

# The “Norwegian Soccer Wonder”

## *A Game Theoretic Approach*

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### Abstract

This paper proposes a simple game theoretic framework for analyzing strategic choices in soccer matches. This framework is applied in order to explain the rise and fall of soccer nations like Norway, who reach international competitive performance by introducing specialized strategies.

Additionally, it is shown that the best choice for such teams may – at certain time points in their “life cycle” – not be to improve their preferred strategy further. It is actually possible to show that such a strategic choice may be disadvantageous.

Finally, certain cases are shown to have characteristics such that it is “optimal”, in a game theoretic perspective, to actually decrease playing strength in order to “flip” the Nash equilibrium to a more suitable one. As such, “unexpected” behavior of very good teams choosing to lose against very bad teams may be explained.

*Key words:* behavioral/social science, game theory, soccer strategy, Nash equilibrium, adverse behavior

## 1 Scientific soccer – some historic remarks

Largely, soccer has evolved more or less unscientifically. If one reads soccer literature, it is full of myths, allegations and non-scientific judgments, with a few noteworthy exceptions. Work by the former (and present) Norwegian national team manager and University professor Egil ”Drillo” Olsen [13], [14] may stand as an example on these exceptions.

In his 1974 master thesis, Olsen [13] did a fairly thorough empirical analysis with the aim of establishing which type of game-play that resulted in goal scoring. Table 1 sums up his basic findings.

Table 1 *Number of passes (%) by the scoring team before a goal [13]*

Number of passes	0	1	2	3	4	5	6	7	8	9
Distribution (%)	7.9	36.5	12.7	7.9	15.9	11.1	1.6	0.0	3.2	3.2

A clearer image is obtained if table 1 is written as in table 2:

Table 2 *Number of passes (%) by the scoring team before a goal [13]*

Number of passes	$\leq 2$	$> 2$
Distribution (%)	57.1	42.9

As table 2 indicates, more than half of the goals are scored with less than 3 passes. In Olsens’ master thesis, the tactical and strategic consequences that could be inferred from the above empirical analysis is not explicitly stated. However, in later work [14], Olsen is more direct:

The balance of the opponents’ defence decides our tactics. When we meet a more or less unbalanced defence, i.e. after a breakdown, our penetrating approach is evident. We try to finish the attack as soon as possible...

Figure 1 may clarify.

In figure 1, a ”typical” Norwegian goal is compared to a ”typical” normal goal – the notable difference is most obviously the number of passes. Hence, what Egil Olsen did was to apply his simple empirical findings into a style of play characterized by:

- If the opponent is balanced (i.e. has enough players behind the ball) use the long pass)
- If the opponent is unbalanced (i.e. a breakdown has emerged) attack fast and with few passes.

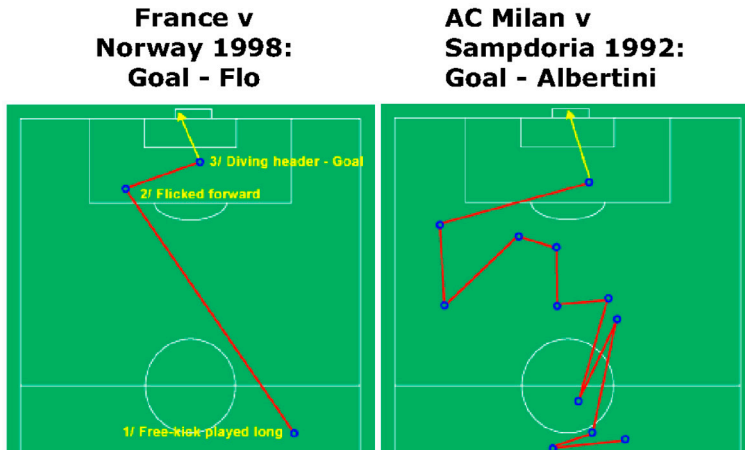


Figure 1 *Norwegian national team playing style*

That is, the key to a successful attack is to be able to win the ball in a favorable position during the opponents attack and then counterattack fast. Consequently, the defence plays a critical role in the attacking strategy. Simply put, the old saying “attack is the best defence” became the opposite, “defense is the best attack”, in Olsen’s terminology.

## 2 The Norwegian soccer wonder

It is interesting to see the effects of this strategy on Norwegian national team results. Figure 2 shows the Norwegian national team’s performance during the last 30 years [11]. The curve (blue) contains data for each year involving only EC and WC qualifier games with the total point score (in a 3-1-0 system) divided by the number of such games played. The red horizontal curves show the average of the blue curve for each manager in the same period.

If the red horizontal curves are compared, it is obvious which coach has the best record – Egil Olsen. He has an average point score of around

2.3 in his period, while the second best, Nils J. Semb has around 1.2.<sup>1</sup> The period before Olsen, with averages way below 1 stresses what (some) experts tend to call "The Norwegian football wonder" – the incredible performance enhancement under the leadership of Egil Olsen.

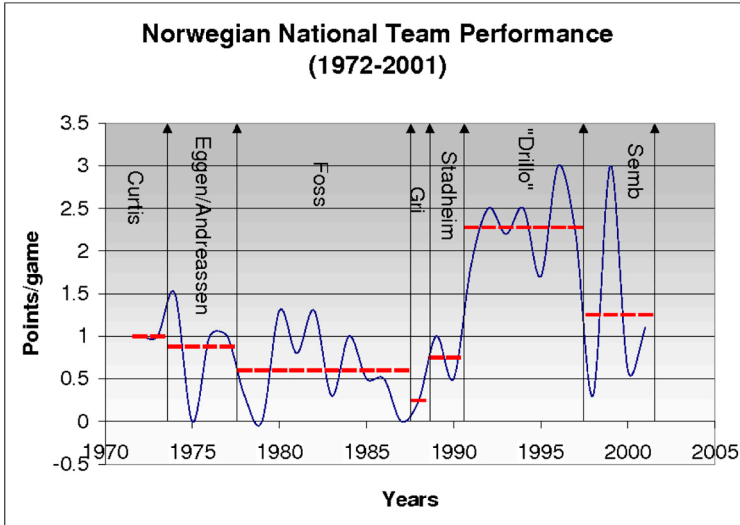


Figure 2 Norwegian national team – historic results

Our concern here is not so much this fact and possible reasons for it, as the subsequent period and the obvious performance decrease which may be observed by figure 2

The question "Why has the Norwegian national teams performance decreased to such an extent the latter years?" will hence be examined somewhat further. In order to address this question, an alternative data set will be used. This data set [10] shows a historic record on Norway's rank (i.e. number on the FIFA/Coca Cola world ranking) over a time span from 1993 up to 2002. These data are shown in figure 3.

The reason for applying these data, as opposed to the data in figure 2, are mostly due to a better time resolution – the data typically spans around 12 observations per year – but also, the fact that these data actually are real – in the sense that they are used as a base for various rankings on national seeding and so on.<sup>2</sup>

<sup>1</sup> The two averages differ significantly (more than 99%) by a standard t-test.

<sup>2</sup> The fact that the FIFA/Coca Cola rankings by many people, both experts and amateurs, are viewed as non correct and unjust is really not the point here. Actually,

In trying to answer the above question, which by the way (obviously) has been the topic of many TV-shows and newspaper articles in Norway the latter years, many more or less subtle explanations arise. These explanations range from the more obvious ones, the change of coach and all possible personal differences between Mr. Semb and Mr. Olsen to lack of success for Norwegian players playing abroad.



Figure 3 *Norwegian national team – historic FIEA rankings*

Surprisingly few have addressed the most evident of all explanations, the opponent's strategic changes to Norway's playing style. The problem with the Norwegian playing style, described briefly in section 1, is that it is very easy, for the opponent, to find countermeasures – the attacking efficiency is hence very vulnerable.

As discussed previously, Norway's style of attack is regarded most efficient when Norway is able to win the ball during the opponents attack, and especially efficient (of course) when the ball is won in a favorable position. A favorable position is surely most favorable when the ball is won as close as possible to the opponents goal and when as many opposing players as possible isn't behind the ball. For a scenario described above to happen, it is evident that the opposing team must play through midfield, i.e. not play (as Norway typically does when the opponent is balanced) long passes over midfield. Consequently, it is actually very easy

various sources are so displeased by these rankings, that alternative rankings are constructed. See for instance [8] for more information on these matters.

to neutralize the Norwegian attacking strategy by simply doing the same as Norway do,<sup>3</sup> use the "long ball" – see [14] for a comprehensive discussion of these matters. Then, if the opponent player by player is better, in most games, Norway should lose. Consequently, Norway's performance during this time period should, if the opponents are not very foolish, decrease.

Probably the most typical example on a Norwegian opponent actually applying a strategy fairly similar to this one is the 2-2 game against Morocco in the 1998 World Cup finals in France. This was the opening match, and Norway was assumed favorites. To much game reporters surprise, Morocco used the "long ball" a lot, actually scoring their two goals by this strategy, and the extract from the Norwegian internet newspaper in figure 4 describes the Norwegians astonishment.

## Grodås: - Marokko spilte likt oss

Av: [Jon Hagebo](#) 11 jun 1998 6:22

**MONTPELLIER (Nettavisen): Keeper Frode Grodås var en av Norges beste spillere. Han mente Marokko overrasket noe. - Det spilte veldig likt oss, sier han til Nettavisen**



Figure 4 *Extract from an article in "Nettavisen"*

The headline from figure 4 translates to: "Grodås (The Norwegian goal keeper): Morocco played like us".

Surely, as Norway reached a competitive level fairly early in Egil Olsen's coaching career – Norway was ranked as the second best national team in October 1993 – we should expect a gradually decreasing performance structure much before the change of coach in June 1998. Actually, if the FIFA ranking may stand as a suitable measure on the performance level of Norway, it is not too hard to establish circumstantial evidence for such a hypothesis.

<sup>3</sup> A "follow the leader" strategy in game theoretic terms.

In figure 5, trend-lines<sup>4</sup> for the two coaching periods are added. As both lines indicates, on average, Norway's FIFA ranking was decreasing in both periods. Surely, the SEMB period has a steeper descent, but this does not necessarily indicate that Semb's qualities as a coach are the reason.<sup>5</sup>

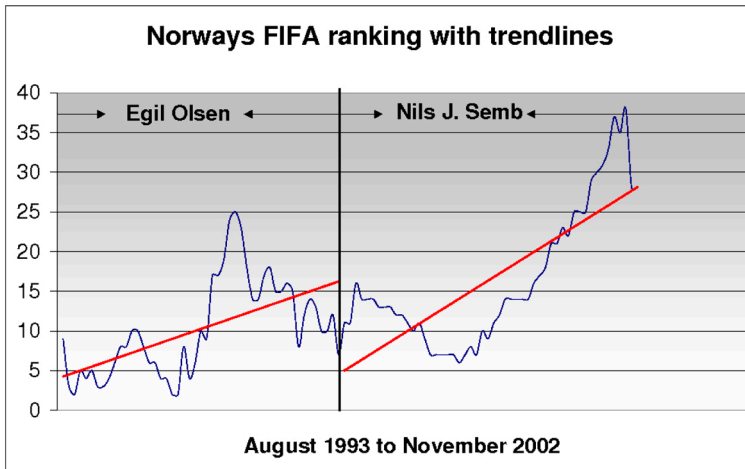


Figure 5 *Historic FIEA rankings – with trend-lines (Values higher up on the y-axis stand for lower FIEA rankings.)*

Hence, to sum up this line of arguing: Norway introduced a strict and simple playing style with Egil Olsen. The style proved efficient initially, but as Norway's performance level increased, Norway's opponents took notice – maybe already as early as before 1993 – and as countermeasures to the Norwegian style were easy to implement, Norway lost more games, and gradually their competitive position.

4 The term trend-line refers to estimation of two linear regression lines one up to 30 of June 1998 and one from this date and up to today. Regression analysis is discussed in any standard statistics text book, see for instance [12].

5 Actually, Nils J. Semb was picked by the Norwegian Football Association (NFF) as the coach that could carry Egil Olsen's work further. As a student of Olsen, and co-worker for many years, NFF could possibly not have found a coach more similar to Egil Olsen.

### 3 The game theoretic approach

What has this to do with Game Theory? Actually, this is the essence of game theory. If you play a game you should expect your opponents to be just as clever as yourself. If you apply strategies which are easy to read, and easy to find countermeasures against, you should definitely assume that your opponents would react, in their best interest.

In this perspective, how could the scientific method of Egil Olsen be described? Surely, he revolutionized Norwegian soccer, let there be no doubt about that. However, the approach of establishing empirical evidence in a game and then applying this type of evidence in decision making is hazardous – at least in the long run.

An alternative example may clarify. Assume one gathers statistics on the number of goals scored in penalty shootouts and split these data in two groups. One group contains all penalties aimed at the sides of the goal, the other group contains all penalties aimed in the middle of the goal. Assume further on that the goal scoring frequency is significantly different between these groups in favor of the penalties aimed in the middle of the goal. That is, according to our data, a penalty aimed in the middle of the goal has (historically) proved a more efficient strategy. Then, a strategy construction similar to the Norwegian national team style of play should mean that the coach should instruct his players to aim all penalties in the middle of the goal. Obviously, this is a hazardous strategy, and no soccer coach would ever give such instructions.

The point should be conceptually simple. In games, you must take your opponents choices into consideration, if not, the result may be disastrous.

### 4 Strategy and tactics for whole games

In subsequent sections, a set of simple game theoretic soccer models will be introduced. Strategic choices at a high level are the main focus, and the case of Norway will be examined specifically.

#### *4.1 Previous Research*

As the sports industry viewed in an industrial context is fairly new, it would be surprising if a rich literature covering these topics would ex-



ist. However, the US sports industry has reached economic significance at a much earlier stage in time, and as a consequence, one would expect more research from US sports like baseball, basketball and ice-hockey. This is indeed the case, and work by Quirk [16], Fort [4], Atkinson [1], Vrooman [18] and Rascher [17] may serve as examples of this literature tradition.

The contents of this research is mainly focused on the the topic of understanding the competitive development of a sports league – typically with emphasis on the US systems without relegation. Tools which are used are mainly of general equilibrium type and as such, this literature is sparse when it comes to explanation of teams' strategic behavior.

An alternative brand of research (recent) focuses on the strategic aspects of the game itself, which is the topic of this paper. Consequently, knowledge of this research seems evident. Work by people at Tilburg University in Holland (Palomino et. al. [15]) seems very promising as a starting point. This work uses a game-theoretic framework with emphasis on the match (that is two teams, two players and a dynamic strategy space). More recent work by Brochas and Carillo [2] apply this framework in analyzing award system changes as well as effects of the "golden-goal" rule. For this paper however, their approach is both too advanced and too limited. Consequently, an alternative (simpler and more flexible) modeling frame will be developed – however much in the spirit of Brochas and Carillo and Palomino et. al.<sup>6 7</sup>

#### *4.2 Basic Game modeling assumptions*

The list below states the basic assumptions used:

- 1) Two teams named  $T_1$  and  $T_2$ .
- 2)  $T_1$  has greater "playing strength" than  $T_2$ .<sup>8</sup>
- 3) Uncertainty regarding match outcome: Teams cannot predict the outcome of a game given known skills perfectly.<sup>9</sup>

6 Chiappori [3] et. al. also use game theory; analyzing penalty-kicks.

7 In a preliminary version of this paper (written around 1999), to my knowledge, these methods were not developed. However, during the last 5 years, I have written and published several other papers applying methods similar (however not equal) to the forthcoming constructs –see [6], [5], [7].

8 The term "playing strength" refers to a teams ability to beat another team and is assumed to be a combination of individual player skills as well as collective player skills. This is surely not a crucial assumption as the probability of finding two equally strong teams in practice is zero.

9 For practical purposes, this means that a probability of loosing or a draw always exists even in the case of Real Madrid playing against Flekkekameratene from Norwegian 6.

- 4) Both teams agree on each other's assessment of the uncertainty regarding match outcome. This means that the probability that team 1 beats team 2 (and all other probabilities involved) is assumed equal from both teams point of view.<sup>10</sup>
- 5) Two discrete strategic choices O=Offensive, D=Defensive (In reality of course, a continuous scale could be used here modeling different playing strategies.)
- 6) Both teams choose strategies simultaneously before the match. (Implicitly, this means a steady strategy during the match.<sup>11</sup>)
- 7) Points are given according to the following rule: W=3, D=1, L=0
- 8) "Rationality"; Teams maximize expected point score.

### 4.3 Input data

The consequence of assumption 3) – Uncertainty regarding match outcome is that both teams are unable to predict a match outcome based on all available information or to be more precise, all information is not available. Consequently, a model involving probability density modeling seems sensible. Assumption 4) and 5) leads to the fact that 4 probability densities must be estimated in order to model the given situation. The reason for this is given in table 3.

Table 3 *Probabilistic modeling*

Strategy of $T_1$	Strategy of $T_2$	$P(T_1 \text{ beats } T_2)$	$P(T_2 \text{ beats } T_1)$
O	O	$p_{12}^{OO}$	$P_{21}^{OO}$
O	D	$p_{12}^{OD}$	$P_{21}^{OD}$
D	O	$p_{12}^{DO}$	$P_{21}^{DO}$
D	D	$p_{12}^{DD}$	$P_{21}^{DD}$

Here, the probabilities  $p_{ij}^{xy}$  denote the probability that Team  $i$  beats Team  $j$  given that Team  $i$  chooses strategy  $x$  and Team  $j$  chooses strategy  $y$ . Hence,  $p_{12}^{OO}$  is the probability that Team 1 beats Team 2 given that both teams choose an offensive strategy (OO) while  $p_{21}^{OO}$  is the probability that

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division.

<sup>10</sup> A game of complete information in game theoretic terms.

<sup>11</sup> The biggest difference between this modeling and the modeling of Palomino et. al. [15] is probably here, as they allow for a dynamic changeable strategy during gameplay.

Team 2 beats Team 1 given similar strategic choice. The third probability – of a draw – is omitted as it always is 1 minus the other two given ones.

#### 4.4 Estimation of input data

Before more analysis is carried out, the question of whether such input data structures may be practically obtainable may be raised. Under the given assumptions it is necessary to observe the results of 2 teams playing against each other repeatedly. Additionally, strategic choices must be observed, and these choices must be static during the matches. Consequently, if Team  $i$  and Team  $j$  have played 50 games against each other, outcomes and strategic choices may be as table 4 indicates.

Table 4 *An example on how recorded and estimated data may look*

$T_1$	$T_2$	$T_1$ win	$T_2$ win	Draws	Games	$p_{12}$	$p_{21}$
O	O	3	6	2	11	0.27	0.55
D	O	6	20	1	27	0.22	0.74
O	D	1	0	3	4	0.25	0
D	D	1	1	6	8	0.125	0.125
Total		11	27	12	50		

The first 2 columns in table 4 ( $T_1$  and  $T_2$ ) denotes strategic choices in the recorded matches. The next three columns ( $T_1$  win and  $T_2$  win and Draws) are recorded game outcomes. The 6th. column, (Games), is just the sum of the three previous columns, while the last two columns ( $p_{12}$  and  $p_{21}$ ) are the estimated probabilities based on such a data set. The computations are simple; the value of 0.27 is for instance computed as  $\frac{3}{11}$ .

The problem (in practice) with this structure, is of course the simple fact that soccer teams choose from a much richer strategic space than our above assumptions indicate. Typically, for instance given that a goal is scored, a change in strategy (for both teams) is needed and also implemented. Consequently, it may be hard to perform an analysis of the type shown above. However, if a more complex strategic space is allowed, the principles remain (apart from the case where a dynamic adaptive strategy is used). In such a case, more complex game theoretic models must be applied.

#### 4.5 An example

Suppose that data is available, the next step is to calculate "Pay-off"-consequences. This is necessary as assumption 8) states that teams maximize expected point score. Given assumption 7) (A 3-1-0 point score), computing expected point scores is straightforward. Table 5 shows this computation for a given data set – this data set is just picked more or less at random.

Table 5 *Computed expected point scores*

$T_1$	$T_2$	$p_{12}$	$p_{21}$	$p_D$	Pay-off 1	Pay-off 2
O	O	0.8	0.1	0.1	2.5	0.4
D	O	0.3	0.2	0.5	1.4	1.1
O	D	0.65	0	0.35	2.3	0.35
D	D	0.1	0	0.9	1.2	0.9

Based on table 5, a normal form game may be formulated as in figure 6.

		TEAM 2	
		O	D
TEAM 1	O	0.4 2.5	0.35 2.3
	D	1.1 1.4	0.9 1.2

Figure 6 *A soccer match modeled as a normal form game*

## 5 The case of Norway

This section will apply the simple framework of subsection 4.2 to explain the rise and (possible) fall of small soccer nations like Norway.

### 5.1 Norway vs. Brazil

In order to analyze an actual (generic) match between an ordinary team like Norway and a much better team – say Brazil, probabilities like those of table 5 must be gathered. Unfortunately, national team games are played at such a low frequency<sup>12</sup> that it makes no practical sense to apply formal means in the estimation process. Consequently, some guess-work (or parametrization) is needed. To make the situation a bit "easier" for the Norwegian team, the match is assumed to take place in Norway. Table 6 shows an example of such guess-work.

Table 6 *Probabilities and expected point scores for an imaginary game between Norway and Brazil*

<i>N</i>	<i>B</i>	$p_{NB}$	$p_{BN}$	$p_D$	Pay-off <i>N</i>	Pay-off <i>B</i>
<i>N</i>	<i>B</i>	0.5	0.4	0.1	1.6	1.3
<i>A</i>	<i>B</i>	0.3	0.5	0.2	1.1	1.7
<i>N</i>	<i>N</i>	0.4	0.2	0.4	1.6	1.0
<i>A</i>	<i>N</i>	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$

This table may need some further explanation. Let us start with the teams: Italic letters *N* and *B* denote the teams, Norway and Brazil respectively. Consequently, the probabilities  $p_{NB}$  and  $p_{BN}$  denote the probability that Norway beats Brazil and vice versa.

The strategy space of the game is defined as:

$$N \in \{N, A\} \text{ and } B \in \{B, N\} \quad (1)$$

The interpretation is straightforward. In the case of Norway, the team can choose to play "Norwegian" (*N*). This refers to the strategy dis-

<sup>12</sup> Norway's record against Brazil, as good it may be, is way too limited in number of games to be any sound base for probability estimation. To be precise, Norway has played against Brazil 4 times, out of which 2 were won by Norway, and the last two ended in a draw [9]. This record is surely much too flattering for Norway, and it makes little sense to use these data for estimating purposes.

cussed in section 2 introduced by Egil Olsen, involving long balls and fast breaks. Alternatively, Norway can choose a strategy (A) which typically may be some kind of continental-oriented – involving more play using mid-field. To sum up: Norway can play as they normally do (N) or choose a more sophisticated alternative (A).

Brazil, may choose to play Brazilian (B) or like Norway (N). That is, Brazil's options are somewhat equal to Norway but opposite.

The probabilities of table 6 may need a more detailed discussion. First of all, as empirical material is sparse, it is obvious that such probabilities may be viewed differently by different individuals. As such, long debates on whether these probabilities are "correct", meaningful or meaningless may be initiated and continued. Luckily, the interest at hand is not necessarily on whether these probabilities are sensible or not, but more on the game-theoretic consequences of them. Additionally, as appendix A, to some extent shows, the basic results are fairly insensitive to variations in the probabilities. Still, the author has tried to put "some sense" into the numbers. A brief discussion of the actual numbers follows:

Table 7 *Probabilities given the (N,B) strategic combination in a (generic) game between Norway and Brazil*

N	B	$p_{NB}$	$p_{BN}$	$p_D$
N	B	0.5	0.4	0.1

Table 7 states that in a game between Norway and Brazil (in Norway), where both teams choose their "normal" playing style, the home team on average would win 50% of the games. Brazil is granted a probability of winning 40% of the games, while merely 10% of the games are assumed to end in a draw. Surely, one could argue that Brazil is a much better team than Norway, but still the actual record shows significant Norwegian advantage. Consequently, the numbers are constructed as some kind of compromise.

Table 8 *Probabilities given the (A,B) strategic combination in a (generic) game between Norway and Brazil*

N	B	$p_{NB}$	$p_{BN}$	$p_D$
A	B	0.3	0.5	0.2

Table 8 states that when Norway choose their alternative strategy (basically trying to play more like Brazil), and Brazil keeps playing like Brazil, the Norwegians' probability of winning is significantly reduced. How much it should be reduced, is surely a matter of different views, some readers may for instance feel that it should have been reduced more, but keep in mind that the proposed reduction from 0.5 to 0.3 actually is a 40% reduction.

Moving downwards in table 6 the degree of "speculation" is surely increasing. The probability consequences of the (weird) strategic choices become more and more difficult to assess.

Table 9 *Probabilities given the (N,N) strategic combination in a (generic) game between Norway and Brazil*

N	B	$p_{NB}$	$p_{BN}$	$p_D$
N	N	0.4	0.2	0.4

In table 9, Norway plays like Norway, while Brazil mimics the Norwegian playing style. It seems sensible that this yields a better situation for Norway compared to the last situation (0.4 > 0.3). As Brazil probably is not that prepared for this playing style, the probability of a Brazilian win is reduced, but more or less moved to  $p_D$ .<sup>13</sup> A seemingly sensible choice if two teams choose the "long-ball" alternative. (See the discussion in section 2 for a more detailed discussion on related issues.)

Table 10 *Probabilities given the (A,N) strategic combination in a (generic) game between Norway and Brazil*

N	B	$p_{NB}$	$p_{BN}$	$p_D$
A	N	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$

<sup>13</sup> It is important to stress that this assumption does not imply that Brazil necessarily is bad at mimicking Norway's strategy. The assumed fact of lack of practice is based on a different argument. Brazil and other distinguished national teams have a seemingly more complex objective than smaller and less distinguished teams. They should not only apply efficient strategies, but also beautiful ones. Hence, we could say that an extra cost in playing like Norway occurs for Brazil compared for instance to Norway. Hence, it seems reasonable to assume that Brazil should be far more reluctant in applying this type of strategy, which could explain the loose term "lack of practice".

In table 10, Norway plays like Brazil and Brazil plays like Norway. Anything can happen (both teams choose an unfamiliar playing style), and a maximal variance distribution is introduced.

The resulting game matrix with a single unique Nash equilibrium is shown in figure 7.

		BRAZIL	
		B	N
NORWAY	N	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px;">1.3</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px;">1.6</div> </div>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; border-radius: 50%; padding: 2px;">1.6</div> <div style="border: 1px solid black; padding: 2px;">1.0</div> </div>
	B	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px;">1.1</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px;">1.7</div> </div>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px;">1.33</div> <div style="border: 1px solid black; padding: 2px;">1.33</div> </div>

Figure 7 “Pay-off” matrix for the “game” between Norway and Brazil

At this point, it may be fruitful to sum up the meaning of this Nash equilibrium<sup>14</sup>: If Norway and Brazil are to play a match against each other, and they both have access to table 6 and agree upon the contents of it, the game-theoretic prediction is that Norway plays like Norway, Brazil plays like Brazil and Norway will win 50% of such matches, Brazil will win 40% while 10% will end in a draw.

Now, this does not seem to be much of a surprise, Norway playing like Norway and Brazil playing like Brazil may seem obvious. As a matter of fact, it is not, and as the next subsection will show, the interesting results arise comparing the two examples.

<sup>14</sup> The Nash equilibrium concept may be popularly defined as: “The strategies of the players in a game are in Nash equilibrium if no player would gain by a unilateral change of strategy.” In the game of Figure 7, best reply functions for NORWAY are shown as circles, while best reply functions for BRAZIL are squares. As a consequence, Nash equilibria emerge as strategic combinations with both a circle and a square.



### 5.2 Norway vs. Belarus

Now, Norway vs. Belarus should be something completely different from Norway vs Brazil. Looking at statistics, it may not seem so, but again the Norwegian record against Brazil is very special. Norway has played against Belarus 5 times, with a record of 2 wins, 2 draws and 1 loss [9]. Looking at the FIFA ranking as of august 2005, Brazil is ranked first, Norway as number 36, while Belarus is placed at 61. Consequently, a match against Belarus for Norway (at home) should imply a fairly certain win given that Norway chooses their preferred strategy and Belarus plays like Belarus – a lot through midfield. As opposed to the Brazil case, Norway may be assigned a bit of a better chance to win even if Norway chooses their alternative strategy as Belarus obviously has poorer individual quality players. Consequently, changes are proposed in lines 1 and 2 in table 6 for instance as in table 11:

Table 11 *Probabilities and expected point scores for an imaginary game between Norway and Belarus*

<i>N</i>	<i>B</i>	$p_{NB}$	$p_{BN}$	$p_D$	Pay-off N	Pay-off B
N	B	0.8	0.1	0.1	2.5	0.4
A	B	0.45	0.45	0.2	1.45	1.45
N	N	0.4	0.2	0.4	1.6	1.0
A	N	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$1\frac{1}{3}$	$1\frac{1}{3}$

In table 11, the (italic) letter B now refers to Belarus as opposed to Brazil in table 6. The Belarussian strategic choice, B, now (of course) refers to Belarus playing like Belarus. Apart from these exceptions, the table is completely analogue to table 6.

Comparing tables 6 and 11 it is readily observed that the changes discussed above has been implemented. Norway has been given a really big winning chance of 0.8 on behalf of Belarus' winning probability of merely 0.1 in line 1. Additionally, Norway's chances of winning if they choose their alternative style are increased from 0.3 to 0.45, the same chance given to Belarus yielding less weight (0.1) on the draw case. The last two lines are unchanged in order to ease the comparison. The normal form game is easily constructed as shown in figure 8.

**BELARUS**

		<i>B</i>	<i>N</i>
<b>NORWAY</b>	<i>N</i>	0.4 <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">2.5</span>	<span style="border: 1px solid black; padding: 2px;">1.0</span> <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">1.6</span>
	<i>A</i>	<span style="border: 1px solid black; padding: 2px;">1.45</span> 1.45	1.33 <span style="border: 1px solid black; padding: 2px;">1.33</span>

Figure 8: "Pay-off" matrix for the "game" between Norway and Belarus

The result is evident. The {N,B} equilibrium from the last paragraph is changed to {N,N}. That is, they (Belarus) choose to mimic the Norwegian playing style. The consequence of this is that Norway's winning probability is reduced with 100% from 0.8 to 0.4 while Belarus' winning probability is increased with 100% from 0.1 to 0.2.

Now, this result is somewhat more interesting. A formal game theoretic model has shown (by example) that under "reasonable assumptions" certain teams which face Norway will choose to mimic the Norwegian style of play – recall the discussion on the match against Morocco in section 2.

The next important conclusion that can be drawn from this analysis, is that Norway can not affect this situation by improving their traditional playing style given that the opponent plays like himself. The only change in table II would then be that 0.8 increases while 0.1 decreases (in line 1). The effect on the game matrix would then be that 2.5 increases while 0.4 decreases, actually only securing the {N,N}-equilibrium.

So, what could Norway do to improve their expected point score? Either improve the winning probability in the {N,B} case or actually develop one, or preferably several, alternative strategies. The first choice is probably the simplest one, typically involving performance enhancement in free- and corner kicks. Unfortunately, some evidence from later Norwegian matches has shown a steady decrease in the number of goals scored as a result of such situations, possibly as a result of opponents reaching the same type of conclusion as this paper does. As such, the fu-

ture for Norwegian national soccer is maybe not that promising. On the other hand, if what is needed is development of alternative (preferably not so easy to mimic) strategies, Norway has players and coaches very well trained in following specific strategic instructions, so the future may still be prosperous.

Some other structural information from figure 8 may also be interesting to note. Suppose that Norway actually lowers their playing quality, transferring marginally more than 20% of winning probability to Belarus for the {N,B} strategic combination. In this case, line 1 in table 11 changes to: ( $\epsilon$  is a small positive number)

$N$	$B$	$p_{NB}$	$p_{BN}$	$p_D$
$N$	$B$	$0.6 - \epsilon$	$0.3 + \epsilon$	$0.1$

Then, the game matrix changes to that of figure 9

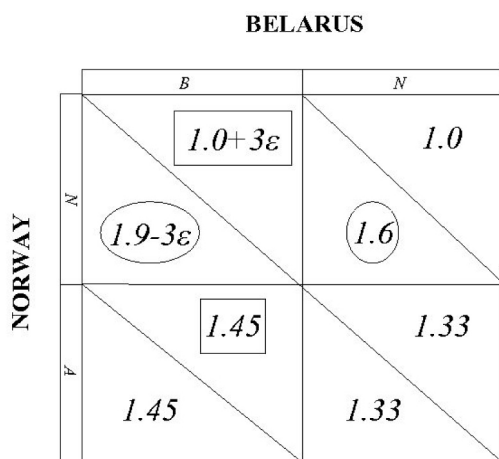


Figure 9 Revised "Pay-off" matrix for the "game" between Norway and Belarus

As figure 9 indicates, the Nash equilibrium has now shifted back from {N,N} to {N,B}. This is probably not that surprising, but if we examine the pay-offs more closely, some interesting features are evident. Firstly, Norway's expected point score has increased from 1.6 to  $1.9 - 3\epsilon$ . Consequently, it is actually "profitable" for Norway to put the team in a situation where their ability to play their preferred strategy is reduced. Sec-

only, and probably more surprising, is the fact that also Belarus has achieved an increase in expected point score, as  $1.0 + 3\epsilon > 1.0$ .

The practical implications of this result, is fairly interesting. If Norway for instance choose<sup>15</sup> to loose some training matches before the important match, or knowingly pick a team with less quality than they could or even deliberately run high intensive trainings before the match with the hope of injuring the best players, it could actually be sensible – not only for Norway but also for the opposing team!

This may actually serve as an explanation on the repeatedly annoying soccer coach interviews with statements like “the quality of our team has never been worse, the injury situation is hopeless and god has in all possible ways turned against us”. It is important to note that this has nothing to do with under-estimation. On the contrary, the ability to signal (credibly) to your competitor that your quality is reduced may actually serve a very reasonable game-theoretic point.

The somewhat puzzling initial results in many world-cup tournaments between presumably good teams, Germany<sup>16</sup>, Italy<sup>17</sup> and Argentina<sup>18</sup> and presumably dark horses may also – at least to a certain extent – be explained by this type of mechanism. If the good teams can affect other good team’s judgment of their playing strength negatively, this can prove efficient with regards to later and definitely more important games in a tournament.

### *5.3 The rise and fall of a soccer team like Norway*

Above, some simple game-theoretic models involving imaginary games between soccer teams of different quality and different basic playing skills have been formulated and analyzed. In section 2 some empirical observations were used in order to discuss the ”life-cycle” of a team like Norway, tentatively concluding with a prediction or hypothesis of a much harder

15 It is probably important to mention that Norway should of course not choose to play with degraded performance, that will never be optimal. The point here is that they should make decisions before the game such that their probability of winning the game is reduced.

16 Germany opened the 1982 world Cup finals in Spain by loosing 2-1 against Algeria, still finishing up as a finalist.

17 A typical example here may be the 1982 World Cup in Spain, where Italy played 3 initial matches against Poland, Cameroon and Peru, all ending in draws, and Italy finished up as winners of the competition.

18 Argentina lost their opening match against Cameroon in the 1990 World Cup finals in Italy, still finishing as runners up.

competitive situation for a team with the Norwegian choice of playing style.

The basic learning from the game-theoretic analysis in previous paragraphs is an obvious confirmation of such a hypothesis. Initially, (before 1990), Norway played only good teams, not necessarily because Norway only met good teams, but basically because the quality of the Norwegian team was poor. In such a setting, the Norwegian playing style was efficient, in the sense that all opposing teams played the role of Brazil, and Norway was allowed to utilize their preferred playing style "without interference". As time progressed, Norway improved, jumped fast up the FIFA-ranking and the teams which before viewed Norway as a simple opponent, started to recognize Norway as a harder opponent – or in the language of former paragraphs, the number of games against Belarus was rapidly increasing. Consequently, Norway was met with mimicking (or alternative neutralizing) strategies, and the Norwegian success should decrease, which it most certainly also has.

There are however possible ways out of this trap, the more exotic one of lowering own quality is probably not a very suitable long-term strategy. Surely, in the short run, it may prove efficient, but still, opponents would soon recognize any attempts to signal incorrect probabilities on own playing strength, and Norway would then be locked to the alternative of actually lowering own playing strength, as such, this may prove a viable strategy if Norway is content with being a fairly good soccer team, but this is most certainly not the goal of Norwegian citizens or soccer officials.

However, a more viable long term strategy would be to utilize old learning of strategy building and construct an alternative strategy which is less vulnerable to the opponents strategic choices. The basic problem with the Norwegian "kick and run" strategy is the simple fact that it is easy to neutralize by a mimicking strategy, and most important, the mimicking strategy is not very hard to apply. Hence, what is needed, is an alternative strategy which is much harder to mimic. This is of course easy to postulate, but maybe hard to both implement and find.

As such, it is hard for a small country to build a viable long term efficient winning strategy. In the end the best teams should and would win, but as history has shown, a simple strategic change as in the case of Norway did last successfully for around 10 years, and 10 years is a pretty long soccer perspective.

Even though the above discussion indicates a seemingly solid (game theoretic) argument for the rise and fall of a “poor-quality” soccer nation like Norway, the reader should not fall into the trap of ignoring other possible explanations. For instance, a seemingly simple argument related to knowledge and the above models’ common knowledge assumptions should be stressed. One possible explanation might be that initially, Norway’s opponents did not know the strength of the Norwegian playing style and hence failed to “see” the true probabilities discussed above. Surely, such an explanation would call for a game of incomplete and asymmetric information. In principle, such a way of reasoning is both feasible and sensible, but I feel that it calls for a paper of its own.

## Appendix A: The “Guess-work” in subsection 5.1

In subsection 5 an imaginary game between Norway and Brazil is discussed. Especially, the probabilities assigned for the outcomes of the game given the strategic choices of {N,B} and {A,B} may be questioned. Consequently, it makes sense to analyze the sensitivities of the solution regarding changes in these probabilities. This appendix accomplishes such an analysis.

Let first us approach this problem by looking at one line in table 6 at a time, and finish up with a more sensible approach. In order to avoid too high complexity, it is necessary to simplify somewhat. The probability of a draw, is (initially) assumed fixed and the probability for a Norwegian win varies. Consequently, the first line of table 6 will read:

<i>N</i>	<i>B</i>	$p_{NB}$	$p_{BN}$	$p_D$
N	B	$p_{NB}$	$0.9 - p_{NB}$	0.1

The resulting expected point scores become:

$$\mu_N^{NB} = 3p_{NB} + 0.1 \quad (2)$$

And

$$\mu_B^{NB} = 3(0.9 - p_{NB}) + 0.1 \quad (3)$$

In order to secure the unique Nash equilibrium of figure 7 it is straightforward to realize that the following conditions must be met:

$$\mu_N^{NB} > 1.1 \text{ and } \mu_B^{NB} > 1.0 \tag{4}$$

Some simple algebraic manipulations on the equalities (2) and (3) then yield:

$$p_{NB} > \frac{1}{3} \text{ and } p_{NB} < 0.6 \tag{5}$$

Equation (5) indicates that our "guess-work" to a certain extent is less important. For instance, the assumption that Norway performs better (on average) at home against Brazil is not crucial. A set of probabilities like:

N	B	$p_{NB}$	$p_{BN}$	$p_D$
N	B	0.35	0.55	0.1

give the same Nash equilibrium.

A similar type of argument applied to the second line of table 6

N	B	$p_{NB}$	$p_{BN}$	$p_D$
N	B	$p_{NB}$	$0.8 - p_{NB}$	0.2

yields (aftermore or less similar algebra)

$$p_{NB} < 0.47 \tag{6}$$

Consequently, some discussion on these probabilities may also prove uninteresting regarding the conclusion.

Above, uncertainty on probabilities in the first line and certainty on probabilities of the second line (or vice versa) was assumed. The discussion in subsection 5 indicates however, that guesses are made on both lines simultaneously<sup>19</sup>.

This calls for a somewhat more complex analysis, which still is feasible from a technical point of view. Now, it is necessary to assess the situa-

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<sup>19</sup> Actually, guesses are made on all probabilities in all four lines, but in order to be able to carry out this type of analysis without making it too complex, we refrain from looking at all probabilities simultaneously.

tion where the  $p_D$ 's of line 1 and 2 in table 6 are kept at their initial values, while the other four probabilities are viewed as variables. This situation is described in table 12

Table 12 *Variable substitution*

<i>N</i>	<i>B</i>	$p_{NB}$	$p_{BN}$	$p_D$
N	B	$\theta$	$0.9 - \theta$	0.1
N	B	$\omega$	$0.8 - \omega$	0.2

Hence the probability that Norway beats Brazil given that Norway chooses the N-strategy and Brazil chooses the B-strategy is named  $\theta$ , while the same probability given the Norwegian choice of the A-strategy is named  $\omega$ .

Then, simple calculations of the expected point scores for these two lines yields a game matrix as shown in figure 10

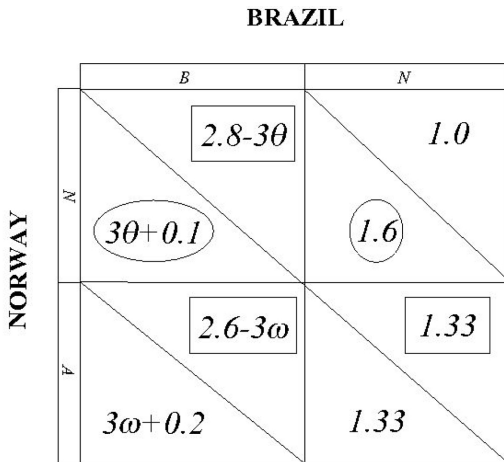


Figure 10 *A parametric game matrix of Norway vs. Brazil*

In order to secure the {N,B} Nash equilibrium, it is necessary that:

$$3\theta + 0.1 > 3\omega + 0.2 \Rightarrow \theta - \omega > 0.033 \tag{7}$$

and



$$2.8 - 3\theta > 1.0 \Rightarrow \theta < 0.6 \tag{8}$$

Note that the size of  $\omega$  compared to 1.33 could be anything, as this maximization does not influence the Nash equilibrium.

Further analysis of inequalities (7) and (8) is easier by a graphical representation. In figure 11, these inequalities are represented by the shaded area.

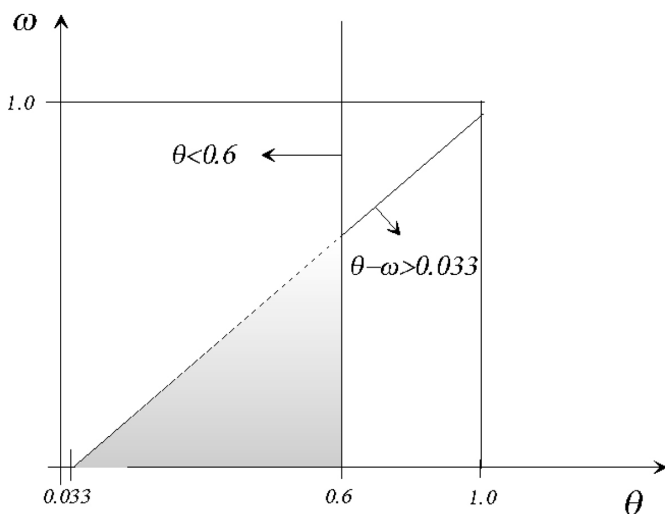


Figure 11 *Inequalities (7) and (8) shown graphically*

As figure 11 indicates, a certain "space" restricts the probabilities  $\theta$  and  $\omega$  if the {N,B} equilibrium is to be preserved. This area may of course be computed as

$$\frac{(0.6 - 0.333)^2}{2} \approx 0.16$$

That is, as much as 16% of the total variational span of these two probabilities will secure the given Nash equilibrium.

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