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Illegal Trade in Tobacco Products Indicator

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***Abstract*— The illicit trade in tobacco products poses a significant challenge to global health by undermining tobacco control efforts, reducing government revenues, and increasing the accessibility of unregulated tobacco products. To address this issue effectively, we introduce the Illicit Trade in Tobacco Products Indicator (ITTPI), a comprehensive tool designed to visualize and track illicit tobacco trade patterns worldwide. The ITTPI integrates data on counterfeit cigarettes, contraband activities, and risk factors associated with these illegal practices. By leveraging an interactive mapping system, this indicator facilitates real-time monitoring of high-risk regions and channels involved in illicit trade. Our study demonstrates how ITTPI can be applied across diverse contexts to identify hotspots of illicit activity and predict future trends based on historical data analysis. This approach not only aids law enforcement agencies but also informs policymakers about targeted interventions needed to strengthen regulatory frameworks against tobacco smuggling. By enhancing transparency and coordination among international stakeholders, the ITTPI offers a promising solution for combating the global problem of illicit tobacco trade while supporting broader public health objectives aimed at reducing smoking prevalence worldwide.**

***Keywords*— drug industry, economic and social effects, smuggling, tobacco smuggling.**

I. INTRODUCTION

The illicit trade of tobacco products represents a multifaceted challenge, impacting public health, government revenues, and overall economic stability. Counterfeit cigarettes, contraband, and other forms of illegal tobacco not only undermine legitimate businesses and taxation efforts but also present significant health risks due to a lack of regulatory oversight and quality control. According to Bulgarian legislation /where the research team is from/, the smuggling of cigarettes constitutes a crime related to the illegal transportation of tobacco products across the state border of the Republic of Bulgaria without the knowledge and permission of customs authorities, as well as outside the designated places or in a manner that evades customs control. However, this clarification regarding cigarette smuggling is applicable to all countries. Accurately measuring and understanding the drivers and consequences of this illicit trade is paramount for developing effective policies and interventions.

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However, the clandestine nature of this market makes direct observation difficult, necessitating innovative and robust methodologies for assessment.

To address this critical need, the Department "National and Regional Security" at the University of National and World Economy (UNWE) has developed a novel and comprehensive approach: the Illicit Trade of Tobacco Products Indicator (ITTPI). This indicator stands as a unique method for measuring the propensity for illicit trade in tobacco products, leveraging the power of Structural Equation Modelling (SEM) through the statistical software R [1]. Unlike traditional metrics that often rely on limited data or anecdotal evidence, the ITTPI employs a sophisticated statistical technique to provide a more holistic and data-driven assessment of the factors driving and the impacts stemming from the illicit tobacco trade.

This methodology offers several key advantages:

1. Identifying Driving Factors: The ITTPI goes beyond simply measuring the scale of the illicit trade; it reveals the primary factors that fuel its growth, providing insights into the relative influence of these drivers.

2. Assessing Socio-Economic Impacts: By modelling the relationship between illicit trade and key social and economic indicators—such as the number of smokers, crime rates, and government tax revenues—the ITTPI quantifies the consequences of illegal tobacco activity.

3. Connecting to Other Crimes: The ITTPI helps illustrate the links between illicit tobacco trade and other forms of organized crime, highlighting the broader criminal ecosystem that sustains it.

4. Generating Forecasts: The ITTPI can produce forecasts for two to three years into the future, provided that publicly available forecasting information exists for certain indicators.

By presenting these findings, the ITTPI offers policymakers and researchers a powerful tool to inform evidence-based decision-making and strategic planning in the fight against the illicit trade of tobacco products. This indicator promises to be a valuable resource for those working to protect public health, safeguard government revenues, and ensure fair market competition in the global tobacco market.

II. MATERIALS AND METHODS

Through MIMIC (multiple indicators, multiple causes) model, statistical relationships between latent (unobserved variables) and observables are estimated.

MIMIC attempts to answer two types of questions:

1. Measuring variables that are unobservable or unmeasurable?

2. Causal assessment based on a theoretical hypothesis?

MIMIC consists of two parts:

1. The measurement part shows how the latent variables are evaluated through the so-called indicators

2. the second model estimates the random relationship between the latent and observed causes.

To compute this model, we can identify four steps:

1. The formulation of theoretical model: a priori we can identify the causal link among the variables and also to formulate the model.

2. The estimation of parameters: we can estimate the covariance matrix, then the coefficient of the measurement and structural model as the value that minimize the difference between the matrix from raw data and who's been estimated from the model.

3. The verification of the model: we can confute the model if the difference mentioned above is too high.

4. The modification: on the basis of previous results, we can eventually modify the model to fit better the data.

The study on smuggling and counterfeiting (C&C) of tobacco products is an extremely difficult task because of the hidden nature of activities and processes. The data gathered and the research conducted within the project show that there are very few sources that directly provide data on C&C.

The study should therefore be oriented towards the use of methods that can indirectly describe these processes. An unmistakable example of such a method is the modelling of multiple indicators, multiple causes (MIMIC), but this is typing a structural equation (SEM). Modern development in this scientific field creates a solid foundation for the study of hidden, unobserved or so-called. "Latent" processes.

These equations use hypotheses such as:

a) The reduction of corrupt practices significantly reduces the opportunities for illegal practices in the production of cigarettes;

b) The manifestations of a grey economy contribute to C&C (Counterfeit and Contraband);The manifestations of a grey economy contribute to C&C (Counterfeit and Contraband);

c) The legislation and its successful implementation (Rule of low) have a direct impact on C&C.

The model consists of monitored and unobserved variables and specific case relationships between unobservant variables.

The model actually checks these hypotheses. The aim is to confirm or reject them.

After the N-versions of the hypotheses are played out, if they are confirmed (the data are statistically significant) coefficients are calculated for the indicators (right side of the model) and for the reasons (left side of the model) that give the relationship and the strength of the impact on Latent variables.

Two MIMIC models have been developed. The first one (Fig. 1) achieves results for the intensity of counterfeiting of tobacco displaced by the countries of the

world, and in the second the smuggling is measured for the level NUTS3 (in Bulgaria these are the areas) (Fig. 2)

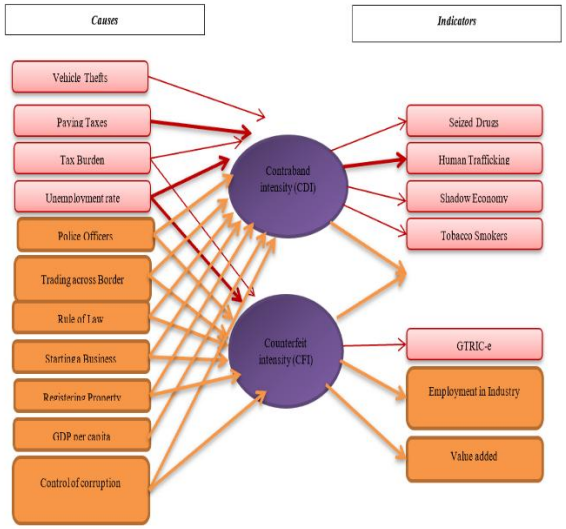

Fig. 1. MIMIC model with two latent variables with data about 186 countries all over the world.

III. RESULTS AND DISCUSSION

The main goal of the model is to describe and analyse the influence of the economic and social factors over C&C, as well as to estimate their significance and to find the indicators for C&C of tobacco products.

In the third chapter of this teaching module, the results of the model analysis are shown as example, an identification of the risk generated by Impact of Tax Burden, Economic Growth and Total Employed Persons on Contraband Intensity.

The model and its outcomes could be used by experts and analysts, as well as at the level of strategic management. The model is applicable to the public and private sector structures, regardless of their legal form and field of activity.

The model would be extremely useful for strategic management, decision-making by higher management at strategic level, long-term planning, implementation of the adopted strategy or, if necessary, for a complete change in the direction of development of the particular organization.

The model has been approbated with data about 186 countries all over the world. It includes 19 variables, chosen by the researchers based on expert evaluation during the weekly discussions, ***Causes of Contraband and Counterfeit*** – **(1)** Registering Property, **(2)** Paying Taxes, **(3)** Trading Across Borders, **(4)** GDP per capita, **(5)** Tax Burden, **(6)** Rule of Law, **(7)** Control of Corruption, **(8)** Number of Policemen, **(9)** Vehicles' Thefts, **(10)** Unemployment, **(11)** Starting a Business.

Indicators of Contraband and Counterfeit – **(1)** Seized Drugs, **(2)** Human Trafficking, **(3)** Tax Revenues, **(4)** Value Added in Tobacco Industry (TI), **(5)** Employment in industry (% of total employment), **(6)** General Trade-Related Index of Counterfeiting for economies (GTRIC-e), **(7)** Shadow Economy and **(8)** Number of Tobacco Smokers. [2]

Description of the variables and hypothesis

Paying Taxes - Paying taxes - This variable is used as a business environment factor. Supposed. that tax increases also increase C&C intensity. [3]

Trade across borders - measures the time and costs (reported by local experts) associated with three sets of compliance procedures - documentary, border and inland transport - the process of exporting or importing goods.

An increase in the coefficient will lead to a decrease in fakes. Data source is World Bank, Cross-Border Trade Methodology, Doing Business.

Registering Property – Estimates common procedures, as well as time and costs for transferring ownership. The hypothesis is that an increase in the factor will lead to a decrease in counterfeits.

Starting a Business - is used to determine the minimum capital, procedures, time and expenses for a small to medium-sized limited liability company to start and operate in the largest business city of the economy [4].

Tax Burden - a statutory measure that reflects marginal tax rates on personal and corporate income and the overall level of taxation (including direct and indirect taxes imposed by all levels of government) as a percentage of gross domestic product (GDP).

Rule of Law - it refers to the observance of rules in society, and in particular, to the performance of contracts, the protection of property, and the work of the police and the courts. The model hypothesis is that an increase in the factor will lead to a decrease in both latent variables – Contraband Intensity and Counterfeit Intensity.

Control of Corruption - The data source is the World Bank's World Governance Indicators (WGI) project [5].

GDP per capita - This measure provides the best comparability between countries data. The hypothesis is if GDP per capita will grow, both latent variables – Contraband Intensity and Counterfeit Intensity will decrease. The source of data is from World Bank Development Indicators.

Police officers - The estimate is for the number of officers whose functions are to detect and investigate crimes and apprehend alleged perpetrators. The hypothesis is that an increase in the factor will lead to a decrease in fakes. The United Nations Office on Drugs and Crime is the source of the data.

Vehicles' Thefts - a highly organized criminal activity is linked to other organized crime activities such as drug trafficking, arms dealing and international terrorism. Therefore, vehicles are mainly stolen and trafficked for providing financial and logistical means to finance other

criminal activities. This variable can be used as a factor alleviating contraband with ready to use contraband channels and facilities. Therefore, the expected relation between vehicle thefts and contraband is that an increase in the factor will lead to an increase in counterfeit. The United Nations Office on Drugs and Crime is the source of data.

Unemployment Rate - This variable reflects the employment gap for people who are in the labor market but cannot find a suitable job.

Employment in the industry - This is the number of people working in the economy.

The hypothesis of the model is that if there is an increase in gray economy, employment in the legal industry will decline

Value Added - is defined as "Food, beverages and tobacco (% of value added in production)" It is expected that with an increase in counterfeits, the value added by the tobacco industry will decrease.

General Trade-Related Index of Counterfeiting for economies (GTRIC-e) – the indicator is supported by OECD

Shadow Economy – The hypothesized says that if Contraband or Counterfeit Intensity increases, then the measured variable will also increase [6] – [8]. For example, Bulgaria's shadow economy accounted for 29.9% of the country's gross domestic product (GDP) in 2017 [9].

Percent of Tobacco Smokers – The indicator is sourced by World Health Organization's statistics.

Seized Drugs – The Seized Drugs indicator data is sourced by UNODC databases [10]. The main idea in this indicator is the same usage of channels for drug trafficking and tobacco products contraband. This indicator is measured by metrics in quantity.

Human Trafficking The main idea in this indicator is the same usage of channels for human trafficking and tobacco products contraband. The human trafficking increases the contraband intensity.

Tax Revenues – total tax revenue as a percentage of GDP is used to account for the share of a country's output that is collected through taxes [11]. For example, the taxes (Excise duties) for tobacco products in Bulgaria form 84% of retail price.

A. Results - Application of MIMIC for Measuring Illicit Trade in Tobacco Products at NUTS 3 Level

The idea is to use this model to estimate smuggling by region:

- GDP per capita is defined on the front page
- Employment (total) - This is how employment in the economy is reported in EUROSTAT
- Employment in Agriculture – These data are maintained in EUROSTAT. The assumption is that in the agricultural regions the illicit trade in tobacco products is higher than in more industrialized and urbanized regions. It is a common assumption in many studies on crime, illicit trade and counterfeit.

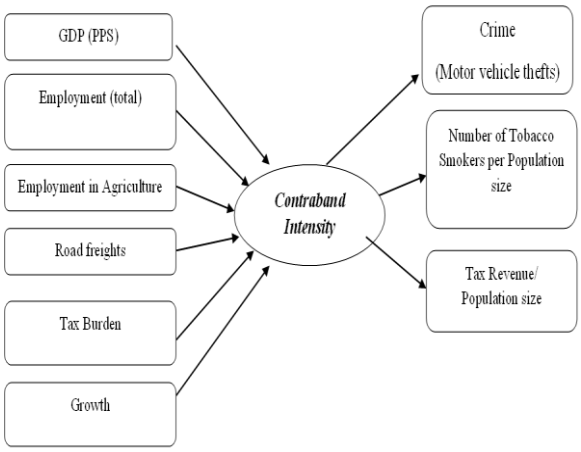

Fig. 2. MIMIC model application at the NUTS3 level.

Road Freight – This indicator uses the road freight transport statistics, which is published by EUROSTAT. This indicator is measured in thousands of tons without additional processing. The assumption is that the quantity of transport facilitates the contraband of tobacco products.

Tax Burden – It is determined by the excise taxes (tax on the sale or use of tobacco) at the country level. The indicator is calculated on the basis of the incomes of the regions (GDP per capita in PPS EUR). If the income at the NUTS3 level is higher than the corresponding income of the country, then the tax burden will be lower for the region and vice versa. The resulting indicator does not correlate with the GDP per capita indicator used in the calculations, so there is no multicorrelation effect in the model.

Motor Vehicle Thefts – determines the number of motor vehicle thefts in a given region. The data are available in EUROSTAT.

The assumption here is that most of these crimes are connected to organized crime and also facilitates the C&C.

Number of Tobacco Smokers – These data are maintained in EUROSTAT. The volume of the tobacco market is determined by the number of smokers.

Tax Revenues – Tax revenues is an indicator that can show the changes in tobacco product markets. The data in million EUR without additional processing is taken from Eurostat. The indicator is measured in million EUR for revenues only for excise duties.

Growth - the growth rate in millions of euros as part of GDP determines the dynamics of economic development.

The created MIMIC model, assists determining trends. This would be possible if an additional database was developed to enter the data over a certain period, as a

result of the static model. It was established the direction and strength of the relationship between the examined variables and the latent variable - Contraband Intensity (CDI).

CDI is a latent variable estimated through the MIMIC model, which links selected observable causes and indicators to obtain a comprehensive estimate of the propensity to smuggle.

The CDI is calculated on data for over 1480 EU regions (NUTS 3 level), thus obtaining CDI values for each region.

The CDI has no measure (like meters, kilograms, Watts, percent etc.

The following table (Table 1 - Increase in the Tax Burden Factor (in %)) shows the impact of Tax Burden on CDI.

Table 1 Increase in the Tax Burden Factor (in %)

Tax Burden	CDI	Crime Level	Tax Revenues	Number of Smokers
-10	-1,24	-0,44	0,47	-0,03
-9	-1,12	-0,4	0,42	-0,03
-8	-0,99	-0,35	0,38	-0,03
-7	-0,87	-0,31	0,33	-0,02
-6	-0,75	-0,26	0,28	-0,02
-5	-0,62	-0,22	0,23	-0,02
-4	-0,5	-0,18	0,19	-0,01
-3	-0,37	-0,13	0,14	-0,01
-2	-0,25	-0,09	0,09	-0,01
-1	-0,12	-0,04	0,05	0
0	0	0	0	0
1	0,12	0,04	-0,05	0
2	0,25	0,09	-0,09	0,01
3	0,37	0,13	-0,14	0,01
4	0,5	0,18	-0,19	0,01
5	0,62	0,22	-0,23	0,02
6	0,75	0,26	-0,28	0,02
7	0,87	0,31	-0,33	0,02
8	0,99	0,35	-0,38	0,03
9	1,12	0,4	-0,42	0,03
10	1,24	0,44	-0,47	0,03

From the data presented in the table, it can be concluded that an increase in the tax burden leads to an increase in the CDI. This leads to the conclusion of a positive relationship between the tax burden and the increase in CDI.

IV. CONCLUSIONS

Within the research it has been examined the development of a MIMIC model with one latent variable - Contraband Intensity on EU Territorial Classification NUTS on lowest level 3 for 30 European countries. It was confirmed that the factor (model's causes) variables GDP (PPS), Employment, Agriculture, Road freight, Tariff and Growth had an impact on the contraband intensity. The same also applies to the impact of latent variable - CDI on the indicators for dependent variables (model's indicators) such as Crimes (motor vehicle thefts), Number of Tobacco Smokers, Tax Revenues.

The developers of the model, having in mind the content of CDI and its application, have decided to name it - **Illicit Trade of Tobacco Products Indicator (ITTPI).**

In conclusion of the research, we can summarise that the Illicit Trade of Tobacco Products Indicator (ITTPI) is the calculated latent variable through the MIMIC model at the NUTS3 level. It shows the propensity of tobacco products to be contraband. The Illicit Trade of Tobacco Products Indicator (ITTPI) can be considered as a measure of the illegal market demand for cigarettes and other tobacco products. The Illicit Trade of Tobacco Products Indicator (ITTPI) is an indicator that can be applied to any country.

REFERENCES

[1] R Core Team, “R: A Language and Environment for Statistical Computing,” R Foundation for Statistical Computing, 2023. [Online]. Available: https://www.r-project.org/

[2] D. Dimitrov, "Tobacco Products Contraband & Counterfeit Risk Identification UNWE Economic Alternatives," UNWE :: UNWE Yearbook, Feb. 10, 2020. [Online]. Available: https://unwe-yearbook.org/en/journalissues/article/10162. [Accessed: Mar. 01, 2025].

[3] “The changing landscape of tax policy and administration across 190 economies.” [Online]. Available: https://www.pwc.com/gx/en/paying-taxes/pdf/pwc-paying-taxes-2020.pdf. [Accessed: Nov. 02, 2020].

[4] “Methodology for Starting a Business,” World Bank. [Online]. Available: https://archive.doingbusiness.org/en/methodology/starting-a-business

[5] World Bank, “Worldwide Governance Indicators,” World Bank, 2024. [Online]. Available: https://www.worldbank.org/en/publication/worldwide-governance-indicators/interactive-data-access

[6] A. Buehn and F. G. Schneider, Institute for the Study of Labor (IZA). [Online]. Available: http://ftp.iza.org/dp4182.pdf

[7] F. Schneider and C. C. Willams, The Shadow Economy. London: IEA, 2013.

[8] F. Schneider and A. Buehn, “Shadow Economies and Corruption All Over the World: Revised Estimates for 120 Countries,” University of Linz, Austria; Technische Universitat Dresden, Germany, 2009. [Online]. Available: http://www.economics.unilinz.ac.at/members/Schneider/files/publications/ShadEconomyCorruption_rev_091009.pdf. [Accessed: Sep. 07, 2017].

[9] I. Mihaylov, “Bulgarian shadow economy accounts for 30% of GDP - study,” SeeNews, Jul. 03, 2017. [Online]. Available: https://seenews.com/news/bulgarian-shadow-economy-accounts-for-30-percent-of-gdp-study-1110983. [Accessed: Mar. 02, 2025].

[10] United Nations, “Statistics and Data | UNODC,” Un.org, 2018. [Online]. Available: https://dataunodc.un.org/

[11] World Bank, “World Development Indicators,” The World Bank, 2023. [Online]. Available: https://databank.worldbank.org/source/world-development-indicators

[12] Bulgarian Industrial Capital Association (BICA), Report on actualisation of composite index “Economy in light”, 2016. [Online]. Available: http://bica-bg.org/wp-content/uploads/2016/07/Doklad-za-Kompozitniaindex-za-20151.pdf