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A Physical Point of View to Some Gambling Problems of Totto, Lotto and Euromillions Lottary: from Principles to Practice

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Abstract. All possible faults of participation in Totto games by means of full or shortened combination forms are duscussed. The influence of these faults could be restricted, using an oriented choice of winning ball-numbers *a priori* and a special method of evaluation the results obtained *posteriori*. Physical, graphical and mathematical models in the field of 6/49, 6/42 and 5/35 Totto games are described and the best ways for their application are proposed. The author's conclusions, experimented during the last 20 years, are in agreement with all printed materials, published by the Bulgarian Sport Tottalizator (BST).

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1 Introduction

Over the last few decades some games of chance like Euromillions Lottary in Western Europe and Lotto and Totto games in Eastern Europe, increased the interest of millions gamblers to permanent participation. The author of this paper aims to justify and revise such interest from a physical point of view, based on his own 50-years of observation and experience. As a result, the process of "writing" combination formes can be transformed to their "designing" with some author's recommendations for application.

The drawing out procedure of winning ball-numbers (BNs) in the above mentioned games, based on using full or shortened combination forms,is carried out in the information space as three separate events (termed "stages" below) but occurring simultaneously in time.

1.1 Initial stage

The purpose here is as many BNs as possible to be hit, for example at least 3 from: 18 BNs in the case of Totto 6/49 and 6/42 or 15 BNs in the case of Totto 5/35.

1.2 Intermediate stage

Now the purpose is at least 3 from all BNs, successfully passing (1.1) stage to fall in one and the same drawing (*first, second* or *third*). Note that if a gambler participates in Totto games with ***full*** combination forms, a possible success in this stage is overturned directly into a winning, whereas every participation with ***shortened*** combination forms is another case, further discussed in detail.

1.3 Final stage (shortened combination forms only)

It is necessary now BNs successfully passing (1.2) stage to fall at least in one combination,not shortened preliminary in the price list of BST. Otherwise the primary success registered at (1.1) and (1.2) stages decreases or vanishes as effect, called "*breakdown winnings*". For example, some successively hit BNs at high levels ("6" and "5") in (1.2) stage are transformed to lower levels like "4" , "3" or "2" in (1.3) stage.

The full or partial success registered in the course of the entire drawing procedure (1.1) to (1.3) is of probable nature. Moreover, the winning as a final effect from the drawing out procedure, constitutes a success only in the third stage. Also note that any failure in the i-th stage leads to a failure in all the next $i + 1$ stages.

Outline. The **basic parameters** of a shortened Totto combination form are the following ones:

- n, the number of BNs paid for;
- m, the number of combinations in the full or shortened combination form paid for;
- k, the system number of combination form according to the price list of BST;
- P, the price of combination form paid for.

The purpose of this paper is to study some possibilities for realization of probable success in stages (1.1) to (1.3) in drawing out procedure,regardless of a trivial use of gigantic values of parameters n, m and P to assure some success and gain. That is why we begin with a review of faults made during any participation in Totto games: *firstly* made (Section 2) in a chronological order according to the drawing out procedure and *secondly* made (Section 6), according to their importance related to the final success. Some drawing out procedures after 1990s of 6/49 Totto game in Bulgaria are used as examples in our study.

A graphical model, permitting an express determination *a priori* the probability every BN to be hit (based on a special choice of BNs) is presented in Section 3.

Further they are named "*oriented BNs",* in contrast to the oposite case of "randomly" chosen BNs, entered in the final list of combination forms and named "*random BNs*.

Another linear model, designed to compare the results *posteriori* from the oriented and random choice of BNs is described in Section 4.

Some expectations for a success in a calendar plan basing the results reported in the paper are discussed in Section 7.

2 All Faults Related to Totto Game Participation

All BNs according to their probability W to be hit in a drawing procedure, could be divided into the following three groups:

- of high probability, for example $W_h \gg 0.5$;
- of low probability, for example $W_l \ll 0.5$;
- of indefinite probability, for example $W_o \sim 0.5$.

2.1 Starting faults of the (1.1) drawing out stage

The *first* fault of the participation in Totto games is when the gamblers fill their combination forms without knowing even approximately the values of W_h, W_l, and W_o. On the other hand an application of Poisson theorem, permitting exact calculation of these probabilities is a formidable task. *Second*, in the correlation

$$W_h : W_l : W_o = x_1 : x_2 : x_3 \tag{1}$$

the values of x_i, $i = 1, 2, 3$ are unknown statistical variables for every act of drawing. For this reason, the choice of x_i values has to be taken randomly. The only known fact is that usualy the amount of BNs with probability W_h is generally above 90% of the amount of BNs of probability W_l and W_o as a whole. Some possibilities for an express determination *a priori* the probabilities W_h, W_l, and W_o of BNs are presented in Section 3.

2.2 Uncontrollable faults at (1.2) stage

The process of BNs falling in one and the same drawing out ("first", "second" or "third") is an entireley random effect and beyond of any control. That is why, it is not discussed further.

2.3 Faults of the final winning stage (1.3)

Since this stage is missing in the case of a participation with full combination forms in Totto games every use of a shorten combination form has to be treated as a *symbolic fault* of participation in Totto games.

In the case of Totto combination systems with *shortened* forms the breakdown winning effect can be restricted to the following precautions, both discuissed in Section 4:

- a suitable choice of boundary values of parameters n, m, and P;
- the use of compact systems of shortened combination form, only.

3 The Orientated Choice as a Graphic Methodology

3.1 The tunnelling effect in semiconductor physics as a gambling model of the success in Totto games

Let us consider the energy diagram of one-dimensional superlattice of triple semiconductor compound like GaP-GaAs-InP, as it is shown in an arbitrary scale in Figures 1*a,b*. Here E_c denotes the conduction-band edge, E_v – the valence-band edge, $E_{_F}$ – Fermi level and E_0 – vacuum level. It is seen that this superlattice is formed on the base of three neighbouring potential wells, crossed by transitions of electrons in a horizontal direction, known as "*tunnelling effect*". Such a probable model of "electron transition" permits one to make an analogy with a probable "success transition" across gambling well (GW). Here (see Figure 1*c*) the success as tunnelling gambling effect is presented by an arrow. The entire triplicated GW as a model of the 3-stage drawing out procedure (see Section 1), is briefly presented by some examples in Table 1.

Table 1. Various levels of realization of success

Graphic presentation of GW:	1GW Initial success	2GW Middle success	3GW Final success
Surface	The number of hit BNs is near to total drawn number	Great number of hit BNs in one and the same drawing	Great number of full combinations with hit BNs
Middle $\longrightarrow$ *success*			
t Bottom	Less than 3 hit BNs	There are less than 3 hit BNs in one and the same drawing	There are no combinations with more than 2 hit BNs

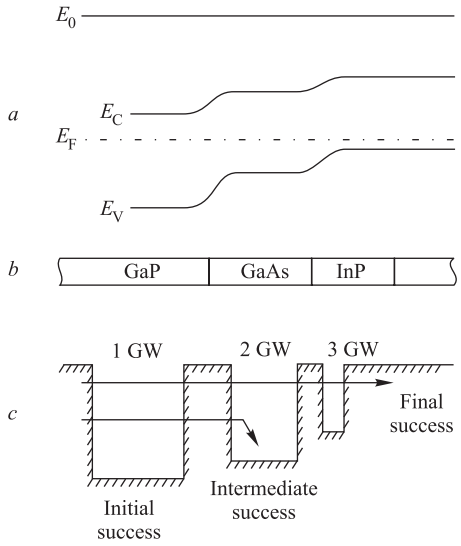

Figure 1. Energy diagram (*a*) of a superlattice of triple semiconductor compound (*b*), and a model of triple GW (*c*).

The probable gambling success, overcoming the triplicated GW discussed above, corresponds to the total probability of

$$W = \prod_{i=1}^{3} W_i \,, \tag{2}$$

where W_i denotes the probability of overcoming the i-th GW. Section 3.2 and Section 4 describe some possibilities for W increasing, by increasing the values of W_1 and W_3, respectively.

3.2 Histograms for an oriented choice of BN

Let us denote by f the frequency of a drawing out procedure of BNs for a given interval of time length between two drawings of several weeks, several months, several years, *etc*. The graphic presentation of *frequency-time* dependence further is named "*first type histogram*", because the data are arranged in the form of columns. A documental example of such a histogram after 28 drawings out of 6/49 Bulgarian Totto game during 1996 year, is presented in Figure 2a.

The next Figures 2*b* to 2*d* represent the dynamic change in the form of histogram as **deformations** of its bell shape and **rearrangements** of its BNs. The subject is the histogram in Figure 2*a*, presented in one and the same scale during: 6 years (Figure 2*c*) and 17 years (Figure 2*d*).

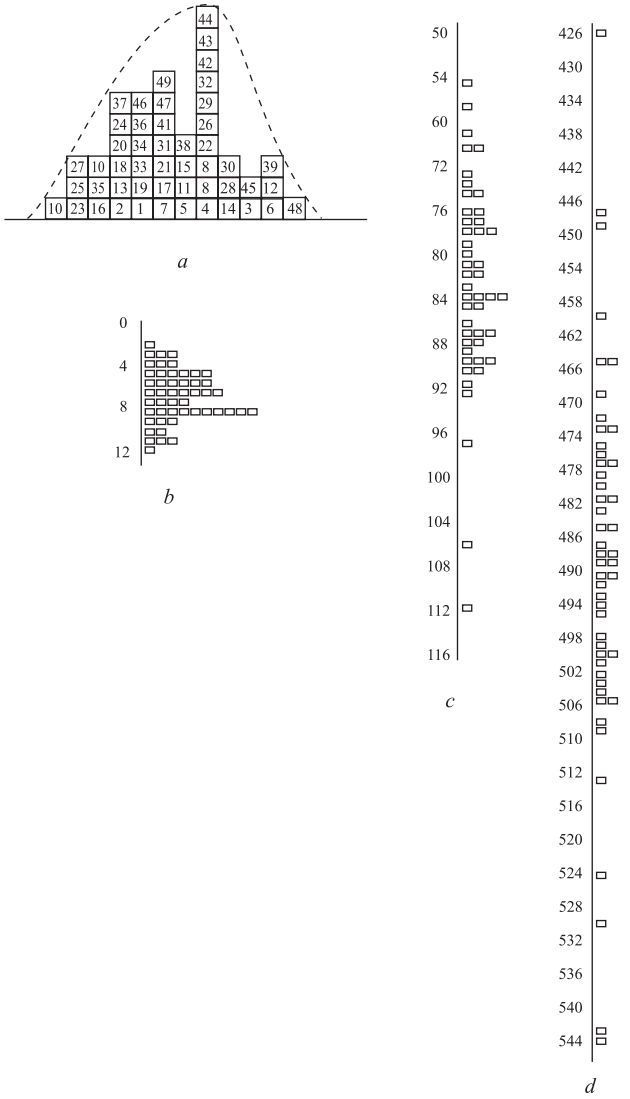

Figure 2. Histograms of BN hit in drawings out: (*a, b*) from No 1 to No 28 of 1996; (*c*) from No 27 of 1990 to No 28 of 1996; (*d*) from No 27 of 1990 to No 104 of 2007.

It is seen how after several weeks the bell shape of Poisson distribution is already formed (a), across several years (b), to nearly by two decades (c) – when the bell-shaped dependence is broken to separate BNs. The visible changes of the histograms could be summarized in the following deformations:

– the height of ball-numbers columns decreases;

– the initial graphical or numerical symmetry existing is changed to a total asymmetry.

All these deformations are used for the purpose of a probability oriented choice of BNs, made *a priori* drawing out procedure.

First consequence. The visible overturning of BNs from the higher to the lower columns of histograms (see Figure 2) has direct analogy with the "success transition" across 1 GW, discussed in Section 3.1. Each high column is a source of BNs going down, *i.e.* all BNs in such columns have a raised probability for being drawn drawing out in comparison with other BN outside the column. For example, in Figure 2*a* such "high probability" BNs are those of frequency f, equal to 7.9 and 12. That is why the highest columns in every histogram could be named "***stick up***" columns and their BNs can be treated with probability for drawing out W_h.

An opposite case of columns collapsed (corresponding to BNs in the bottom of 1 GW from Table 1) are those of frequencies $f = 8$ and $f = 11$ in Figure 2*a*. These BNs could be named "***holes***" and their probability for being drawn out corresponds to values W_l.

Second consequence. Another source of deformations in the histogram discussed now are all symmetric numerical or graphic forms, existing or appearing during some drawings. For example, such symmetric configurations with BNs are the following two ones, seen in Figure 2*a*:

- two columns with BNs of frequencies $f = 3$ and $f = 4$, as well as $f = 5$ and $f = 6$, which all could be named "***tables***";
- BNs as 33 and 34 (in column of $f = 6$) as well as 8 and 9 (in column of $f = 9$) could be named "***neighbours***".

Also, the symmetry of BN 7 in Figure 2*a* coinciding with its frequency $f = 7$, also is a source of deformation, named "***coincidence***" and characterized with values of probability W_h for hit. Finally, BNs of a "***single position***", separated between them (see the histogram in Figure 2*d*), can be treated as BNs with "indefinite" probability W_o for hit.

A summing of all BNs with highest values of their probability for a hit (satisfying the above mentioned graphic by several criteria simultaneously), permits one to form a final list of BNs for his paid combination forms. All details of this procedure as sequential algorithms (of updated interest for PC use) are given in the book [1].

How many oriented BNs one has to include in his final list, is a subject of the next Section 4.

4 Recommended Values of Parameters in the Case of Shortened Combination Forms

This Section gives some useful information about the choice of the most suitable values of n, m, and P.

4.1 The compact shortened combination form

First of all we note, that the following condition for a ***compact*** shortend system has to be realized:

$$m/n \gg 1. \tag{3}$$

Second, raising n and m, the price of combination form P increases faster in the case of m than in the case of n, as it is seen in Figure 3. This means that it is cheaper for one to rise the number of combinations m than the number of BN n, included in these combinations.

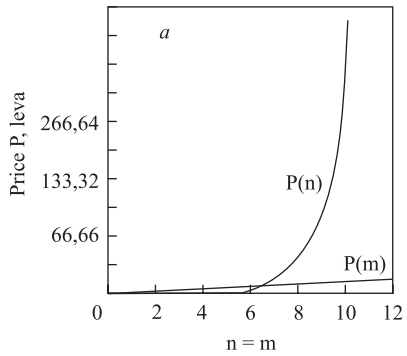

Figure 3. Graphical dependence of the price, P, of combination form on the number of BN, n, and the number of combinations, m.

4.2 The maximum

If one desires to participate in the game simultaneously with many BNs, n, and many combinations m (called a "trivial" decision), this is impossible due to two reasons:

- it is difficult for one to waste a mint of money;
- when varying the number k of shorten combination systems (see the price list of BST) their maximum value should not exceed: $n_{\max} = 30$ at Totto 6/49 and 6/42 as well as $n_{\max} = 17$ at Totto 5/35.

That is why

$$n_{\max} \leq 30 \quad \text{for Totto 6/49 and 6/42} \tag{4}$$
$$n_{\max} \leq 17 \quad \text{for Totto 5/35.} \tag{5}$$

4.3 The minimum

Some observations and experiments show that below a certain value of $n_{\min}$ even though the condition (3) is satisfied, the probability for winning goes to zero. Against a similar effect, a simple equation in the field of all Totto games is suitably applicable

$$f/(F - n_{\min}) = 1.4, \tag{6}$$

where F gets values of 49, 42 or 35, corresponding to the Totto game type.

4.4 A compromise

Having in mind the restrictions (4) and (5) and Eq. (6), one can obtain the entire interval of values of n and m assuring probable success in a forthcoming drawing out. This range of values is

$$14 \leq n \leq 30 \quad \text{for tt 6/49} \tag{7}$$
$$12 \leq n \leq 30 \quad \text{for tt 6/42} \tag{8}$$
$$10 \leq n \leq 17 \quad \text{for tt 5/35,} \tag{9}$$

also keeping the condition (3) in the case of shorten combination forms.

5 Experimental Verification of Oriented BN Choice

5.1 linear model of random BN choice

Let us denote by x the number of BNs hit in a drawing out procedure. Since x is directly proportional to the number of BNs, n, in the combination form, the following linear equation is valid:

$$\frac{x}{n} = \frac{z}{F}\,, \tag{10}$$

where z is the total number of Bs hit: 6 in one drawing, 12 in two drawings and 18 in three drawings.

Equation (10) describes all Toto games, independently on the type of BNs choice: whether it is designed for random or oriented BNs. For example, in the case of Totto 6/49 (three drawings), Eq. (10) is transformed to

$$x = 0.364n\,. \tag{11}$$

Table 2. Equations for the expected BN hit in Totto games

Number of drawings	Equatons (8)		
	6/49	6/42	5/35
One	$x = 0.123n$	$x = 0.143n$	$x = 0.143n$
Two	$x = 0.245n$	$x = 0.286n$	$x = 0.286n$
Three	$x = 0.364n$	$x = 0.429n$	$x = 0.429n$
Four	$x = 0.490n$	$x = 0.571n$	$x = 0.571n$

Table 2 presents: all Totto game varieties, also all possible cases of one, two and three drawings, also the random and oriented BNs choice.

A graphical presentation of Eq. (8) is illustrated in Figures 4*a* and *b* for Totto games 6/49, 6/42 and 5/35 in the case of three drawings. All *calculated* points from the lines correspond to a random choice of BNs, while really (experimentally) obtained points ***above*** the lines denote a choice, better than the random one. Every experimental point ***under*** the lines represents a worse choice than the random one.

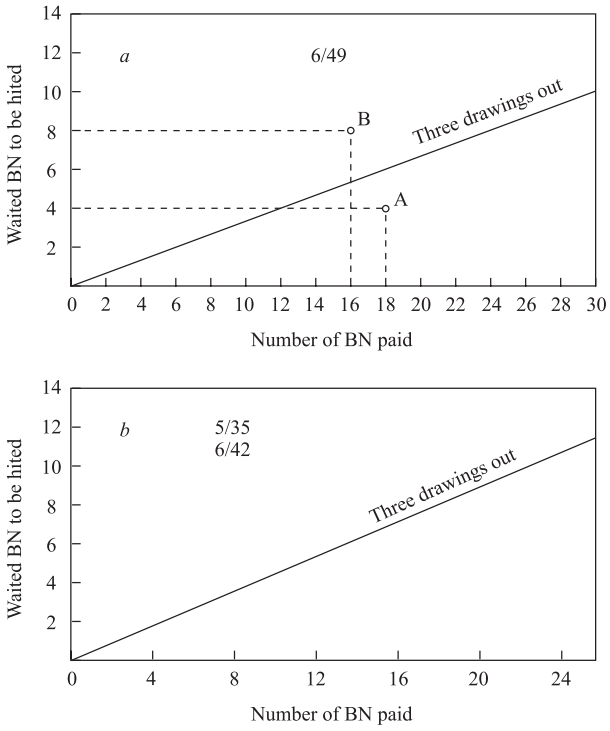

Figure 4. Graphical illustration of linear Eq. (10) for random BN choice.

5.2 A comparison between the oriented and random BN choice

Let us define effectiveness Δ as a difference between the number of BN hit in reality x_r and the number of BN, x, calculated using Eq. (10)

$$\Delta = x_r - x\,. \tag{12}$$

Let us consider as a *first* example participation in 6/49 Totto game with a combination form, consisting of oriented BN with a parameter:

$$n = 18\,.$$

If the gambler hit $x_r = 4$ oriented BN only (see point A in Figure 4*a*), this event means that his result is below the number of BN randomly chosen. Then, using the graphic data in Figure 4 the effectiveness for x obtained from (12) is *approximately*

$$\Delta = -2\,,$$

or *exactly calculated* from Eq. (11)

$$\Delta = 4 - 6.552 = -2.552\,.$$

Let us consider as a *second* example participation in 6/49 Totto game with

$$n = 16\,,$$

when another gambler hit 8 oriented BNs (point B in Figure 4a). Then the effectiveness is

$$\Delta = 2\,.$$

The next Figure 5 presents some experimental data for the effectiveness Δ, evaluated during 13 nonstop drawings in 2008. It is seen that in 77% the effectiveness Δ is of positive sign, regardless whether there is or there is not a registration of some winnings.

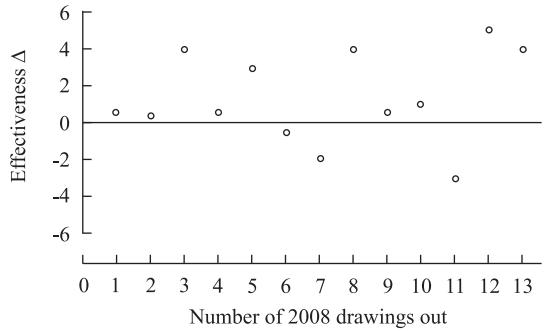

Figure 5. The effectiveness of BN oriented choice, evaluated from several series drawings during 2007/2008.

6 Once Again about the Faults

Having in mind the preceding presentation, all faults discussed in Section 2 are reevaluated.

First group faults are those, which are out of control in the drawing procedure:

- to hit BNs in one and the same drawing out;
- to know the exact uncertainty percentage of oriented BNs with high, low and indefinite probability.

Note that the presence of such most essential faults explains why the big winnings in all games of chance like Totto are exclusively rare events.

Some gambling events permitting partial control in the drawing procedure, represent generators of a **second group** of faults like the following ones:

- the faults, related to the success traversing the 1 GW could be minimized, using the express graphic method for a determination of the probability values to hit BNs;
- the faults, related to the success across 3 GW (only in the case of participation with shortened combination forms) could be minimized using *suitable* numbers k of the shortened combination systems, satisfying conditions(7-9).

It is possible a **third group** of faults to be outlined. The existing of such faults (usually due to a lack of consideration and experience) is not correctly, since in a well designed and verified combination form, any presence of such faults is an anachronism. Note also, that the use of a growing histogram (formed after several drawings only), also is a source of poor reliability for a further success.

Finally, even though the use of graphical method is effective, only separate (not all) BNs from column like "stick up" or "tables", or "neigbours"' *etc.*, are hit simultaneously.

7 Prediction Algorithm

The models, methods and recommendations reported in this paper and aimed as "success" or "gains", are tested and verified *in time* by special observation, here named "prediction algorithm". It is illustrated in Figure 6 by our experimental data, obtained during several years of participation in the 6/49 Totto game in Bulgaria. The prediction algorithm is referred to (1.2) intermediate stage only, excluding (1.3) final stage of drawing out procedure.

No existence of 6 BNs hit in one and the same drawing in our data so far.

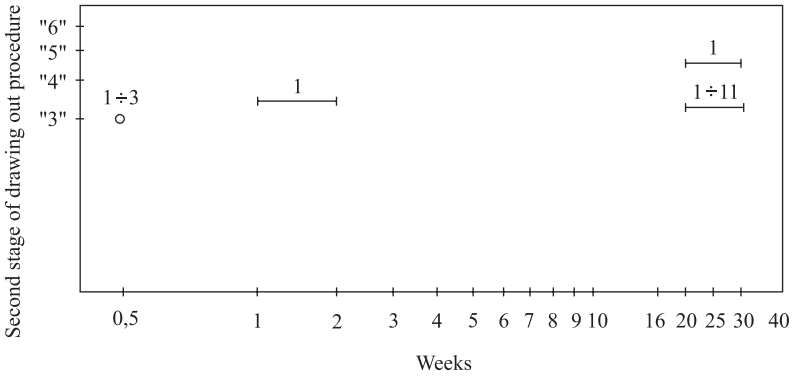

Figure 6. A prediction algorithm of success at intermediate stage of drawing procedure.

8 Conclusion

All possible faults of participation in Totto, Lotto and Euromillions Lottary with full or shortened combination forms are reviewed. A physical model (Section 3.1), a graphical model (Section 3.2) and a linear mathematical model (Section 5.1), studied in this paper, permit Totto, Lotto and Euromillions Lottary games to be transformed in design and calculation, directed towards a systematic and expected realization of probable success and winnings (Section 7).

References

[1] N. Borissov (2006) *Ball-Numbers of Raised Probability for Drawing out in Totto Games*, "'Prof. M. Drinov Academic Press", Sofia, in Bulgarian.