Illegal gambling: measuring the market using the MIMIC model

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\textbf{ABSTRACT}

Using a multiple indicators and multiple causes (MIMIC) model, this paper estimates the extent of illegal gambling in Italian regions over the period 2013–18. By treating illegal gambling as an unobserved latent variable directly related to its causes and effects, this model gives information about the relationship between cause and indicator variables and the latent variable from covariance structures. From the analysis, it emerges that the share of illegal gambling increases with the value of the winnings paid; it decreases when the number of authorized machines increases. We also find that individuals with low levels of education and low income show a greater propensity to gamble illegally.

\textbf{KEYWORDS}

illegal gambling; MIMIC model; market gambling; amusement machine

\textbf{INTRODUCTION}

The aim of this paper is to estimate the magnitude of the illegal gambling (IG) market in Italy with regard to the amusement machine segment. This issue raises significant concerns, given the momentous consequences that recourse to IG can have on final consumers (particularly young people and the most vulnerable social classes), as well as on the government and operators in the legal gambling circuit chain. In spite of various legislative interventions over the past few years, which have aimed to hinder illegal, irregular or unauthorized gambling with cash winnings, the investigations and audits that have been conducted still indicate a significant presence of abuse and illegality in the gambling industry which, in many cases, is associated with infiltration by organized crime (Agenzia delle Dogane e dei Monopoli (ADM), 2016–19; Guardia di Finanza, 2017). To a greater or lesser extent, these phenomena involve all segments of the public gambling market.

From an economic point of view, the amusement machine sector represents the largest share in the gambling market. In 2016, according to the ADM, more than half of total takings, winnings and spending by players was associated with amusement machines. In the same year, more than 56% of tax revenues came from that segment. As indicated by the Associazione Concessionari Apparecchi da Intrattenimento (ACADI) (2016), approximately 80% of illegal takings in the public gambling market come from unauthorized amusement machines and online casinos that lack a concession.

From the perspective described above, estimating the amount of IG is clearly a very important issue that has not yet been adequately analysed. Indeed, in spite of growing interest in the non-observed economy (Schneider & Buehn, 2018), studies regarding the quantity and determinants of IG are still rather limited. The reason for this is primarily the considerable difficulty in quantifying the actual economic weight of illegal activities and the shadow economy (Organisation for Economic Co-operation and Development (OECD), 2002), which has given rise to empirical literature that is significant, yet also quite heterogeneous in terms of the logic of the analysis, the econometric methods used, and the results obtained (Dell’Anno, 2005). Official estimates based on narcotics trafficking, prostitution and tobacco contraband are provided in the...
official statistics relating to Italian economic accounts (Istituto Nazionale di Statistica (ISTAT), 2017). Intuitively, the main limitations are the inadequate availability of informational sources regarding illegal activities, together with the limited reliability of data, especially when attempting to estimate specific sectors, such as gambling. From this standpoint, the IG market is not an exception in Italy. Furthermore, aside from the lack of data and information, the methods used to estimate the industry are not always transparent (Calderoni et al., 2014).

When focusing on the amusement machine sector, Calderoni et al. (2014) estimate illegal takings in 2011 as being from €326 million to €522 million, based on both on regional data regarding takings from amusement with prize (AWP) and video lottery terminal (VLT) machines, as well as the infringement rate, calculated as the ratio of informal infringements to the number of machines inspected and their corresponding illegal takings.

However, Eurispes (2009) and Confesercenti (2012) estimate the size of the gambling market to be €23 billion and €4 billion, respectively. The ACADI (2016) calculates the illegal takings from amusement machines, online casinos, bets and lotteries to be almost €25 billion, based on a share of no more than one-third of the legal market.

Within the framework outlined above, in this research we propose using the multiple indicators and multiple causes (MIMIC) model to estimate the size of the illegal amusement machine gambling market in Italy. To the best of our knowledge, this is the first study that has used a MIMIC model to estimate this aspect of the illegal economy.

The remainder of the paper is structured as follows. The next section provides a framework for IG in the amusement machine segment that proposes a taxonomy of informal infringements to the number of machines inspected and their corresponding illegal takings.

The third section describes the study’s estimate approach and the key variables used in the econometric model in light of the most extensive reference literature on determinants of gambling and the shadow economy. The fourth section explains and discusses the estimation results, proposing an initial interpretation of results, including an analysis on a regional basis. Finally, the last section concludes.

WHAT IS KNOWN ABOUT ILLEGAL ACTIVITIES IN THE AMUSEMENT MACHINE SEGMENT?

The definition of illegal activities has been widely debated in the context of studying the unobserved economy (Dell’Anno, 2005; Schneider & Buehn, 2018). Systems of national accounts traditionally include illegal activities within the non-observed economy, along with shadow activities and the informal economy, namely all activities that, for different reasons, escape direct statistical observation (OECD, 2002). The System of National Accounts 1993 (SNA93) defines illegal activities as those prohibited by law or activities that, even though per se legal, are not legal if engaged in by unauthorized persons. Conversely, shadow activities include those activities consisting of legal production, which the government is unaware of for different reasons (e.g., different forms of evasion: tax, social security, etc.; non-compliance with regulations; non-compliance with administrative rules), that are caused by a deliberate intent to violate the law, resulting in activities that are not detected at an official level due to inefficiency or technical difficulties in estimation and detection methods. Finally, the informal economy encompasses production units with a low level of organization, little division between capital and labour, and/or employment relationships based substantially on occasional employment, family relationships or personal relationships.

With reference to the amusement machine segment, in order to identify the boundaries between IG and shadow gambling, it is necessary to examine the functioning of the two entertainment devices that offer cash winnings: AWPs and VLTs.

According to Law 266/2005, AWPs are electronic devices consisting of a cabinet and a game card that are jointly approved by the certifying bodies representing the Customs and Monopolies Agency, and registered in the list of certified models. Each device has a game card installed internally which interacts with the licensee’s system through an access point. The pay out for each single device must be at least 68% and is calculated over 140,000 games. No minimum bet is required, while the maximum cost of a game is €1. The highest possible winning is €100 and there is no jackpot. VLTs are the latest equipment in the gaming industry and can be considered an evolution of traditional AWPs. They are real terminals connected to a central game system and therefore have no ‘game card’ installed; the game and outcome of the bet are calculated on the central system and then displayed on the VLT screen. The pay out is at least 85% and is calculated over a cycle of approximately 5 million bets. The minimum bet is €0.50 and the maximum bet is €10. The maximum pay out is €5000, but a national jackpot (up to €500,000) and local jackpots (up to €100,000) are possible.

In essence, AWPs are connected to the central system of the monopolies to verify their proper functioning as well as the correct pay out, while VLTs are connected to the central monopolies system not only for legality checks but also to correctly calculate the jackpot.

Focusing on the amusement machine segment, non-observed activities therefore include a set of abusive and illegal practices that aim to prevent the government and authorized operators entrusted with providing legal gambling (i.e., the concessionaires) from accurately determining the volume of gambling and, consequently, (from) imposing taxes and compensating the various operators in the supply chain (ACADI, 2016). Moreover, the payoff structure of this gambling can be altered to reduce the
Table 1. Taxonomy for non-observed activity in the amusement machine market.

| Illegal gambling                                                                 | Shadow gambling                                                                 |
|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| (1) Activating machines that have never been registered and authorized, so that  | (3) Interrupting the system in which legally registered machines transmit         |
| the machine, while functioning normally, is not connected to the concessionaire’s  | gambling data for specified periods of time                                      |
| electronic network and thus transmits no information about the games played and   | (4) Altering flows of communication between machine and concessionaire by         |
| gambling data                                                                     | installing ‘suppressors’, namely devices that interfere with the electronic      |
| (2) Modifying machines under Article 110, paragraph 7 (video games)\(^{a}\) by   | connection by modifying the data being transmitted so as to conceal the takings   |
| installing a second electronic card that converts them into a new slot machine    | resulting from the use of the machines (an aspect that involves amusement with    |
| whose cash winnings are not connected to the electronic network                   | prize (AWP) machines in particular\(^{b}\)                                      |
| (3) Interrupting the system in which legally registered machines transmit         |                                                                                |
| gambling data for specified periods of time                                      |                                                                                |
| (4) Altering flows of communication between machine and concessionaire by         |                                                                                |
| installing ‘suppressors’, namely devices that interfere with the electronic      |                                                                                |
| connection by modifying the data being transmitted so as to conceal the takings   |                                                                                |
| resulting from the use of the machines (an aspect that involves amusement with    |                                                                                |
| prize (AWP) machines in particular\(^{b}\)                                      |                                                                                |

Note: \(^{a}\)TULPS — Italian Consolidated Act on Public Safety (Royal Decree, 773, 18 June 1931).

\(^{b}\)Video lottery terminal (VLT) machines cannot be detached since the electronic network is managed nationally.

Source: Authors’ elaboration.

player’s odds of winning, so as to increase the profits of those engaging in illegal activities.

Based on the investigation by the Italian Senate of the Republic (2016), Table 1 provides a taxonomy of non-observed activities in the amusement machine segments by differentiating between illegal and shadow activities.

Although ideally different, in practice single non-observed activities are hard to distinguish. Data relating to control and monitoring activities by the state regard the type of sanction imposed (e.g., administrative or criminal) rather than actual illegal conduct.

In 2018 in Italy, 263,322 AWP s were installed in 62,894 venues and 57,967 VLT s in 4979 venues. There were 27,239 inspected venues (40.1% of the total) and 2056 violations were found (ADM, 2016–18).

Furthermore, from a socio-economic standpoint, the motivations behind these behaviours and the conditions that encourage them or make them more likely, either individually or together, overlap to a significant extent.

On the supply side, the operators, authorized or not, carry out illegal conduct with the aim of increasing their revenues, while simultaneously reducing or eliminating the taxes to be paid to the state, the compensation to be paid to the concessionaire and, consequently, to the other components of the supply chain. In this case, the individual operator’s decision entails a comparison between the potential benefits from illegal conduct and the costs of administrative and/or criminal sanctions (Schneider & Buehn, 2018). The latter, in turn, depend on the frequency of audits and inspections that will determine the probability of that sanction being imposed by the state.

On the demand side, consumers are in many cases unable to distinguish between legal and illegal amusement machines, or between shadow and illegal activities, partly because those who engage in illegal conduct have no interest in making those differences known. However, there are cases, such as clandestine gambling, where it is difficult to believe that consumers are unaware of the illegal nature of their gambling. On the contrary, IG activities can create a certain fascination in consumers, particularly for young people who are attracted by the associated risk as well as the potentially higher odds of winning, and wish to avoid social disapproval.

EMPIRICAL STRATEGY AND RESEARCH HYPOTHESES

Estimating IG using the MIMIC model

To estimate the size of IG in Italy, we apply a structural model of MIMIC (Breusch, 2005; Breusch, 2016; Del’Anno, 2007; Dell’Anno et al., 2007; Schneider, 2017) on a set of regional data (NUTS-2 level) covering the period 2013–18. Table A1 in Appendix A in the supplemental data online gives details on the dataset used.

The MIMIC is a special case of the structural equation models (SEM) that permits specification of the statistical relations between causal variables (observed) and latent variables (unobserved), which, in turn, indirectly affect a set of observed indicators (Feld & Schneider, 2010; Frey & Weck-Hanneman, 1984; Hancock, 2004; Joreskog & Goldberger, 1975; Muthén, 1989). It treats non-observed economic activities as a latent variable connected to: (1) a number of observable variables (indicators) reflecting potential changes in the size of non-observed economic activities; and (2) a set of observable variables (causes) that are considered to be some of the most important determinants of those activities. Both indicators and causes are observable variables.

The MIMIC model has been increasingly applied both at national and international levels to estimate non-observed economic activities. Bruno and Weck-Hanneman (1984) first used the technique of unobserved variables to estimate the size and development of the hidden or underground economy in OECD countries. Several studies have since applied the same methodology to assess the economic relevance of the different components of non-observed economy in different countries: Loayza (1996) for Latin American countries, Giles (1999) for New Zealand, Giles et al. (2002) for Canada, Dell’Anno (2003) for Italy, Bajada and Schneider (2005) for Asia-
Pacific countries, Schneider (2005) for 110 countries, Del’Anno et al. (2007) for France, Greece and Spain, Del’Anno (2007) for Portugal, and Schneider and Buehn (2009) for 120 countries in Eastern Europe and Central Asia.

In general, some scholars have highlighted the potential of the MIMIC model in estimating the non-observed economy compared with other methodologies, because it ensures broad flexibility in defining the framework (Schneider & Enste, 2000) and it does not require restrictive hypotheses, given that the only real limit lies in the choice of variables (Thomas, 1992). However, this model is not exempt from criticism. Indeed, unlike the linear regression model, it shows significant instability in the coefficients when sample size is changed, that is, the previously obtained results could be compromised when additional years and/or additional variables are included (Helberger & Knepel, 1988; Schneider & Buehn, 2018). Moreover, the estimated parameters are very sensitive to alternative specifications of the model, even though recent studies have shown that using a significant number of observations makes the model more stable than had previously been observed in the literature. Finally, but nonetheless a criticism that is equally important, is the dependence of results on the scale coefficient; in fact, in this approach, the terms, sign and size of the value of the coefficients associated with the latent variable are implicitly a function of the researcher’s work.

Causes and indicators of IG: the research hypotheses

Why do people engage in gambling?: the theoretical framework

One of the most frequently analysed aspects of economic, sociological and psychological literature concerns the social stratification of gambling. Sarti and Triventi (2012) prepared an interesting survey of the main theories, which proceed along three main lines: (1) the ‘functionalist theories’ that developed in the 1950s considered gambling to be a tool that would be able to reduce the social conflict inherent in the inevitable clashes produced by modern society (Bloch, 1951); (2) the ‘anomie theory’, according to which the propensity to gamble increases in individuals who believe that the place they hold in society is beneath their educational level, since gambling is seen as a mechanism for social mobility (Lagneau, 1965); and (3) the ‘fascination theory’, according to which gambling is perceived by individuals of low social extraction as a democratic mechanism for social promotion, since the odds of winning are independent of the player’s initial social position and employment status (McCaffery, 1994).

Turning now to the economic context, consumption theories maintain that the most vulnerable and least wealthy classes are more attracted to gambling because they perceive gambling, and especially the possible winnings associated with it, as a surrogate for the acquisition of luxury goods that, because of their limited financial resources, are generally beyond their reach. In essence, for the most vulnerable consumers, buying a lottery ticket generates satisfaction because of the mere fact that it allows them to fantasize about the hypothetical purchases they could make with a significant win (Campbell, 2005).

Potential causes

According to the abovementioned theoretical framework, we include in the estimation process the main potential determinants of IG: income, unemployment rate, education level, amount of winnings and number of entertainment machines (both VLTs and AWPs).

One of the most studied variables in the literature is income, since one of the most interesting research questions is if and to what extent the propensity to gamble depends on individual and/or family income. The results are a mismatch. Using the American market and the varied world of lotteries as a reference, numerous studies show that the propensity to play lotteries decreases as individual income increases (Abbott & Cramer, 1993; Holtz-Eakin & Selden, 1995; Scott & Garen, 1994). According to Blalock et al. (2007), there was a positive and significant relationship between poverty rates and lottery sales in the United States. Indeed, most of the research identified lotteries as a regressive form of taxation. In the UK market, however, income is positively correlated with both the rate of gambling and the number of games played (Orford et al., 2010). Using lotteries as a reference for gambling, the prevailing thesis is that gambling is a ‘tax on poverty’, namely a hidden form of regressive taxation (Clotfelter & Cook, 1991; Miyazaki et al., 1999; Rogers, 1998; Walker et al., 1998). Recently, Fu et al. (2021) find that in Canada people in lower socio-economic status neighbourhoods appear to engage in more lottery gambling than those in higher socio-economic status neighbourhoods. However, when studying the German market, Beckert and Lutter (2009) deny that there is any correlation between income and lottery participation rate. Welte et al. (2002), while demonstrating a close relationship between income and participation in gambling, dispel the idea that gambling is widespread among individuals who live close to the subsistence threshold and that there is, therefore, a direct relationship between poverty rate and participation in gambling. Comparison of the various studies is also difficult due to the different types of gambling analysed in each study; when simple games (instant lotteries) are analysed, those less well-off spend a higher portion of their income on these games than the more affluent, but as the complexity of the game grows, this relationship weakens, to the point that it is insignificant for sports betting (Mikesell, 1989; Price & Novak, 1999; Worthington, 2001). Amusement machines are a very simple form of gambling, so, according to the prevalent literature, in this case individuals with less income are more likely to gamble. Accordingly, there should be a negative correlation between income and non-observed gambling takings (i.e., the expected sign should be negative). As a proxy for per capita disposable income, namely the amount of income that can be spent on consumption or savings, we use data for gross domestic product at market prices per inhabitant (GDPpc) provided by ISTAT.
Illegal gambling: measuring the market using the MIMIC model

Hypothesis 1: The lower the per capita income, the higher/larger the size of IG, ceteris paribus.

The thesis that an increase in the unemployment rate increases the likelihood of gambling is widely accepted in the literature (Mikesell & Zorn, 1987; Scott & Garen, 1994; Smith, 2002; Vrooman, 1976). As observed for income, in conditions of significant social unease, gambling is seen as an opportunity to improve one's socioeconomic status. When analysing Maine State lottery sales after 2008, Gabrielyan and Just (2020) show that an increase of 1% in the unemployment rate results in a 0.38% increase in lottery sales. Ólaore et al. (2021) and Mustapha and Enilolobo (2019), while studying Lagos and Nigeria, respectively, confirm that the unemployed have an intense interest in gambling in order to sustain their income. Accordingly, we expect a positive sign in this coefficient. The data relating to the unemployment rate (UN) was taken from the ISTAT's territorial database indicators.

Hypothesis 2: The higher the unemployment rate, the larger the size of IG, ceteris paribus.

Another factor that explains gambling, for which there is significant agreement in the literature, relates to individuals' educational attainment. Many scholars confirm that the lower analytical capabilities of the least educated individuals cause them to overestimate the odds of winning, thus triggering a greater likelihood of gambling (Rogers, 1998; Stanovich & West, 2008). Classic examples are: the 'neglected numbers' in the lottery game, namely the belief that the odds of drawing a number increase as the number of drawings where that number has not yet been drawn increases; the 'near miss' effect, that is, the belief that having a close call with winning (mainly in slot machines and the lottery) increases the odds of winning on the next turn (Ariyabuddhiphongs, 2011; Rogers, 1998) – in other words, a kind of unrealistic optimism, that perceives the odds of winning to be greater based on irrational criteria (lucky number, lucky day, superstition); and the 'escalation effect', namely the difficulty found in stopping even as losses increase, with the hope of recovering what has been lost. Even though erroneous cognitive assessments are normally negatively correlated with educational level, some research shows that these errors of assessment do not solely affect poorly educated individuals (Boudon, 1995; Kahneman & Tversky, 1979), although the dominant literature shows a positive relationship between cognitive abilities and educational level (Park & Kyei, 2011).

According to the prevalent literature, we assume that individuals with low levels of education show a greater propensity to gamble illegally. Accordingly, there should be a negative correlation between the level of education and non-observed gambling takings (i.e., the expected sign should be negative). As proxy for the educational level on a regional basis, we used the rate of post-secondary education (EDUC), which includes the number of individuals from all those in the 30–34-year age group who obtained a university degree, calculated and provided by ISTAT in the territorial database of indicators for development policies.

Hypothesis 3: The lower the education level, the larger the size of IG, ceteris paribus.

Moreover, it can be assumed that the quantity of non-observed gambling activity is linked to the value of winnings paid to players in the form of cash prizes dispensed by amusement machines. Many scholars confirm that high jackpots have a positive impact on total lottery sales (Quiggin, 1991; Scoggins, 1995; Thiel, 1991). With regard to lottery sales, according to Clotfelter and Cook (1991), the jackpot size mattered more to consumers than the probability of winning. Other scholars agree with the 'lotto mania' thesis, which suggests that large jackpots could trigger an irrational increase in purchasing even if the expected earnings remain low (Beenstock et al., 2000; Peel, 2010). It is not possible to measure the actual winnings from IG, nor are there any statistics on this aspect. However, based on the literature reviewed and the mechanism of how the games function, some considerations can be made. IG promises higher winnings than legal gambling, further justified by the absence of taxation, in order to attract more consumers. According to this literature, an increase in winnings would lead to an increase in legal gambling. It follows that as legal winnings increase, illegal winnings must also increase to maintain the attractiveness of this channel to consumers. Consequently, we assume that as legal (known) winnings grow, so will winnings in illegal (unknown) channels. The growth in winnings from illegal gaming leads to an increase in gaming volumes. In summary, we assume that as legal winnings grow, so does IG. Since an increase in winnings should result in an increase in individuals’ propensity to gamble, the expected sign should then be positive. The data for the annual amount of winnings (WIN) were obtained from ADM.

Hypothesis 4: The higher the amount of winnings paid, the larger the size of IG, ceteris paribus.

A theory that is much debated, both scientifically and as a policy matter, relates to the existence of a substitutive rather than a complementary relationship between legal gambling activity and non-observed gambling activity. In other words, the issue is whether the introduction of new authorized gambling can take market share away from IG activity, which is generally monopolized by organized crime, or rather whether this would have the effect of increasing the audience of potential players, who in turn might come into contact with the criminal offering. In order to take these aspects into account, two variables (both of which are provided by the ADM, on a regional basis) were added to the model, which would make it possible to take into account the size of the authorized gambling offering. The first variable is the number of VLT
machines (VLT), while the second is the number of active and operating new slot machines (NEWSLOT) (both the variables are measured as the number of machines per 100,000 inhabitants). From an empirical standpoint, the presence of a positive sign would be signal of a direct relationship between the legal offering and the amount of non-observed gambling, which is consistent with a hypothesized synergistic effect between the two phenomena. On the contrary, an inverse correlation would indicate a relationship of potential substitutability.

Hypothesis 5: The higher the number of VLT, the larger (smaller) the size of IG, ceteris paribus.

Hypothesis 6: The higher the number of NEWSLOT, the larger (smaller) the size of IG, ceteris paribus.

Indicators for IG

In the MIMIC model specifications, the indicator variables are not used to estimate the latent variable directly, but rather perform a control function. The role of the indicators is then to verify whether the estimate is consistent with the relevant context. In the estimation process, we include the following three observable variables: total gambling takings; the number of criminal violations; and the number of people reported.

The relationship between legal and IG is highly debated at policy level (Livingstone et al., 2018; Rolando et al., 2020). Indeed, one of the main arguments justifying progressive legalization of the gambling industry relies on the prospect of reducing the size of IG by expanding legal gambling opportunities, which would also result in a corresponding increase in the government’s tax revenues (Micangeli, 2021). If the crowding out effect of IG is presumed, that is, resources are absorbed by IG thus reducing those available for legal gambling (Humphreys, 2021), a negative correlation should then be expected between legal and IG. Conversely, the marketing and promotion of gambling activity through legalization have been regarded as enabling an increase in the share of population engaging in gambling activity, further harming those with gambling disorder, and ultimately provoking a potential increase in criminal activity to support their addiction (Lipnowski & McWhirter, 2018). Consequently, we should expect there to be a positive correlation between legal and IG, because an increase in the size of legal gambling should lead to a corresponding increase in IG. Studies, as well as evidence of the relationship between legal and IG, are however extremely scant (Albanese, 2017). In the estimation process, we argue that a complementary relationship does exist. This hypothesis is consistent with the context of a mature market like that of the public gambling market in Italy. As a proxy of the size of legal gambling, we use data for the total amount of money that players wager in authorized gambling activities using amusement machines. Data were sourced from the various available editions of the annual Blue Book – Organization, Statistics and Activity of the ADM (ADM, 2016–19). In our MIMIC model, the total gambling takings derived from authorized gambling activity are the reference variable used to control the size of IG and to test the relationship between IG and legal gambling. The variable (COIN) is measured as an index number (base year 2013 = 100) and is fixed to +1 throughout the different model specifications.

Hypothesis 7: The larger the size of IG, the higher is COIN, ceteris paribus.

The other two indicator variables included in the MIMIC model specifications refer to law enforcement policies for amusement machines. Under the assumption that illegal activity can be reduced by increasing law enforcement, a positive correlation would be expected between legal and IG. Conversely, the marketing and promotion of gambling activity through legalization have been regarded as enabling an increase in the share of population engaging in gambling activity, further harming those with gambling disorder, and ultimately provoking a potential increase in criminal activity to support their addiction (Lipnowski & McWhirter, 2018). Consequently, we should expect there to be a positive correlation between legal and IG, because an increase in the size of legal gambling should lead to a corresponding increase in IG. Studies, as well as evidence of the relationship between legal and IG, are however extremely scant (Albanese, 2017). In the estimation process, we argue that a complementary relationship does exist. This hypothesis is consistent with the context of a mature market like that of the public gambling market in Italy. As a proxy of the size of legal gambling, we use data for the total amount of money that players wager in authorized gambling activities using amusement machines. Data were sourced from the various available editions of the annual Blue Book – Organization, Statistics and Activity of the ADM (ADM, 2016–19). In our MIMIC model, the total gambling takings derived from authorized gambling activity are the reference variable used to control the size of IG and to test the relationship between IG and legal gambling. The variable (COIN) is measured as an index number (base year 2013 = 100) and is fixed to +1 throughout the different model specifications.

Hypothesis 7: The larger the size of IG, the higher is COIN, ceteris paribus.

The other two indicator variables included in the MIMIC model specifications refer to law enforcement policies for amusement machines. Under the assumption that illegal activity can be reduced by increasing law

Figure 1. Hypothesized structure of the multiple indicators and multiple causes (MIMIC) model for illegal gambling. Source: Authors’ elaboration.
enforcement activities, the literature usually considers the variables related to deterrence enacted by the state as being among the determinants of criminal activities (Bun et al., 2020). However, the empirical results regarding the effects of deterrence are mixed and the question whether it is deterrence policies that influence the size of the shadow economy, or whether the shadow economy justifies an increase in law enforcement activities remains open (Feld & Schneider, 2010; Schneider & Buehn, 2018). Since our empirical analysis considers a limited time span (2013–18), we therefore argue in our MIMIC model specifications that the deterrence variables may be viewed as indicators of the size of IG, meaning that higher law infringement rates relating to amusement machines would be a sign of greater illegal activity. As indicator variables, we select the number of criminal infringements discovered for all operators inspected (CRIMEVIOL) and the number of persons reported to the judicial authority (PEOPLE_REPORTED). Both these variables, measured in terms of the number of criminal charges per 100,000 inhabitants, have been sourced from the various available editions of the annual Blue Book (AAMS 2006–19) that describe the results of Monopolies Office inspections in the amusement and entertainment machines segments.

Hypothesis 8: The larger the size of IG, the larger the number of criminal violations, ceteris paribus.

Hypothesis 9: The larger the size of IG, the higher the number of people reported, ceteris paribus.

Table 2. Multiple indicators and multiple causes (MIMIC) estimation of illegal gambling in Italy.

| Variables/specifications | MIMIC1 | MIMIC2 | MIMIC3 | MIMIC4 |
|--------------------------|--------|--------|--------|--------|
| **Causes**               |        |        |        |        |
| GDPpc                    | −0.180** | −0.177*** | −0.187** | −0.186*** |
|                          | [0.082] | [0.069] | [0.083] | [0.071] |
| UN                       | −0.007  | −0.001  |        |        |
|                          | [0.098] | [0.100] |        |        |
| EDUC                     | −0.261*** | −0.26*** | −0.259*** | −0.259*** |
|                          | [0.097] | [0.093] | [0.092] | [0.089] |
| WIN                      | 5.408*  | 5.456** | 6.211** | 6.219** |
|                          | [2.898] | [2.832] | [2.989] | [2.927] |
| VLT                      | −0.395  | −0.393  |        |        |
|                          | [0.475] | [0.476] |        |        |
| NEWSLOT                  | −0.294* | −0.295* | −0.325* | −0.325** |
|                          | [0.16]  | [0.16]  | [0.16]  | [0.169] |
| **Indicators**           |        |        |        |        |
| COIN                     | +1      | +1      | +1      | +1      |
| PEOPLE_REPORTED          | 0.471** | 0.469*** | 0.441*** | 0.441*** |
|                          | [0.19]  | [0.19]  | [0.179] | [0.179] |
| CRIMEVIOL                | 0.081** | 0.081*** | 0.078*** | 0.078*** |
|                          | [0.032] | [0.032] | [0.030] | [0.031] |
| **Statistical tests**    |        |        |        |        |
| Root mean square error of approximation (RMSEA) | 0.008 | 0.022 | 0.008 | 0.027 |
| Coefficient of determination (CD)     | 0.876 | 0.875 | 0.872 | 0.872 |
| Observations             | 120     | 120     | 120     | 120     |
| Satorra–Bentler chi² (p-value) | 11.81 | 11.20 | 10.954 | 10.93 |
|                          | (0.4607) | (0.3418) | (0.361) | (0.2057) |
| Comparative fit index (CFI) | 1.000 | 0.990 | 0.999 | 0.987 |
| Akaike information criterion (AIC)    | 3558.505 | 3058.069 | 3420.652 | 2921.938 |
| Bayesian information criterion (BIC)   | 3675.58 | 3152.844 | 3515.427 | 2997.2 |

Note: Standard errors are reported in parentheses. *, **, ***Significance at the 1%, 5% and 10% significance levels, respectively. Intercepts are omitted because they are not statistically significant. The models were estimated by maximum likelihood (ML) for a panel of 20 Italian regions over the period 2013–18. Standard errors are robust to non-multi-normality (Satorra–Bentler).
variables of IG are shown on the left and the indicators on the right. The expected signs are derived from the research hypotheses developed above. The full set of variables is presented in Table A1 in Appendix A in the supplemental data online, which also provides a synthesis of their descriptions and main statistics.

ESTIMATION RESULTS

Results of the detailed SEM applied to our sample of Italian regions over the period 2013–18 are provided in Table 2. To capture the magnitude and effect of different causal variables on the size of IG, we estimated four different specifications of the model. The first specification – MIMIC1 – includes all causal variables identified in previous section, whereas in the second – MIMIC2 – and third – MIMIC3 – we exclude all the not significant variables in order to determine the most pertinent causes that explain the existence of IG in Italy (as in MIMIC4). Before commenting on these results, it is worth noting that since our variables are not multi-normally distributed (see Table A2 in Appendix A in the supplemental data online), we use a robust maximum likelihood (ML) estimator that corrects for non-normality-induced bias in the standard errors and produces Satorra–Bentler \( \chi^2 \) (chi2sb). When observing the results, we notice that two of the six variables that we have hypothesized to be potential causes of IG are not statistically significant, namely \( UN \) and \( VLT \). For this reason, in columns 2 and 3 we provide results excluding, alternatively, these two variables, thereby confirming that, based on our theoretical considerations, all the causal variables behave as expected (except for \( UN \) and \( VLT \)).

As a result of this procedure, we can therefore conclude that the main driving factors of IG in Italy are \( GDP_{pc} \), \( EDUC \), \( WIN \) and \( NEWSLOT \), as in specification MIMIC4.

The structural equation resulting from our model is:

\[
IG_{kt} = -0.186GDP_{pc_{kt}} - 0.259EDUC_{kt} + 6.219WIN_{kt} - 0.325NEWSLOT_{kt} \tag{1}
\]

Equation (1), together with the benchmarking or calibration procedure, allows us to provide some indication about the trends of IG in Italy over the 2013–18 period. Without a doubt, the benchmarking or calibration procedure is one of the most critical points when applying the MIMIC model method. This is because the MIMIC model ‘simply’ provides an estimation of the relative evolution in size of an unobserved economy over time or, more correctly, as stated by Joreskog and Goldberger (1975), it is supposed to be estimating a ‘latent variable’, which is a sort of ‘hypothetical construct’ that cannot be directly observed but has ‘operational implications for relationships among observed variables’ (Joreskog & Goldberger, 1975, p. 631). In the literature, the issue of benchmarking procedures is widely discussed, but ‘there is no agreement on which procedure is superior to the other’ (Hassan & Schneider, 2016, p. 331). However, all procedures require prior knowledge and estimation of

Figure 2. Estimates of illegal gambling for Italian regions.
the latent variable that is to be measured. In order to calculate the size of IG in the Italian regions, an exogenous estimation of the relative size of IG at regional level is needed. To the best of our knowledge, this data is not yet available, so we can only provide (some) indications relating to the trends of IG.2

Keeping in mind this aspect, in the current study we calculate the following index:

\[
IG_{kt} = \frac{\hat{IG}_{kt}}{IG_{index\ base, 2013}}
\]

where \(\hat{IG}_{kt}\) denotes the value of the MIMIC index for each region \(k\) at time \(t\) according to structural equation (1); and \(IG_{index\ base, 2013}\) is the value if the MIMIC index in 2013 (our base year). The index \(IG_{kt}\) will assume the value of 1 for each region in 2013, while for each subsequent year (\(t = 2014, 2015, 2016, 2017, 2018\)), it will measure deviations from the base year.3

Figures 2 and 3 provide a representation of the trend in Italian IG, estimated by region over the period 2013–18. The IG regional indexes generally show an upward trend in the first years of the period, followed by a decrease in the period 2017–18. Regional disparities could reflect differences in terms of local regulation as a number of municipalities have taken measures aimed at reducing the number of amusement machines by limiting the times and places where gambling is allowed (Rolando et al., 2020).

CONCLUSIONS

By using the MIMIC methodology, our study proposes an empirical estimate of the amount of non-observed gambling from amusement machines in Italy over the period 2013–18.

Various contributions regarding the evaluation of non-observed economic activities have recently shown the potential of the MIMIC methodology, whose limits essentially relate to the selection of the cause and indicator variables, for which careful analysis of the relevant literature is necessary.

The structural equation derived from our analysis confirms what has already been analysed in the literature on gambling, with reference to simple games such as amusement machines. The estimation results allow us to state that the share of IG is larger when the value of the winnings paid to players are high, in the form of cash prizes dispensed by the amusement machines. Moreover, it decreases when the number of places where it is possible to play legally and the number of authorized machines increases. Finally, we also find that individuals with low levels of education and low income are more likely to gamble illegally. Study of the indicators confirmed the consistency of that pattern. In addition, the indicators show that as IG increases, so do complaints and violations of the law.

Analysis of the regional IG index has shown an increasing trend in IG between 2013 and 2018 in the
Italian regions, with a peak in all regions in the two-year period 2016–17, with few exceptions.

In synthesis, our analysis conforms with the typical identikit of illegal gamblers: they have a lower level of education, a low per capita income and are drawn to the idea of their potential winnings. Furthermore, the analysis shows that an expansion in the legal offer will also strengthen the illegal offer, hence an increase in the availability of legal gambling outlets leads to an increase in IG. From these results we can derive important policy indications on how to contrast IG.

According to our analysis, IG needs to be contrasted by means of information policies that aim to raise awareness in those disadvantaged consumers who are most at risk, informing them of the dangers intrinsic in the world of IG, rather than by means of the demonization or outright repression of gambling. A second policy lever can be applied by strengthening legal channels, especially in terms of monitoring and controlling players. As the legal gambling offer becomes increasingly widespread, there will be growing opportunities for IG to expand. This is an important issue for political debate, suggesting that by monitoring the behaviour of consumers in legal gambling, players could be oriented towards a more mature and responsible relationship with gambling in general. In this way, consumers could be dissuaded from shifting towards IG, leading to a decrease in further complex phenomena such as problem gambling, and excessive or pathological gambling.

Future developments of this paper should include an analysis of the relationship between physical and virtual gaming. Our analysis considers only physical amusement machines and not the equivalent online slot machines. The Covid-19 pandemic has resulted in the closure of gaming venues for many months, encouraging the migration of consumers to online channels where new forms of IG are available. A development of this paper could also consider an estimation of the substitutability between physical and online gambling, with the ultimate aim of estimating IG overall.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

NOTES

1. Following the main literature, the choice of the MIMIC model was based on several model-fit characteristics. Overall, a perfect model fit requires an insignificant chi-square (i.e., p > 0.05), a comparative fit index (CFI) closer to 0.95, a standardized root mean square residual (SRMR) closer to 0.09 and a root mean square error of approximation (RMSEA) closer to 0 (Hassan & Schneider, 2016).

2. The authors thank an anonymous referee for very helpful comments.

3. If we had known an exogenous value (i.e., in 2013 euros for each region), we could have multiplied it and obtained an index of the scale (e.g., if your IG_base, k, 2013 = €IG, then the index would have measured illegal gambling in euros for each region).

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