

Shadow Economy and Bibliometric Analysis: What Is the Trend in Current Times ?

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Abstract

Through VOSviewer bibliometric analysis, the changing academic focus on the link between technological progress and shadow economy is examined. The study highlights the broad research areas, emerging themes, and gaps in this interdisciplinary topic by mapping keyword co-occurrence networks. Digitalization, corruption and tax evasion have recently received a lot of attention, but the results show that digitalization and technology have always had an impact on informal economic activity. The report also shows that people are becoming concerned about how shadow economy affects the environment, particularly in terms of carbon emissions and sustainable development. However, there are substantial knowledge gaps due to weak links between shadow economy, public policy and productivity. Policy interventions and the wider economic consequences of informal activity could be the subject of future research. In an increasingly digitized and interconnected world, the importance of taking a comprehensive approach to understanding the shadow economy is highlighted.

Key words: shadow economy, technology, digital, innovation

J.E.L. classification: O17, E26

1. Introduction

Nowadays, the scientific community and ordinary citizens alike show a growing interest in shadow economy. The phenomenon is perceived as a combination of uncontrolled economic activities that take place in parallel and in the shadow of the legal economy. This includes a wide range of informal, undeclared and criminal economic activities which, although operating outside official control, contribute to employment, consumption and production. However, this sector limits tax collection, falsifies official data and can hinder progress in governance and the economy (Munteanu et al., 2024, p. 4). The relationship between technology and the underground economy has grown with the development of the technological and digital side. Not only do technologies such as digital payment systems and blockchain provide means to combat shadow economic activity, but they also provide new opportunities for informal transactions.

Using bibliometric analysis, the paper analyzes the intensity of this interest in recent years. The program used is VOSviewer. This is a software program that helps to visualize and explain the structure of research fields by mapping co-authorship networks, keywords and citation patterns (Aivaz & Petre, 2024, p. 6). The study uses keywords such as "shadow economy" and "technology", to assess the degree of engagement of the academic community in this topic. It also identifies specific subfields or elements that receive the most attention from researchers.

Trends in research on the relationship between technological innovation and shadow economy will be presented in this study, comparing areas that have received significant attention with those that remain underexplored. The general hypothesis proposed is that scientific interest, in how technology connects with the underground economy, increases with the growth of the digital

economy and rapid advances in technology. The objective of the analysis is to identify the level of interest among the scientific community, to identify thematic areas of focus and to determine whether this topic has become a "heated discourse" in contemporary research.

2. Literature review

The underground economy, comprising economic activities that evade official regulations, has strong ramifications on national economies. The phenomenon is influenced by various factors, especially economic ones, such as taxes and the unemployment rate, but also political ones, such as the quality of governance, or social ones, such as culture and even personal happiness (Clement et al., 2023, p. 829; Davidescu et al., 2022, p. 685). The problem of informality is also complicated by the fact that these effects differ from one region to another (Davidescu et al., 2022, p. 686). As e-government activities can increase transparency and decrease informality, technological advances have significant repercussions on the shadow economy. However, the question arises whether the benefits brought by technological innovations, in the fight against shadow economy, are really significant, or the shadow economy has just gained a new branch in which to operate. Chacaltana et al. (2024, p. 21) and Kireenko et al. (2018, p.2) found that while technology promotes transparency, it can also facilitate informality through freelance work, resulting in digital economies that are both formal and informal.

As more and more people shop online, a new underground economy has formed where customers put convenience ahead of compliance. According to Gaspareniene et al. (2016), legislators face new obstacles in the form of an unregulated digital industry. To address these informal practices, they need to create legal frameworks, educate consumers and enforce legislation (Gaspareniene et al., 2016, p. 503). In areas such as West Africa, where the development of ICT (Information and Communication Technology) in line with the SDGs (Sustainable Development Goals) has revolutionized the informal sector, shadow economy has also been deeply affected by ICT (Ajide & Dada, 2022, p. 10).

By providing information on topic groups and publication patterns, bibliometric analysis has become an invaluable tool for tracking research trends in shadow economy studies. Analyzing through the VOSviewer program, Zolkover and Terziev (2020) were able to uncover recurring themes in the underground economy literature, including tax evasion, corruption and urban informality (Zolkover & Terziev, 2020, p. 109). In their proposal for a bibliometric research framework, Öztürk et al. (2024) extend this approach by emphasizing the importance of structured bibliometric methodologies in effectively capturing complex research landscapes and improving methodological rigor (Öztürk et al., 2024, p. 3341). Starting from these techniques, several authors offer various solutions by performing bibliometric analyses, defining the fundamental procedures and tactics needed to investigate complex aspects such as the shadow economy and its interaction with other aspects of the economy (Passas, 2024, p. 1018; Matei & Aivaz, 2023, p. 986; Florea, Aivaz & Vancea, 2023, p. 72; Aivaz, Florea & Munteanu, 2024, p. 7).

Shadow economy has recently attracted more attention from academia around the world. The top three publishing nations in this area are India, the US and the UK. The transition from informal to formal economies and the impact of digital innovations on this transition are becoming increasingly important themes in published works (Timofte & Coca, 2020, p. 35). In addition, Nica et al. (2024) conduct a bibliometric analysis of shadow banking and financial contagion, showing that discussions of the underground economy often focus on systemic risk and regulatory challenges. This is especially true in research conducted after the 2008 financial crisis (Nica et al., 2024, p. 12).

Taking all these aspects into account, the literature shows that the shadow economy is multifaceted and complicated, with influences from the economy, society and technology. This dynamic, the grouping of research themes and the tracking of changes in academic orientation over time, benefited from important help from bibliometric analysis. This analysis highlights how technology influences informality and how bibliometric research provides a framework for understanding the underground economy in the context of a dynamic economic and technical environment.

3. Research methodology

This study analyzes the relationship between technological improvements and shadow economy using the VOSviewer program. Co-citation networks, topic clusters, and keyword co-occurrence patterns are all examined in this article. Because bibliometric analysis is a quantitative tool to find patterns in a large number of published scientific works, it is increasingly used to study transdisciplinary topics (Passas, 2024, p. 1018; According to Öztürk et al., 2024 , p. 3341). Relevant literature was collected using the E-nformation platform. The database accessed is Scopus, to ensure relevance to current technological and economic contexts. The selected period was from 1981 to 2023 inclusive. Eligible articles were further screened to ensure they were consistent with the study objective. The collection was narrowed using keywords such as "economy", "shadow" and "technology".

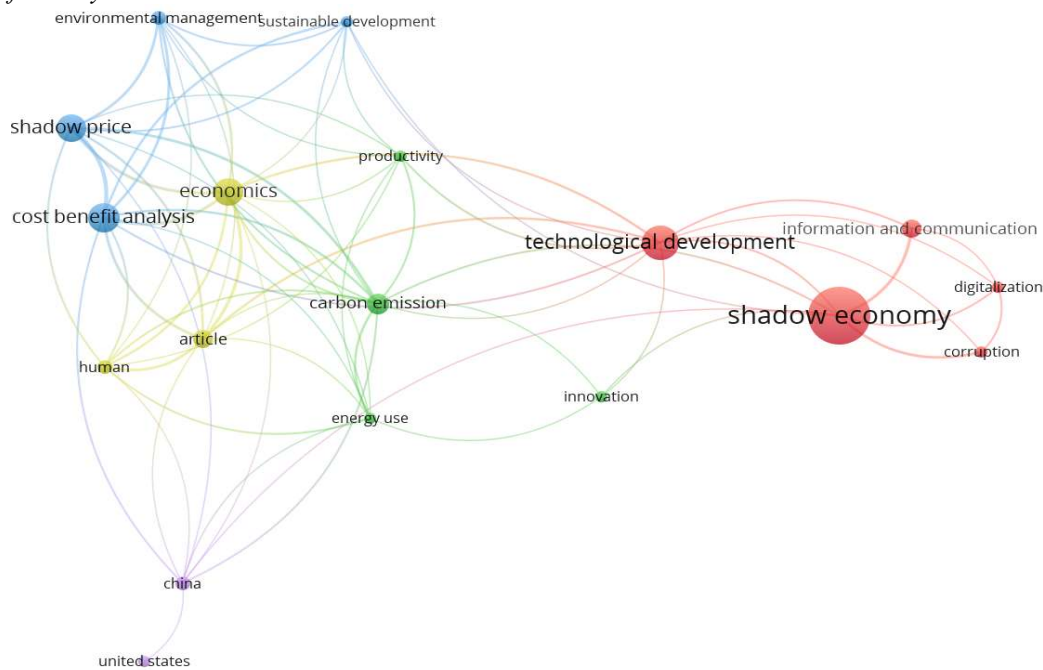
Using descriptive and network-based bibliometric methodologies, this study showed clusters of recurring themes and provided a quantitative analysis of research productivity. Academia is increasingly interested in how technology intersects with shadow economy, as shown by Clement et al. (2023, p. 829), Chacaltana et al. (2024, p. 21), Gaspareniene et al. (2016), Ajide & Dada (2022, p. 10) and others. This is particularly true in terms of how digital tools influence informal economies and the regulatory issues that arise in different global contexts. By integrating performance analysis and scientific mapping, this study looks at the development of the field and areas of interest. By identifying the lack of research and orientation studies, it lays the groundwork for future research on the complex interactions between technological innovation and informality (Nica et al., 2024, p. 12).

4. Findings

Through the E-nformation platform, the Scopus database was accessed. A first search of the keywords "economy" and "shadow", resulted in a number of 3,418 scientific papers. This was anticipated, with shadow economy already being a niche topic. Next, the keyword "technology" was added, thus resulting in a number of 245 scientific papers. This number was further filtered by limiting the period to 2023 as the final year and selecting only scientific articles already published that are in English. The final number was 139 scientific papers available for analysis. By comparison, the combination of the keywords "economy", " shadow" and "digital", after filtering, resulted in a number of 46 available scientific papers, a number too small to be relevant for the proposed analysis. Also adding more than three keywords reduces the number of scientific papers available for this topic too much. The minimum number of occurrences for a keyword was set to 5. The resulting keywords were processed to avoid their duplication, resulting in a total of 18 relevant keywords.

In the graph generated with VOSviewer (Fig. 1), a network of keywords can be observed that reflects the links between "shadow economy" and "technological development". Terms like "digitalization," "corruption," and "carbon emission" have connections to the theme of the underground economy, suggesting an interdependence between technological progress and factors influencing the informal sector. The grouping of words such as "cost-benefit analysis" and "sustainable development" highlights aspects related to the assessment and impact on the shadow economy and sustainable development. The keywords were organized into 5 clusters, in which one cluster contains only the terms "china" and "united states".

Figure no. 1 Bibliometric analysis, keywords "economy", "shadow", "technology", minimum 5 occurrences for a keyword



Source: Own processing based on the database on E-nformation and VOSviewer

As can be seen in Fig.1 and Tab.1, the map has 5 clusters, in which the relevant keywords resulting from the analysis are grouped. For a clearer visualization of the composition of the clusters, they were presented in a tabular form (Tab.1.).

Table no. 1 Summary of the co-occurrence network of VOSviewer terms - keywords "economy", "shadow", "technology", minimum 5 occurrences for a keyword

Cluster 1	1.corruption 4.shadow economy	2.digitalization 5.technological development	3.information and communication technology
Cluster 2	1.carbon emission 4.productivity	2.energy use	3. inovation
Cluster 3	1.cost benefit analysis 4.sustainable development	2.enviromental management	3.shadow price
Cluster 4	1.article	2.economics	3.human
Cluster 5	1.china	2.united states	

Source: Own processing based on the database on E-nformation and VOSviewer

The first network view in VOSviewer (Fig. 1.) presents a bibliometric map of the shadow economy and the relationships between economic, environmental and technological ideas. This chart provides insight into the current state of research on the intersection of the shadow economy and technological progress. It also helped reveal burning matters, emerging themes, and uncharted territories.

Central research ideas and current topics are represented by the relationship between the notions of "shadow economy" and "technological development". These are obvious pressing concerns in the current research, as they emerged as major nodes. There is great curiosity about the effects of new technologies on the informal or uncontrolled economy. Experts are concerned, above all, with how innovation and digitalization are changing the underground economy. In other words, which way was the balance leaning, rather towards preventing and combating the shadow economy or rather towards facilitating access to new sectors. As digital tools become more pervasive in everyday life globally, the consequences of technology on the underground economy have broad political implications, making this a heated discourse.

"Carbon emissions" and "energy consumption" appear to be related to "technological development" and the "shadow economy", indicating a growing multidisciplinary interest in the effects of the shadow economy on environmental indicators. The environmental costs of unregulated operations, which frequently circumvent sustainable norms and regulatory frameworks, are becoming increasingly visible, as this link shows. Although research into the environmental effects of the underground economy is ongoing, the focus so far has been on technical rather than environmental aspects.

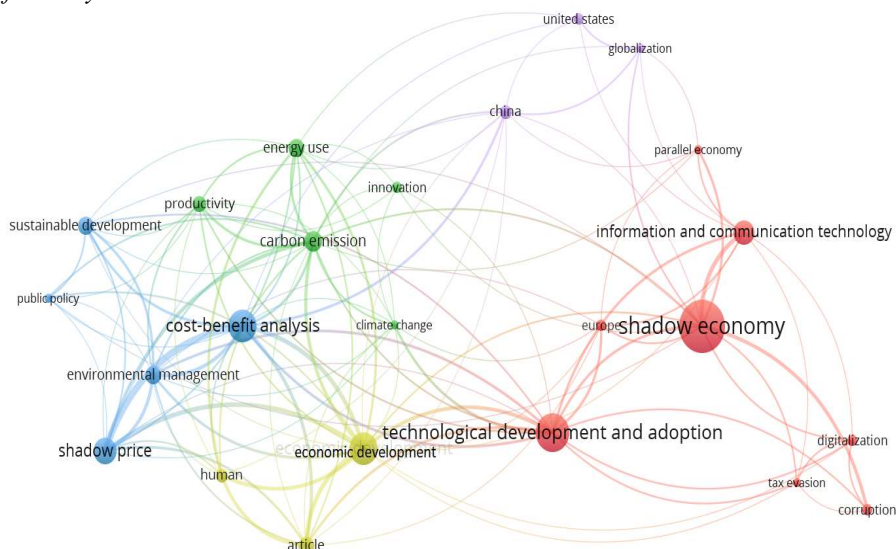
Among the group of new ideas and disconnected topics are the grouping of "carbon emissions" and "energy consumption" with "sustainable development", "environmental management" and "productivity". They demonstrate the emergence of a new field of study that combines aspects of sustainable development with the shadow economy. Thus, research no longer focuses on direct costs, but on indirect ones, such as the effects on resource management and the environment caused by underground economic activity. Although sustainability is becoming increasingly important, it is still in its early stages and has not reached the same level of attention as technology-related themes, as shown by its somewhat weaker relationship with major nodes.

Finding missing pieces of information and unexplored relationships is a necessary thing in scientific research. There is a wealth of information about technical progress, but it seems that certain important areas are still unexplored. For example, "public policy" and "cost-benefit analysis" are mentioned but not specifically related to the main ideas. There appears to be a lack of studies on specific policy interventions and cost-benefit assessments of shadow economy management, even though the relationship between the phenomenon and technology has been extensively studied. Research is needed on the advantages and disadvantages of technological solutions for the shadow economy, as well as studies quantifying the economic benefits and costs of these interventions.

The visualization also draws attention to a possible knowledge gap regarding the relationship between the "shadow economy" and more systemic economic effects such as productivity. Although productivity is addressed, it appears to be peripheral to the main points, suggesting that research on the effect of the underground economy on macroeconomic productivity may be lacking. Particularly with regard to informal employment and undeclared economic activity, future studies could examine the effects of shadow economy on overall economic growth, efficiency and productivity.

Although the relationship between the shadow economy and technological growth is a popular research topic, the bibliometric analysis of this view indicates that there is a chance to extend the examination to other important areas. To better inform policy decisions, further studies can examine the effectiveness of digital tools in reducing shadow economy activity and provide evidence-based cost-benefit assessments. The literature would also benefit from a deepening of the negative effects of the shadow economy on the environment, such as the carbon footprint and energy inefficiency.

Figure no. 2 Bibliometric analysis, keywords "economy", "shadow", "technology", minimum 4 occurrences for a keyword



Source: Own processing based on the database on E-nformation and VOSviewer

As can be seen in Fig.2 and Tab.2, the map also has 5 clusters , in which the relevant keywords resulting from the analysis are grouped. In contrast to the first analysis (Fig. 1 and Tab. 1.), the second analysis outlined the composition of the clusters in a welcome complementary manner. For a clear visualization of the composition of the clusters, they were also presented in a tabular form (Tab.2.).

Table no. 2 Summary of the co-occurrence network of VOSviewer terms - keywords "economy", " shadow", "technology", minimum 4 occurrences for a keyword

Cluster 1	1.corruption 4.information and communication technology 7.tax evasion	2.digitalization 5.parallel economy 8.technological development	3.europe 6. shadow economy
Cluster 2	1.carbon emission 4.innovation	2.climate change 5.productivity	3. energy use
Cluster 3	1.cost benefit analysis 4.shadow price	2.enviromental management 5.sustainable development	3.public policy
Cluster 4	1.article	2.economic development	3.human
Cluster 5	1.china	2.globalization	3.united states

Source: Own processing based on the database on E-nformation and VOSviewer

However, the analysis shows a superficial picture of the scientifically investigated facets of the shadow economy. Because of this, together with the smaller number of scientific papers available for this topic, the minimum number of occurrences for a keyword was reduced to 4. The resulting keywords were processed to avoid their duplication, and thus remained a number of 24 relevant keywords. Through this modification, the analysis can explore more deeply the researched dimensions of the shadow economy.

The Figure 2 provides a detailed and interconnected look at how shadow economy relates to a range of economic, environmental and technical ideas. Central research ideas and current topics are represented by significant nodes such as "shadow economy", "technology development and adoption" and "information and communication technology". This focus indicates a strong interest in examining the effects of digital change on shadow economy, particularly through ICT. Researchers focus on which side the balance is tipped by the technology: its ability to enable unregulated economic activities (such as digital transactions that evade regulatory inspection) and its potential to detect and mitigate these activities. The subject's importance to the future of economic policy and global governance in a highly technological society makes it an obvious a burning matter (Herciu et al., 2023, p. 307).

Avant-garde regional and environmental perspectives are brought into play by 'Europe' being a node adjacent to the "shadow economy". Thus a regional component is added, showing that studies on the shadow economy in European contexts are becoming more popular. This indicates an opportunity for researchers to delve into the specific legislative and regulatory issues facing Europe, particularly given its highly integrated economy. "United States," "China," and "globalization" form a cluster that adds a significant global dimension to the study. This suggests that the underground economy is increasingly being studied in relation to other large economies and the interconnectedness of the world. Thus, people are beginning to realize that the underground economy is affected by international economic dynamics, supply chains and trade and is not limited to a single country.

The grouping of terms indicating an increase in environmental concerns includes "cost-benefit analysis", "environmental management", "sustainable development" and "carbon emissions". This interdisciplinary approach reveals a growing need to understand the indirect effects of shadow economy on the environment, such as the potential for unsustainable practices, resource mismanagement and increased carbon emissions resulting from uncontrolled economic activity. The focus on sustainability suggests a possible avenue for further research. Researchers are beginning to notice the hidden ecological consequences of shadow economy, even if it is still a secondary concern compared to technology.

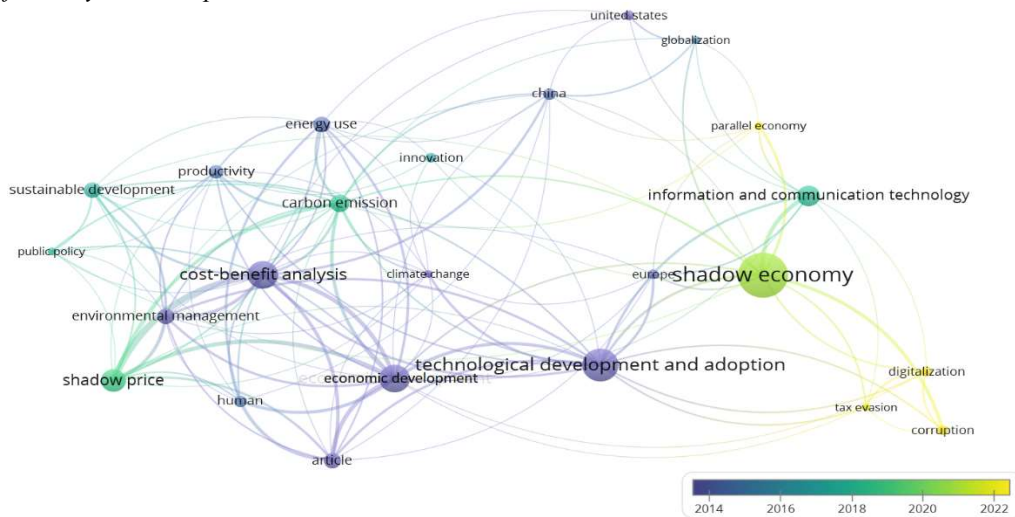
However, some research gaps remain despite the increasingly close links between technology, regional focus and environmental effect. An example is the weak relationship between "public policy" and central nodes, especially the " shadow economy". This discrepancy indicates that while

there has been extensive research on the effects of technology on the shadow economy, there has been less research on the effects of specific policy interventions. Researchers should take advantage of this gap in the literature to examine the effectiveness of regulatory measures, particularly in the European context, and the ways in which governments could use technology to limit informal economic activities.

The link between productivity and shadow economy is another uncharted territory. There appears to be a dearth of research on the effects of informal economic activity on macroeconomic productivity because the network does not include "productivity" as a central node. Particularly as digitization continues to reshape economic structures, future research could investigate this link by examining the possible effects of the shadow economy on productivity.

This view brings together technology, regional politics, and environmental issues, underscoring the multidisciplinary nature of shadow economy studies. To help policymakers strike a balance between economic growth, sustainability and regulatory oversight in a rapidly digitizing world, more research in these areas is needed. This would lead to a better understanding of the role of the underground economy in modern economies.

Figure no. 3 Bibliometric analysis, keywords "economy", "shadow", "technology", minimum 4 occurrences for a keyword, temporal characteristic



Source: Own processing based on the database on E-nformation and VOSviewer

While the "shadow economy", "technology development and adoption" and "information and communication technology" continue to play a significant role, new studies have turned their attention to "digitalisation", "corruption" and "tax evasion". As a result, the topic is becoming increasingly popular and has important consequences for the governance of the digital age, as people ask how digitization impacts informal economic activity and regulatory difficulties.

"United States", "China" and "globalization" in a more subdued tone suggest that research focused on the world or cross-national comparisons has been going on for some time. One possible explanation for the recent growth in research related to "Europe" is the growing interest in studying how the policies of different regions have reacted, especially in the context of European Union regulations. Another explanation may be the much easier access to relevant and long-term statistical data for Europe compared to other areas of the world.

Interest in the environmental costs of the shadow economy has increased, with a new emphasis on sustainability. The clustering around "sustainable development", "environmental management" and "carbon emissions" illustrates this trend. However, there is still a lack of strong links between "public policy" and policy intervention research, even if these topics are relevant. Research on the effects of the underground economy on "productivity" could be fruitful in the future, as this variable appears to have received little attention to date.

There are large knowledge gaps regarding the effectiveness and productivity of public policies, as this historical review shows a trend towards digitization, environmental effects and regional studies. Addressing these gaps could lead to a more complete picture of the function of the underground economy and, in a world where everything is digital, to better targeted and long-term policy responses.

5. Conclusions

The study uses bibliometric analysis, presented through three VOSviewer graphics, to provide a complete picture of the current research landscape on the shadow economy and how it intersects with technology. This discipline of shadow economy studies is dynamic and interdisciplinary. The visualizations show not only the core topics, but also new areas of interest and research needs. The preponderance of technology-related phrases, such as "digitalization," "technology development and adoption," and "information and communication technology," stand out in the three images. The continuing interest in understanding how digital changes are altering informal economic activity is demonstrated by the continued use of these concepts. Digital payment systems, blockchain and information and communication technology (ICT) have all had an effect on unregulated transactions. The change highlights the complex role of technology as a tool for facilitating but also monitoring informal economic activities.

The final image incorporates a chronological overlay, providing a more in-depth look at the data. It shows how "corruption" and "tax evasion" have come under increasing scrutiny in relation to digitalisation. This demonstrates the increased attention paid to the difficulties of digital facilitation of informal economic activities in terms of governance. The field of study involves researchers trying to make sense of the double-edged sword that is technology. On the one hand, it provides new tools for monitoring compliance with regulations, on the other hand, it opens the door to more complex ways of circumventing them. It is to the benefit of decision makers to consider these findings.

Terms such as "carbon emissions", "sustainable development" and "environmental management" highlight another important aspect, namely the effect of the shadow economy on the environment. The increased visibility of expressions over time shows a growing awareness of the environmental implications of informal economic activities. Even if they are still secondary among the technology-focused nodes. A number of environmental problems, including pollution and resource misuse, are exacerbated by the underground economy, as it frequently avoids environmental restrictions. Understanding the effects of economic informality on the environment can help policy makers strike a better balance between economic and environmental objectives, so this is an issue that needs more investigation.

The use of time also reveals regional differences in shadow economy studies. The recent addition of "Europe" indicates a growing curiosity about how other areas, particularly the European Union, are dealing with regulatory hurdles related to the underground economy. Nodes for "United States," "China," and "globalization" show that comparing other countries is still important, but that people are starting to focus more on the effectiveness of regional policies. As a result of this development, a more in-depth analysis of European policy frameworks is possible, which is likely a reflection of the region's distinct regulatory climate and data availability. In order to better understand best practices and policy effectiveness, comparative studies on how different areas and countries deal with shadow economy issues could be very useful.

Even with all these improvements, there are still some gaps. The term "public policy" is still only loosely related to general themes, indicating a neglected part of the shadow economy literature. More research is needed on the effectiveness, cost-effectiveness and technological adaptability of certain policy initiatives. Furthermore, the low emphasis on "productivity" implies that the monetary effects of the shadow economy, particularly on efficiency and productivity, have not been studied in detail. To better understand the effect of the underground economy on long-term GDP growth, it might be useful to analyze the relationship between informal activities and macroeconomic productivity.

These images show how shadow economy is complex and interconnected with many other factors, including politics, the environment, technology and productivity. A comprehensive research strategy that considers these relationships holistically is needed, as the illustrated development shows. In an increasingly digitized and interconnected world, it will be imperative to close the gaps

in our understanding of the underground economy. This includes policy impact assessments, productivity impacts and environmental effects. To strike a balance between economic innovation, regulatory oversight and sustainable development, policymakers will benefit from this deeper understanding when designing tailored actions.

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