.2	-7.2	2.2	0.7	Lebanon	19.6	3.5	4.5	1.9
Angola	30.2	3.2	2.2	3.4	Lesotho	30.9	-9.1	-2.3	-1.3
Argentina	17.8	-0.7	0.7	0.7	Libya	16.3	0.2	2.4	-1.0
Armenia	18.9	-19.4	-10.3	-2.9	Lithuania	7.4	-12.8	-3.5	-0.7
Australia	5.7	-1.7	-0.1	-0.1	Luxembourg	6.1	-0.9	0.3	0.2
Austria	6.6	-2.4	-0.6	0.0	Malawi	30.9	-8.0	-3.1	-1.3
Azerbaijan	17.7	-15.1	-4.0	-4.7	Malaysia	12.3	-4.7	-2.6	-0.3
Bahamas	5.4	1.0	-0.4	1.1	Mali	46.8	-1.2	1.0	-1.5
Bahrain	2.5	0.6	-0.2	-0.2	Malta	7.5	-2.7	-1.5	-0.3
Bangladesh	29.0	-10.0	-5.1	0.2	Mauritius	10.6	-7.4	-2.0	0.1
Belarus	18.3	-7.9	0.0	2.5	Mexico	17.9	-1.0	0.5	-0.2
Belgium	6.6	-3.1	-1.4	-0.8	Montenegro	13.6	-8.9	-3.5	-2.1
Benin	32.9	-4.4	-2.6	-2.1	Morocco	27.0	-8.9	-4.0	-0.8
Bolivia	32.1	-3.0	3.2	1.0	Mozambique	39.8	-11.9	-2.6	-0.7
Bosnia and Herzegovina	18.6	-11.2	-5.3	-1.8	Myanmar	37.9	-30.0	-6.2	0.9

Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23	Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23
Botswana	17.0	0.3	-0.4	-0.4	Nepal	51.0	-8.9	-3.3	-0.6
Brazil	20.6	-2.5	1.1	-0.1	Netherlands	6.3	-1.6	-0.3	-0.2
Bulgaria	10.5	-12.0	-4.7	-1.1	New Zealand	8.2	-2.0	-1.0	0.1
Burkina Faso	43.8	-14.1	-4.1	-1.2	Nicaragua	30.7	-0.9	-0.1	1.1
Burundi	49.2	-12.4	-4.6	-1.6	Niger	56.3	1.4	9.4	5.4
Cambodia	26.4	-28.3	-6.7	-0.8	Nigeria	30.0	-7.0	-3.1	-3.9
Cameroon	33.3	-7.7	-4.6	-1.0	North Macedonia	16.9	-10.3	-6.3	-2.7
Canada	4.5	-2.7	-0.3	-0.2	Norway	6.4	-0.8	-0.7	0.0
Chile	11.9	-1.4	1.4	0.0	Oman	6.4	-0.4	2.0	0.9
China	20.3	-17.9	-7.6	-1.5	Pakistan	35.0	-1.7	-2.6	0.7
Colombia	20.9	-6.9	0.8	-0.2	Panama	12.1	-5.0	-0.8	-0.4
Congo, Dem. Rep.	42.1	-12.7	0.4	-1.1	Papua New Guinea	31.4	-15.8	-2.1	0.3
Congo, Rep.	32.6	-1.7	1.4	-0.2	Paraguay	20.9	-8.7	-3.0	-1.5
Costa Rica	13.8	-3.6	-1.6	-1.7	Peru	27.1	-4.7	-1.4	-0.3
Cote d'Ivoire	28.8	-11.4	-3.8	-1.5	Philippines	20.7	-7.2	-4.2	-0.8
Croatia	9.3	-9.7	-4.7	-1.9	Poland	9.7	-9.4	-3.7	-1.4
Cyprus	5.3	-4.6	-2.5	-0.4	Portugal	9.3	-2.5	-2.1	-0.1
Czechia	6.5	-6.6	-2.3	-0.4	Puerto Rico	10.3	1.3	1.0	0.2
Denmark	5.9	-2.4	-0.6	-0.4	Qatar	2.2	-3.1	0.0	-0.1
Dominican Republic	16.2	-3.2	-4.0	-1.7	Romania	13.1	-18.2	-6.4	-2.0
Ecuador	26.5	-3.2	3.2	0.6	Russian Federation	13.1	-8.4	-0.2	0.8
Egypt, Arab Rep.	21.2	-7.0	-6.5	-1.1	Saudi Arabia	5.2	-4.8	0.1	0.1
El Salvador	19.9	-5.3	-3.2	-3.2	Serbia	17.2	-14.5	-6.0	-1.2

Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23	Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23
Estonia	7.4	-7.0	-2.5	-0.4	Sierra Leone	64.5	6.1	16.1	6.9
Ethiopia	50.2	-11.7	-7.7	-1.8	Singapore	3.4	-0.8	-0.2	-0.2
Finland	6.6	-1.6	-0.4	0.3	Slovak Republic	8.9	-7.1	-2.7	-0.2
France	6.7	-2.9	-1.6	-1.1	Slovenia	8.0	-5.2	-2.9	-0.3
Gabon	23.1	0.9	0.8	-0.3	South Africa	26.3	0.4	3.9	2.2
Georgia	22.1	-19.7	-7.3	-2.3	Spain	7.5	-3.5	-2.9	-0.2
Germany	6.8	-2.8	-0.3	-0.1	Sri Lanka	20.1	-11.7	-2.5	-0.2
Ghana	26.8	-9.6	-2.5	-0.2	Sudan	34.9	-12.6	-6.7	-2.9
Greece	12.0	-6.6	-3.7	-1.8	Sweden	6.7	-1.1	0.3	0.0
Guatemala	24.3	-8.3	-2.8	-0.8	Switzerland	5.1	-0.7	-0.3	-0.1
Guyana	11.8	-21.8	-17.1	-14.0	Tajikistan	33.2	-9.7	-3.0	-1.6
Honduras	26.7	-2.3	-2.9	-0.9	Tanzania	44.7	-10.9	-6.3	-3.4
Hungary	9.2	-3.6	-3.7	0.0	Thailand	24.0	-8.6	-3.8	0.5
Iceland	7.6	-2.2	-0.2	0.5	Togo	28.1	-16.2	-13.5	-2.7
India	26.1	-8.2	-3.0	0.1	Tunisia	21.2	-2.8	-0.8	0.2
Indonesia	23.8	-10.3	-4.7	-1.5	Türkiye	16.1	-10.9	-2.4	-2.5
Iran, Islamic Rep.	22.5	-2.9	1.9	0.1	Turkmenistan	19.7	-12.8	-0.3	0.4
Iraq	24.8	0.1	3.2	2.2	Uganda	31.1	-11.9	-5.6	-3.6
Ireland	5.1	-2.1	-0.1	0.1	Ukraine	19.3	-7.5	-1.0	-0.1
Israel	5.5	-5.0	-1.7	-0.6	United Arab Emirates	2.1	-0.8	-0.1	-0.7
Italy	7.8	-2.4	-1.8	-0.7	United Kingdom	5.3	-1.1	-0.8	-0.2
Japan	6.7	-3.9	-1.1	-0.2	United States	5.0	-1.0	-1.3	0.5
Jordan	18.3	-1.0	1.7	-1.0	Uruguay	13.5	-5.2	-2.2	-1.0

Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23	Country	Level 2023	Change 2000-23	Change 2013-23	Change 2019-23
Kazakhstan	11.2	-12.6	-2.8	-0.6	Uzbekistan	24.4	-15.9	-6.7	-3.2
Kenya	38.4	-13.3	-2.7	-2.1	Vietnam	25.1	-22.0	-6.3	-1.4
Korea, Rep.	7.6	-8.7	-1.6	-0.7	World	19.3	-6.7	-2.0	-0.6
Kuwait	4.0	-3.7	1.3	0.8	Zambia	35.6	-19.6	-6.5	-3.9

Notes: Countries sorted in alphabetical order. Estimates based on the econometric model that, on average, best fits the data for all countries in the estimation sample. For some countries in-depth analysis accounting for their specifics may bring more precise estimates. For Azerbaijan we present estimates based on our separate study focusing on this country, adjusted for the large role of the country's oil sector.

Source: EY analysis

A.9. Why people often expect a higher shadow economy size than is realistically possible

Below we discuss various reasons why, quite often, people expect a higher shadow economy size than is realistically possible.

To begin with, they often confuse the shadow economy (share of unregistered GDP in total GDP) with the share of unregistered employment in the total employment. The latter is most often higher, among other reasons, due to relatively low value added or generated by unregistered employees and registration of some of this value (e.g., registered sale of house built with unregistered work, see section 2.1 for more details).

Next, people often look from their own regular consumer spending perspective, which could be quite misleading. They do not know or forget that GDP (in the so-called final expenditure approach) includes not only domestic spending of consumers but also of government, investing companies and foreign entities (exports), which in most cases do not include shadow economy transactions. In addition, they frequently focus on daily, often low-value transactions (e.g., buying food, small services) where indeed the shadow economy may play a large role, forgetting about high-value transactions that either happen more automatically (e.g., payment of rent) or less often (e.g., purchase of durable goods, such as household equipment), which are less affected by the shadow economy.

Alternatively, looking at GDP from the perspective of production and income, remember that their significant share is generated by the public sector, public companies and various large private companies that are unlikely to not report their economic activity (such entities may generate some tax gap in other ways or be engaged in corruption, but these are different topics).

Finally, it is important to remember large income inequality and, as a result, spending inequality within many countries. An affluent person, who contributes to the total consumer spending in the country more than the median-income or low-income consumer, may be relatively more likely to buy various goods and services (e.g., food or clothing) from large, legally operating companies than from businesses that engage in shadow economy activities (e.g., informal street vendors). In such situation, even if for the median consumer, e.g., 30% of their spending value is unregistered, then such share for consumer expenditure in the whole economy could be closer to 20% or even 10% (depending on the scale of income and spending inequality in the country).

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