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METHODOLOGICAL ASPECTS OF ASSESSING THE HIDDEN ECONOMY IN THE DIGITAL ECONOMY

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Abstract. *The hidden economy remains one of the most complex and pressing challenges for modern states, undermining tax collection, distorting statistical data, and reducing the effectiveness of economic policy. In the era of digital transformation, new methodological approaches are required to accurately assess the scale and dynamics of the hidden economy. This paper explores the methodological aspects of measuring hidden economic activities within the framework of the digital economy, where the growing role of information technologies, e-commerce, and financial innovations significantly reshapes both formal and informal markets. The study reviews classical models such as the MIMIC (Multiple Indicators Multiple Causes) approach and dynamic stochastic general equilibrium (DSGE) modeling, while also examining their applicability to digitalized environments. Special attention is paid to the integration of big data, electronic payment systems, blockchain technologies, and digital footprints into hidden economy measurement methodologies. The paper emphasizes that traditional survey-based and indirect indicator methods are no longer sufficient in capturing rapidly evolving informal digital transactions.*

Keywords: *hidden economy, digital economy, econometric modeling, MIMIC model, big data, blockchain, economic security.*

1.Introduction

World economists are faced with the problem of creating a single integrated indicator for evaluating the value and efficiency of the digital economy in today's increasingly digitized global world. The lack of empirical and statistical data, the rapidly changing processes of technological development, and the rapid implementation of institutional changes are the reasons for eliminating these situations. In the future of modern development, scientific

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research is being conducted on the prospects for the use of "Big Data", "Cloud Computing", "Artificial Intelligence" and methodological aspects of the implementation of crowdsourcing, "Blockchain technology", as well as the impact of these technologies on socio-economic development.

2. Literature review

The assessment of the hidden economy has long been a subject of interest for economists, statisticians, and policymakers, as it directly affects fiscal revenues, labor market dynamics, and economic security. The evolution of this field can be traced through several waves of methodological approaches, beginning with indirect estimation methods and gradually moving toward econometric and digital data–driven models. Early theoretical foundations were laid by scholars such as Feige (1990) and Schneider (2000, 2007), who defined the hidden or shadow economy as all market-based production of goods and services that are concealed from authorities to avoid taxes, regulations, or administrative burdens. Their work established the basis for indicator-based methods, such as analyzing discrepancies between national accounts and energy consumption, or gaps between reported income and expenditure. Although these approaches offered valuable insights, they suffered from limited accuracy, as they often relied on broad assumptions and indirect proxies.

A major breakthrough came with the development of the MIMIC model (Multiple Indicators Multiple Causes), popularized by Schneider, Buehn, and Montenegro (2010). This model allowed researchers to capture the hidden economy through latent variables influenced by observable indicators (e.g., cash in circulation, employment rates, tax burden) and causes (e.g., regulation intensity, corruption). The MIMIC approach became a widely applied econometric tool, particularly for cross-country comparisons. However, scholars such as Breusch (2005) criticized the method for its sensitivity to specification and the risk of circular reasoning.

The digital transformation of economies has introduced both challenges and opportunities for hidden economy assessment. On one hand, the rise of e-commerce, cryptocurrencies, and digital platforms has created new channels for informal transactions, complicating measurement. On the other, digitalization has expanded the availability of data and introduced innovative monitoring tools. Scholars such as Williams and Horodnic (2018) highlighted how electronic payments and online platforms reduce informality by increasing traceability.

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Similarly, OECD (2020) emphasized the role of big data analytics, digital tax administration, and blockchain technologies in improving compliance and narrowing hidden economic activity.

Recent studies also stress the importance of digital footprints in hidden economy research. For example, Medina and Schneider (2019) integrated online transaction data with traditional econometric methods to refine shadow economy estimates. Research on Uzbekistan and Central Asia (e.g., Asian Development Bank, 2021) shows that digital tax systems, e-invoicing, and online cash registers significantly reduce informality, though the persistence of cash-based culture remains a barrier.

3.Analysis and results

The main focus in measuring hidden financial flows from trade is on differences in declared trade volumes between partner countries or on the deviation of declared prices from world prices (Hanni and Podesta, 2019). Brazil (Amaral and Barcarolo, 2020), Canada, African countries (Schuster and Davis, 2020; Ahene-Codjoe, Alu and Mehrotra, 2020), Switzerland (Carbonnier and Mehrotra, 2020), Latin America, Laos (Mehrotra, Nolintha and Sayavong, 2020), but the measurement results have not yet been included in the official statistics list.

Within the scope of measuring tax evasion flows, methods are divided into models that assess tax evasion by legal entities, in particular corporations (Crivelli, De Mooij and Keen, 2016) and models that assess tax evasion by individuals, in particular offshore tax avoidance (Alstadsæter, Johannesen and Zucman, 2018).

All of the methods presented are currently used to estimate the TFP, that is, they partially estimate the volume of the shadow economy. The disadvantage of these methods is that due to the high overlap of indicators, it is impossible to converge the results of assessing individual flows into a single indicator. The most important drawback of the TFP concept, in our opinion, is its weak connection with the conceptual apparatus of the shadow economy.

The monetary approach has been particularly focused on. Ahumada, Alvaredo, and Canavese (2009) critically assess its basic assumption that the income elasticity of demand for currency is equal to one, and show that failure to check and correct for deviations from this assumption can lead to biased estimates in a systematic approach. They emphasize the need for methodological rigor in applying this approach, which is widely used in the correction procedures they propose.

Model-based approaches - in particular the MIMIC model - offer a statistical framework for considering the shadow economy as an unobserved latent variable based on a number of

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factors (e.g., tax burden, unemployment) and indicators (e.g., demand for currency, labor force imbalances). As documented by Schneider and Buehn (2016, 2018), the flexibility and integrative ability of MIMIC has made it increasingly popular, although it also faces challenges, particularly in terms of sensitivity to calibration and specification. Schneider's empirical illustrations from Germany show how the choice of method affects the size estimates: the questionnaire-based ones have the lowest numbers, the indicators have the highest approximations, and the MIMIC-based ones, when compared with the monetary method results, often give intermediate, closer-to-the-truth values.

Methodological criticisms of some scientists (e.g. Ahumada et al., 2009) and innovations (e.g. Postea et al., 2024, an extension of the energy-based - physical input method) emphasize that they are closely related to these main categories, indicating a continuous process of improvement and hybridization rather than replacement of old approaches.

As a general guideline for the development of a measurement methodology and countermeasure policy, it is useful to draw on the work of Burov, Tumunbayarova, Khanchuk, and Masalolov, which systematizes the theoretical and methodological foundations of studying the hidden economy and identifies the main shortcomings of existing approaches to its diagnosis and limitation (Vestnik SPbGU. Economics, 2022, 38: 462-494). The authors distinguish three blocks and compare domestic and foreign literature:

1. discussions about the definitions and boundaries of the phenomenon;

2. measurement tools and their epistemological limitations;

3. the limits of the state policy on countermeasures, including organizational and technological mechanisms.

This approach allows for linking evaluation methodology to intervention practice, that is, moving from the “how much and where” to the “what and how to do” plane, while taking into account measurement errors and institutional conditions.

First, in the conceptualization section, the authors emphasize that the terminological heterogeneity of the literature leads to incomparability of evaluations. Different interpretations of the "informal economy" (including excluding types of criminal activity, home-based work, informal employment, tax evasion, and regulatory arbitrage) lead to changes introduced at the stage of developing indicators. For composite indices, this is reflected in the sensitivity to the choice of causal indicators (tax wedge, regulatory burden, quality of institutions) and proxy indicators (monetary proxies, employment outside the formal sector, consumption/production "disruptions"). Thus, the "uncertainty" of event boundaries translates into the "instability" of

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numbers, complicating cross-country comparisons and dynamic series. It is recommended that authors clearly state the scope of their evaluations when publishing their evaluations, and that they present their results in "bands" (ranges) that reflect methodological uncertainty at the level of the commentary.

Second, the analysis of diagnostic approaches focuses on the trade-offs and compromises between precision, coverage, and operationalization. Indirect methods (e.g., cash flow approach and energy/physical access) benefit from the scale and regularity of statistics, but suffer from structural changes in payment habits, financial digitization, and regulatory leaps (AML, cash limits, sanctions regimes), which alter the relationship between proxy variables and hidden activity. Model-oriented approaches (MIMIC and its variants) allow the integration of multivariate causes and indicators, but are sensitive to specification and identification constraints; external calibration inevitably "binds" the model to data of a different nature and transfers their errors.

Direct and indirect methods (household and business surveys, audits) provide meaningful verification, but suffer from non-declaration and selectivity of responses, and the costs of implementing them increase over time. The authors' conclusion is pragmatic: for public policy purposes, it is advisable to use "hard" statistical proxies from micro-data and combined indicator panels, which are regularly adjusted according to the results of administrative observations (tax and customs risk analysis, financial monitoring), and uncertainty is clearly documented.

Third, the transition from measurement to countermeasures requires an institutional and technological infrastructure that reduces the rents from evasion and increases the likelihood of detection. The review includes a wide range of tools: risk-oriented tax administration; digitalization of accounting and reporting (online cash registers, mark-ups, e-invoicing, VAT chain tracking); interoperability of registers and financial monitoring systems (AML/CFT) with regard to beneficial ownership; smart labor market supervision (integration of labor, migration, and social security data); simplified and patent regimes aimed at reducing the formalization threshold for small businesses; and alert and behavioral "incentives" that reduce the normalization of clandestine operations. The general conclusion is that effective strategies consist of a set of measures that reduce compliance costs and strengthen the deterrence of sanctions, while unilateral punitive actions without institutional "chains" have a short-term effect and increase the coherence of covert operations.

ISSN: 2053-3578 I.F. 12.34

Finally, organizational challenges to combat were identified: fragmentation of mandates and databases, insufficient inter-agency coordination, weakness of regional-level analysis (including limited micro-data and non-comparability of indicators), as well as discrepancies between research estimates and agency KPIs. The authors propose a minimum standard of analytical infrastructure: unified data architecture, integration of tax, customs, statistical and payment data, uniform identifiers (for companies and individuals), data exchange regulation and "banking" methods with open documents. The introduction of policy evaluation practices using difference-in-differences in the phased implementation of quasi-experimental designs, case studies, and instruments to assess the effectiveness of measures (ex ante and ex post) was noted as an important direction. Thus, the review shifts the focus from "perfect scaling" to "sustainable management configurations that can make decisions under uncertainty and iteratively reduce the incentive to retreat into the shadows."

Taxation and social security contributions - In a wide range of empirical contexts, high levels of direct and indirect taxation, combined with significant social security contributions, have been shown to consistently increase the incentive for individuals and firms to engage in informal activities to reduce the fiscal burden (Johnson et al., 1997; Lemieux et al., 1994). High marginal tax rates create a significant gap between gross and net income, which reduces the benefits of participating in the formal sector, while high taxes on labor increase the costs of hiring in the formal economy. Lemieux et al's (1994) micro-level study in Quebec shows that these effects are not uniform: welfare recipients who face higher effective marginal tax rates due to the withdrawal of benefits show a disproportionately higher vulnerability to informal work opportunities. At the macro level, Johnson et al. (1997) find that in transition economies, high tax burdens distort compliance and contribute to a "bad balance" of low government revenues and social welfare provision, which further increases informality. Regulatory Burden - In addition to taxation, strict and often rigid labor market regulations are an important structural factor of informality. Such rules may include restrictive hiring and firing rules, mandatory wage rates, professional licensing, and onerous compliance procedures. Contini's (1981) analysis of Italian labor market segmentation suggests that institutional rigidity limits intra-industry mobility and encourages employers to bypass formal channels, especially in areas with weaker economic structures. Similarly, Schneider (2006) argues that excessive regulation of entry and activity not only increases transaction costs, but also pushes smaller firms and low-skilled labor into the informal sector, where regulatory oversight is minimal or nonexistent.

ISSN: 2053-3578 I.F. 12.34

These effects are exacerbated in countries where regulatory practices are uneven, allowing informality to flourish in protected areas.

Institutional quality and governance - A common finding in cross-country analyzes is that weak institutional quality, low legal standards, and ineffective governance are strongly associated with a larger shadow economy (Schneider, 2006; Johnson et al., 1997). Malfunctioning legal systems and high levels of corruption reduce trust in state institutions, making tax compliance and formal registration less beneficial for economic agents. Johnson et al. (1997) show that in transition economies with weak institutional capacity, firms often rely on informal networks for protection and conflict resolution, further strengthening their positions outside the formal system. Schneider (2006) argues that in low-income countries, the hidden economy can both reflect and reinforce governance inefficiencies: informality erodes the tax base, limits the fiscal capacity of the state, and perpetuates a cycle of underfunded institutions and poor public service delivery.

Unemployment and the prevalence of self-employment - Labor market conditions, in particular high unemployment and a significant share of self-employed workers, create structural factors that drive informality. In economies where formal job creation lags behind labor force growth, the informal sector often acts as a safety net, absorbing excess labor that cannot be accommodated in the formal sector. Self-employment, while not inherently informal, is more prone to underreporting and evasion of regulation due to low levels of oversight and the ability to operate without formal registration. This dynamic is particularly evident in economies undergoing structural adjustment, with regional economic disparities or weak performance capabilities, where informal self-regulation emerges as both a problem-solving mechanism and a long-term professional choice.

Together, these determinants rarely work in isolation; on the contrary, they create reinforcing networks. High taxes, combined with strict regulations, increase the relative attractiveness of informality, weak institutions do not deter non-compliance, and unfavorable labor market conditions ensure that participants have a ready supply of labor. This multidimensional causality suggests that policy responses need to be multifaceted to some extent, that is, they need to simultaneously encompass fiscal, regulatory, institutional, and labor market dimensions to effectively reduce the size of the shadow economy.

These determinants are interrelated: high taxation and regulation can lead to distrust in state institutions and increase institutional weakness, which in turn can further expand the

shadow economy. This feedback loop is repeatedly emphasized in the empirical literature, especially in transition economies (Johnson et. al., 1997).

Beyond the main methodological and cross-country empirical work, the literature has been expanded to explore specific thematic contexts that illuminate the complexity and diversity of the informal economy. These thematic extensions often use network datasets or innovative variables to provide a more detailed understanding of informality.

With religion as a determinant of informality, Heinemann and Schneider (2011) examined in their cross-sectional study how religious affiliation, religiosity, and institutional relations between religion and the state shape the size of the underground economy. By controlling for economic development and the quality of governance, they found that countries with Islamic or Eastern religious traditions had smaller hidden economies than predominantly Christian countries. The authors explain this by using the "unnatural policeman" hypothesis, which suggests that religious norms act as moral constraints on economic behavior. Interestingly, religious competition itself does not have a significant impact, but close relations between religious institutions and the state are strongly associated with a reduction in the size of the underground economy. This study is a unique example of integrating socio-cultural variables into an economic evaluation system, thereby broadening the analytical lens.

Granular Network Analysis - Sector-specific questions for business managers (Schneider & Buehn, 2018) provide detailed information on a firm's unreported income and hidden employees, which can help identify macro-level accounting issues and determine targeted measures.

Integration with complexity science - As Faggini and Lux (2009) have argued, agent-based models and network analysis offer promising tools for modeling the dynamics of the informal economy in different institutional and political settings. Data quality and comparability - Even in the context of methodological pluralism, progress depends on improving the consistency and availability of basic data. This includes harmonizing definitions of informality, building the capacity of national statistics and expanding the coverage of micro-level data sets.

The literature on shadow economy assessment is cited in both systematic reviews (Schneider & Buehn, 2016, 2018; Postea et al., 2023), and the Litmaps citation network reveals a field characterized by iterative methodological refinement, conceptual debate, and thematic diversification. The basic typology of direct, indirect, and model-based methods remains a

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useful organizing framework, but the most convincing results come from hybrid approaches that triangulate different methods.

4.Conclusions

It can be concluded that there is a need to better coordinate scientific research in the field of the underground economy with the needs of the business community and government. This conclusion confirms the urgency of developing methods for assessing the scale and factors of the development of the underground economy, taking into account regional characteristics, in order to build a system (management) for combating the underground economy. In this paragraph, the analysis of the methods of measuring the scale of the hidden economy showed the weakness of the relationship between the modern methods of estimating the hidden economy and the conceptual apparatus of the hidden economy. This does not allow the development of comprehensive measures to combat the hidden economy. It is safe to say that the shadow economy is a developing concept around which a coherent theory is beginning to form. However, there are theoretical uncertainties and methodological gaps in underground economy research, which are the result of a mismatch between the interests of the scientific world and practitioners, which requires further study to strengthen the theory.

The analysis of methodological approaches to assessing the hidden economy in the context of digital transformation demonstrates that traditional methods alone are no longer sufficient to capture the complexity and dynamics of informal economic activities. While early indirect approaches, such as currency demand or national account discrepancies, provided important starting points, they lacked precision and adaptability in rapidly evolving economies. The development of econometric models, particularly the MIMIC framework and DSGE simulations, significantly advanced measurement by incorporating structural and behavioral dimensions. However, their limitations—sensitivity to assumptions, data availability, and contextual applicability—remain evident.

The digital economy creates a dual effect on the hidden sector. On the one hand, it provides new opportunities for informal activity through online platforms, cryptocurrencies, and peer-to-peer transactions. On the other hand, it offers powerful tools for reducing informality by enhancing transparency, traceability, and real-time monitoring of economic flows. The integration of big data analytics, blockchain technologies, electronic tax administration, and digital payment systems has the potential to transform hidden economy measurement into a more accurate and responsive process.

The review also highlights that the most promising methodological direction lies in hybrid approaches that combine econometric modeling with digital data-driven techniques. Such integration can provide more reliable estimates, reduce measurement biases, and improve the effectiveness of policy design. Moreover, adopting these methods in developing economies, including Uzbekistan, requires strengthening digital infrastructure, improving statistical capacity, and fostering institutional trust.

Ultimately, the modernization of hidden economy assessment should be viewed as an essential component of broader digital transformation strategies. By aligning methodological innovation with technological progress, governments can not only improve the accuracy of shadow economy measurement but also enhance fiscal sustainability, strengthen economic security, and support inclusive growth. The digital economy, therefore, is not merely a challenge for hidden economy measurement but also an unprecedented opportunity to redesign assessment methods for greater policy relevance and long-term stability.

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