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MASTER IN ECONOMICS, FINANCE AND INTERNATIONAL INTEGRATION

MANAGERIAL RISK-TAKING

– EVIDENCE FROM THE GERMAN BUNDESLIGA

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The greatest risk is to risk

nothing at all.

Leo Buscaglia

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Zusammenfassung

Diese Masterarbeit untersucht die Auswirkungen früherer und unerwarteter Ergebnisse auf die Risikobereitschaft von Managern anhand des natürlichen Experiments Fußball und der Daten der deutschen Fußball-Bundesliga. In der Studie wird anhand von anfänglichen Formationsänderungen und Auswechslungen das Risikoniveau gemessen, das Trainer während eines Spiels eingehen. Die Untersuchung stützt sich auf die bekannte Prospect-Theorie (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) und den Realisationseffekt (Imas, 2016), die besagen, dass sich Individuen verlustavers verhalten und risikofreudiger handeln, bevor sie den Verlust realisieren. Die Studie zeigt, dass Trainer bei der Aufstellung der Anfangsformation nach vorangegangenen Verlusten tendenziell risikofreudiger sind, während des Spiels jedoch weniger riskant handeln. Diese Untersuchung entwickelt die Studie von Bucciol et al. (2019) weiter, indem sie einen anderen methodischen Rahmen verwendet und den referenzabhängigen Ansatz von Bartling et al. (2015) bezüglich Auswechslungen einbezieht. Die Ergebnisse haben Auswirkungen auf die Sichtweise von Risikobereitschaft von Managern im Fußball und bieten eine neue Perspektive auf das natürliche Feldexperiment des Sports.

Keywords: Managerial risk-taking, Football, Reference points

JEL: D81, D91, Z20

PsycInfo classification: 3720

Riassunto

Questa tesi di laurea magistrale esplora gli effetti dei risultati precedenti e di quelli inattesi sul comportamento manageriale di assunzione del rischio utilizzando l'esperimento naturale del calcio e i dati della *Bundesliga* tedesca. Lo studio utilizza i cambi di formazione e le sostituzioni iniziali per misurare il livello di rischio assunto dagli allenatori durante una partita. La ricerca si basa sulla ben nota teoria della prospettiva (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) e sull'effetto realizzazione (Imas, 2016), che suggeriscono che gli individui si comportano in modo avverso alle perdite e agiscono in modo più rischioso prima di realizzare la perdita. Lo studio rivela che gli allenatori tendono a essere più rischiosi quando impostano la formazione iniziale dopo le perdite precedenti, ma meno rischiosi durante la partita. Questa ricerca fa progredire lo studio di Bucciol et al. (2019), utilizzando un quadro metodologico diverso e integrando l'approccio della sostituzione dipendente dal riferimento di Bartling et al. (2015). I risultati hanno implicazioni per l'assunzione di rischi a livello professionale e manageriale nel calcio e forniscono una nuova prospettiva sull'esperimento di campo naturale dello sport.

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Abstract

This Master's thesis explores the effects of prior and unexpected results on managerial risk-taking behavior using the natural experiment of football (soccer) and data from the German *Bundesliga*. The study uses initial formation changes and substitutions to measure the level of risk taken by coaches during a match. The research builds on the well-known prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) and the realization effect (Imas, 2016), which suggest that individuals behave as loss-averse and act more risk-tolerant before realizing the loss. The study finds that coaches are more likely to take risks when setting up the initial formation after previous losses but less risky during the game. This research advances the study of Bucciol et al. (2019) by using a different methodological framework and integrating the reference-dependent substitution approach of Bartling et al. (2015). The findings have implications for professional and managerial risk-taking in football and provide a new perspective on the natural field experiment of sports.

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1 Introduction

Imagine you arrive at the checkout area of the supermarket and are faced with the decision of which cash register to line up in front of. Do you stay in your current line? Or do you switch to the side where it seems to go a little faster? In another situation, imagine driving your car on the highway, heading to an appointment, but running some minutes late. Do you drive faster than the speed limit, if there is a possibility of being flashed or even provoking an accident?

Risk-taking is an inherent part of our daily lives. Every day we are confronted with decisions whose consequences and outcomes are uncertain. We must make decisions and weigh up risks. They vary from small or mundane decisions, as described above, to more important decisions like financial planning, family decisions, and decisions about life and death. We take these risks to achieve a better outcome, such as arriving at our desired destination faster or achieving a higher financial payoff (Figner & Weber, 2011).

It is common knowledge that there exists a tradeoff between risk and return. Increased risk-taking typically comes with a higher return and vice versa (Figner & Weber, 2011). Risk-taking can be beneficial, however, risk-taking does not always pay off. Empirical studies and laboratory experiments show both positive (Adams & Waddell, 2018; Thaler et al., 1997) and negative results (Grund & Gürtler, 2005) of risk-taking behavior.

Risk-taking behavior stems from an evolutionary point of view (Kruger et al., 2007; Mishra, 2014) and is influenced by psychological factors like for instance personality traits (Bucciol & Zarri, 2017), cognitive biases (Tversky & Kahneman, 1974) and emotions (Beisswingert et al., 2015). Those factors can influence decision-making processes in various contexts, from ordinary decisions to financial decisions or sports competitions. The well-known prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) states that individuals behave loss-averse and relative to a reference point when facing decisions under uncertainty. Following this work, there are many exciting further research papers. For instance, Imas (2016) identifies the so-called realization effect, which means that people take on greater risks when previous losses have not been realized yet and are less risky after the realization and internalization of the loss have been completed.

Of course, risk-taking is a crucial point of interest for economists. For instance, risk-taking is relevant for entrepreneurs when starting a new business. An obvious application is also the finance sector since portfolio managers must assess risks and make decisions daily (Barberis, 2013). They are experienced individuals who are expected to make the best decisions (Bernile et al., 2017). As Brown (2013) cites Green, they "[…] are not risk takers. They are calculated risk takers." Hence, an interesting and growing area of research is the field of professional and managerial risk-taking.

A fairly new branch of research focuses on the natural field experiment of sports, particularly football (soccer). The motivation for research in this area stems from the mass of data that can be extracted from one football game, which is an advantage compared to business or financial data. Not only are goals recorded, but also possession, shots, running distance, and routes of each player and substitutions. Most of the data is open source. Since the rules of football are consistent over time (Kleinknecht & Würtenberger, 2019), it is an ideal research environment. Football coaches and managers are, similarly to portfolio managers, professional individuals. They must make risky decisions to achieve success and the best possible outcomes in matches, seasons, and even their careers. This is also an advantage compared to laboratory experiments. The risk-taking behavior of a head coach in football can be seen in separate ways. A head coach has various possibilities to account for different levels of risk. A straightforward way is to tell the players to be more offensive and to play with higher pressure. This is, however, not objectively measurable. Research mostly focuses on the composition and the formation, the coach chooses. On the one hand, this could be done by choosing the players and the team formation before each game to adjust for the individual opponent. On the other hand, risk can be reflected by strategic changes, to be more precise, formation changes and substitutions during the game. With these substitutions, the coach could not only substitute exhausted or injured players but also adjust the level of risk by non-neutral substitutions. These non-neutral substitutions may reflect the risk the trainer wishes to take or implicitly takes, for example, if he substitutes a striker for a defender (Bartling et al., 2015).

This Master's thesis focuses on the effects of prior and unexpected results on risk-taking behavior using data from the German *Bundesliga*. The analysis is conducted in terms of prospect theory, reference-dependency concerning prior game results, and current unexpected results.

This thesis is closely related to Bucciol et al. (2019), Grund and Gürtler (2005), and Bartling et al. (2015). It aims to advance the paper of Bucciol et al. (2019) using a slightly different framework. The thesis uses data from the full season and a different methodological framework compared to the paper of Bucciol et al. (2019). In addition, the thesis integrates the substitution approach of Bartling et al. (2015) into the same setting, which allows for assessing the interaction between previous and current results.

The work reveals that coaches behave in a riskier way in setting up the initial formation after previous losses, whilst less risky within the game. Being behind expectations in the match leads to an increase in risk-taking. The thesis also finds that previous outcomes indeed interact with outcomes in the current game, constituting an interaction of different reference points. Especially, risk-taking is increased if the result of the game is not as expected and the previous match was lost. This is a clear difference from the main effect that risk-taking is reduced after prior defeats.

This work can be classified and interpreted in terms of the realization effect (Imas, 2016). The realization of losses does not occur immediately after the lost game, but with closing the mental account at the start of the next game.

To my knowledge, it is the first thesis to be able to disentangle the discussed mechanisms and to find a way of assessing the realization effect in football.

This thesis is structured as follows. Chapter 2 presents the literature on risk-taking in general, various determinants, and possible explanations for risk-taking. Chapter 3 discusses the field of managerial risk-taking in particular and deals with the field of football as a context of professional and managerial risk-taking. Furthermore, it introduces the precise research environment. Chapter 4 covers the methods of analysis, the results of which are descriptively and graphically presented in Chapter 5 and econometrically in Chapter 6. The discussion of the results concerning the research and literature is done in Chapter 7. The thesis concludes with a conclusion and an outlook.

2 Risk-Taking and Decisions under Uncertainty

This chapter highlights the foundations and determinants of risk-taking behavior in general.
The foundations of risk-taking behavior are an object of investigation in many different research areas. The goal of this subchapter is to answer the question of, why we as individuals take risks and characterize different determinants and facets of risk-taking behavior. Particular attention is paid to the prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), the central theory of behavioral economics, which explains decision-making processes under uncertainty. The subsequent subchapters describe determinants and attempted explanations of risk-taking behavior, especially situational and personal aspects (following Figner & Weber, 2015). This is preceded by two short subsections on evolutionary and cultural aspects. It is noted that this breakdown is not a one-to-one mapping, and that often multiple factors interact in decisions under uncertainty naturally.

2.1 Prospect Theory

The prospect theory is a general comprehensive theory about decision-making under uncertainty and a counterpart to the expected utility theory which states that individuals act rationally by maximizing their expected utility (von Neumann & Morgenstern, 2007).
The original version of the prospect theory expresses that decisions under uncertainty are not made based on expected utility. Decisions are based on a reference point, for instance, the status quo or a desired state (Kahneman & Tversky, 1979). Deviations from these reference points could cause individuals to feel "psychologically different" (Bartling et al., 2015, p. 2647), for example, through increased pressure or frustration, which may lead to behavior that is not fully rational (Bartling et al., 2015). This ends up, causing individuals to behave in a loss-averse

manner. Loss aversion manifests itself as follows. When individuals must choose between a certain payoff and an uncertain but higher expected payoff in the sense of expected utility theory, they tend to prefer the certain, lower payoff. This reverses when losses are considered instead of gains. According to prospect theory, individuals act risk-tolerant, risk-prune, or riskier when they must choose between an uncertain, but, in terms of the expected value, higher loss and a certain, lower loss (Kahneman & Tversky, 1979). This leads to the well-known S-shaped value function of prospect theory, which is concave in the region to the right of the reference point, so in the domain of gains, and convex in the region to the left of the reference point, so in the domain of losses. This value function is sharply kinked at the reference point, meaning it is steeper for losses than gains. This phenomenon is also called diminishing sensitivity (Barberis, 2013).

In summary, the theory states that deteriorations, compared to the status quo, are interpreted as losses and these are weighted more heavily than corresponding gains (Kahneman, 2003; Kahneman & Tversky, 1979).

Following the original paper (Kahneman & Tversky, 1979), the authors develop an advancement, the cumulative prospect theory (Tversky & Kahneman, 1992). It is a theoretical development explaining that individuals tend to overweight extreme events, which is also known as probability weighting (Barberis, 2013; Kahneman & Tversky, 1979). Experimental evidence shows that individuals behave risk-averse in gaining and risk-seeking in losses when facing a high occurrence probability. Contrary, humans behave risk-seeking in gaining and risk-averse in losing when facing a low occurrence probability (Tversky & Kahneman, 1992).

Another, at first sight, inconsistent behavior when confronted with losses is explained in terms of the realization effect (Imas, 2016). Whilst some empirical work shows that risk-taking is increased after a loss (Imas, 2016; Shefrin & Stateman, 1985; Weber & Camerer, 1998), other work finds a decrease in risk-taking after losses (Barberis et al., 2001; Dillenberger & Rozen, 2015; Flepp et al., 2021; Imas, 2016). Imas (2016) finds a consistent way of integrating both results by distinguishing between already realized losses and not yet realized paper losses. Individuals increase their risk-taking when confronted with unrealized paper losses and decrease it after the loss has been realized. Mental accounting is a concept used to explain this (Thaler, 1985). A mental account can be seen as a memory area in which current situations are processed. Imas (2016) elaborates that the mental account remains open whilst facing paper losses because one can still act and erase the previous negative result. This leads to the individuals being more willing to accept risks. However, if the loss is realized, the mental account is closed because erasing previous negative results is not possible anymore. This leads to an internalization of the loss and an update of the reference point. New risky choices are no longer connected to the previous loss, meaning that individuals will behave more optimally in terms of their risk-taking strategy, that is, that the tendency to take risks decreases. A similar realization effect is also found when considering paper wins. When the win has not been realized, riskier behavior is shown to build up a cushion against losses (Merkle et al., 2021). Thus, differentiating between realized and not realized losses and wins has important implications on the cumulative prospect theory (Tversky & Kahneman, 1992) leading to more realistic predictions of individual behavior (Imas, 2016).

Many more studies follow up on the work of Kahneman and Tversky (1979). A further concept based on that research is the myopic loss aversion described by the experiment of Thaler et al. (1997). The authors find that short-term gains and losses are overweight compared to long-term gains and losses. Trying to avoid short-term losses instead of reaching long-term gains leads to worse results for individuals (Thaler et al., 1997). However, Eriksen and Kvaløy (2014) suggest that myopic loss aversion may not hold under tournament incentives. In their results, the authors find the tendency that the more frequent evaluation of the results leads to higher risk-taking behavior.

On the other hand, a critique of prospect theory or at least its application in empirical research exists. Although it is a respected theory, there are only a few economically accepted applications. The main challenge lies in the lack of clarity regarding the precise application of the theory. One key difficulty is determining a reference point and defining what constitutes gains and losses (Barberis, 2013). Kahneman and Tversky (1979) assume one, but varying, reference point in their work, mostly the status quo. Nowadays, this is further evolved. One widely accepted viewpoint suggests that people use their expectations or beliefs as a reference point to assess gains and losses (Barberis, 2013; Kőszegi & Rabin, 2006; Kőszegi & Rabin, 2007; Kőszegi & Rabin, 2009). Although, other factors could shape reference points. For instance, forecasts can become reference points. Experimental evidence suggests that the forecasts are more likely used as reference points, the more effort was invested in making them. Individuals using those effort-based forecasts as reference points, show more risk-taking behavior when performance was below those reference points (Shrader et al., 2021). Due to the social comparison theory, Jani (2021) proposes that peer performance could also be seen as a reference point. Research also deals with multiple reference points and examines how different reference points are being used (Baillon et al., 2020; Hack & Von Bieberstein, 2015; Koop & Johnson, 2012).

One main application is the field of finance where especially natural reference points, other than expectations, exist and where gains and losses are monetary. The field is characterized by a dynamic environment in which factors such as momentum also play a role. Other applications are insurance economics or consumption-savings decisions (Barberis, 2013). Also, another utilization is found to be the endowment effect (Barberis, 2013), a cognitive bias describing the tendency of individuals to value an object or item higher, if they own it, compared to the value when they do not own it. So, in the short term, people tend to overvalue things they possess, only because they possess them (Thaler, 1980). This is also well-known from experimental designs (Kahneman et al., 1990; Kahneman et al., 1991).

There exist further applications, including in the field of sports economics (Bartling et al., 2015), to which this work also belongs.

2.2 Evolutionary Aspects

Risk-taking behavior is predisposed from an evolutionary point of view. A biological and psychological consensus is that risk-taking behavior originates from our ancestors' decisions to survive and reproduce (Kruger et al., 2007; Mishra, 2014).

Risk-taking is not a human-specific behavior. It is observed within non-human ape species such as chimpanzees, bonobos, orangutans, and gorillas (Bourgeois-Gironde et al., 2021; Brosnan, 2021; Brosnan & Wilson, 2023; Calcutt et al., 2019; De Petrillo & Rosati, 2021; Keupp et al., 2021; Martin et al., 2014), somewhat more distant species like macaques (Nioche et al., 2021), and even plants (Dener et al., 2016).

2.3 Cultural Aspects

The level of risk-taking varies between distinct cultural groups. Profound and systematic differences in risk-taking between individualistic cultural groups compared to collectivistic cultural groups are found. Generally, risk-taking behavior is higher in individualistic groups than in collectivistic groups (Kim & Park, 2010; Park et al., 2015).

2.4 Situational Aspects

People behave differently when they are in a social environment. Many classic and well-known studies can support this, for example, the conformity experiment by Asch (1961), the study of obedience by Milgram (1963), or the Stanford Prison Experiment (Haney et al., 1973). Those describe the so-called *Power of the Situation*-axiom of social psychology. Concerning risk-taking behavior, this is also evident. In particular, Bourgeon et al. (2022) assess, using a natural experiment concerning the COVID pandemic and a French radio game show, that individuals who play the game show in a social context act more riskily than those who do not. One possible explanation could be choking under pressure. Choking under pressure describes that performance decreases due to social pressure (Baumeister, 1984). Higher pressure could cause stronger risk-taking behavior (Genakos & Pagliero, 2012). Another possible explanation is that risk perception is influenced by the social environment (Knoll et al., 2015).

As already stated above, the social comparison theory implies that individuals frequently assess their performance by comparing it to a relevant peer group (Jani, 2021). In a prior paper, this is also assessed. Individuals tend to match the performance of the winners. The findings suggest that risk-taking behavior is influenced by a reference point shaped by social comparisons (Fafchamps et al., 2015).

Another social construct relevant is rivalry. In a laboratory experiment, To et al. (2018) show that rivalry exhibits risk-taking behavior. The authors attribute this to higher physiological arousal and an increased promotion focus when faced with a social rivalry setting.

Additionally, non-social situational aspects can moderate risk-taking behavior. For instance, regarding financial risk-taking, one could think that prior experiences influence risk-taking behavior. This is examined in a study about financial risk-taking behavior and macroeconomic experiences. The study finds that humans who experienced a bad macroeconomic environment and low stock or bond market returns during their life behave more risk-averse and invest less in stocks or bonds. They also find that more recent return experiences have a stronger influence (Malmendier & Nagel, 2011). This is consistent with different collection methods like self-reported questionnaires (Dohmen et al., 2018), laboratory results (Guiso et al., 2018), and panel data (Necker & Ziegelmeyer, 2016; Schildberg-Hörisch, 2018). Bucciol and Zarri (2015) find that financial risk-taking is also negatively influenced by individual-specific negative events, such as being a victim of a physical attack or losing a child. As a result, risk-taking is less likely after negative individual events. Furthermore, the correlation between risk-taking behavior and the loss of a child is long-lasting, indicating that the past casts a long shadow over individuals' current decisions, even in unrelated domains. Contrary, Abatayo and Lynham (2020) examine in a field experiment that individuals show more risk-taking behavior after extremely negative events, such as experiencing a typhoon. The last result could be explained in terms of the risk-sensitivity theory. It posits that individuals tend to switch from risk aversion to risk-taking behavior when facing a high discrepancy between the status quo and a desired state. Mishra (2014) provides an example. Assume an individuum faces a $5,000 debt. Based on that theory, the individual would prefer a 10 % chance of winning $5,000 to earn $500 with certainty. Here, the riskier choice could compensate for this discrepancy. Thus, decision-makers do not necessarily try to maximize their outcomes, much more they aim for compensating that discrepancy.

2.5 Individual-Specific Aspects

A further side of risk-taking includes intra-individual aspects. That is that there exist intra-individual factors that induce or inhibit risk-taking behavior. Those are, for example, cognitive, genetic, and gender-specific individual factors.

Often, risk-taking is referred to as cognitive bias. One relevant concept in cognitive psychology used to explain cognitive biases is heuristics. Heuristics enable individuals to make quick decisions without utilizing extensive cognitive resources. Tversky and Kahneman (1974) identify three fundamental judgment heuristics, the representativeness heuristic, the availability heuristic, and the anchor heuristic. By using the availability heuristic, people tend to assign greater weight to information that is readily accessible or easy to retrieve. The representativeness heuristic suggests that events are considered more likely to occur if they closely resemble the population. In contrast, the anchor heuristic indicates that individuals are influenced by irrelevant environmental information when making decisions. This information acts as an anchor, impacting the decision-making process. A related cognitive bias is the overconfidence effect where individuals tend to overestimate their abilities, knowledge, or the accuracy of their judgments. This can lead to individuals taking more risks than they should, as they believe they are better equipped to manage the risk than they are. It can occur when people tend to rely on their knowledge and beliefs when making judgments about uncertain events, rather than considering all available information. This can result in people overestimating their ability to predict outcomes and underestimating the likelihood of negative outcomes, resulting in higher risk-taking behavior.

Personality factors are often considered when it comes to the explanation of human behavior. The five-factor or Big Five model is the most dominant model for explaining human personality. A study shows that, regarding the main factors, extraversion and agreeableness predict risk-taking behavior best. On the facet level, the conscientiousness-facet responsibility explains most of the total variance regarding risk-taking behavior. In general, the authors contend that individuals who are risk-takers tend to possess a personality characterized by extraversion, openness to experiences, disagreeableness, emotional stability, and a lack of responsibility (Joseph & Zhang, 2021). Comparable results are found in Bucciol and Zarri (2017). The authors show that agreeableness, anxiety, and cynical hostility are significantly negatively correlated with risk-taking behavior. Additionally, Josef et al. (2016) find that individual changes in risk-taking throughout life are more strongly associated with changes in personality over time rather than changes in economic factors like income.

Broad research focuses on gender-specific differences in risk-taking behavior. Women tend to be more risk-averse than men (Figner & Weber, 2011; Josef et al., 2016). One possible explanation by Figner and Weber (2011) is that men and women perceive risks differently. For instance, in social situations, women perceive lower risks compared to men. Consequently, risk perception could also be a leading determinant in risk-taking behavior.

Researchers discuss whether risk-taking behavior is a state or a trait, that is, whether risk-taking behavior is a stable characteristic over the life span. It exists the assumption that risk-taking behavior is a stable personality trait, meaning that individuals behave and take risks similarly in various settings and over time (Figner & Weber, 2015). Figner and Weber (2011) argue that risk-taking behavior is not a single trait, but dependent on the situation, the individual, and the interactions between both. Thus, they consider risk-taking behavior a function depending on the individuum and the situation. Josef et al. (2016) examine the stability of risk-taking behavior using a large sample (N = 44,076) and a broad age range (18 to 85). Using self-reports, they assess risk-taking behavior across adulthood as a moderately stable trait with reliable mean-level differences across the lifespan. Within individuals and domains, significant variation exists. Although, risk-taking typically decreases with age. These effects can coexist and are not contradictory (Mata et al., 2018). Comparable results are seen in Banks et al. (2020). The authors use data from older adults to show that risk aversion increases with age. Analogous to Josef et al. (2016), Frey et al. (2017) find evidence that risk-taking preferences are stable and can be seen as a psychological trait, a general factor of risk preference, *R*, appears like *g*, the general factor of intelligence.

The research covers also analyses regarding genetic factors and risk-taking. For instance, the results of Cesarini et al. (2010) are, based on twin data and financial risk decisions, that approximately 25 % of individual variation in risk-taking behavior can be explained in terms of genetic variation. That proves that genetic factors matter in terms of risk-taking behavior.

Physiologically, a study confirms that risk-taking behavior is related to the activity of the *nucleus accumbens*, a reward region within the brain, and age. The study shows that risk-taking behavior decreases after adolescence (Braams et al., 2015).

Emotions can also influence risk-taking behavior. Experimental evidence suggests that anger mediates the relationship between subjective loss of control and risk-taking behavior, consequently, anger leads to less risk aversion (Beisswingert et al., 2015). Furthermore, emotion regulation has an impact on risk-taking behavior. de-Juan-Ripoll et al. (2021) find that cognitive processes such as locus of control, emotion regulation, and executive control impact risk-taking behavior. For instance, an external locus of control and emotional suppression corresponds to a higher risk-taking behavior. Stronger risk aversion is expected to result from lower levels of self-control (Schildberg-Hörisch, 2018).

Another relevant individual-specific factor is education. Black et al. (2018) and Banks et al. (2020) show that more education is related to less risk-averse behavior.

Decision-making under uncertainty can be influenced by how information is presented or framed and thus observed and processed. The so-called description-experience gap refers to the difference in how individuals perceive and interpret information when it is presented in written form versus when they experience it. If information is given descriptively, individuals tend to overweight the probability of rare events concord to prospect theory. In the case of experience-based decisions, individuals tend to underweight the probability of rare events (Hertwig et al., 2004; Hertwig and Erev, 2009). Thus, decision-making under uncertainty can be influenced by experience.

To briefly summarize, there exist many approaches to explain general risk-taking behavior.

3 Managerial Risk-Taking

Because individuals act differently based on experience and situation, managerial risk-taking moves to the spotlight of research. Decision-making is a fundamental aspect that managers must oversee daily. In the context of managerial risk-taking, the concepts of uncertainty and risk play a crucial role, because the decisions can have significant implications for the success or failure of an organization. When making strategic choices, managers must carefully assess and balance the potential risks against the potential rewards.

Understanding how prospect theory and decisions under uncertainty impact managerial risk-taking is essential for effective leadership and organizational success. Managers aware of their biases and cognitive limitations can make more informed decisions and adopt appropriate risk-management strategies.

3.1 Foundations of Managerial Risk-Taking

Building on the previous chapter, this section summarizes research on managerial risk-taking behavior.

In a strict sense, the term "managerial" comprises only people administrating organizations such as CEOs. In a wider sense, it can be referred to as individuals acting professionally in general. In this work, the expression managerial is interpreted more broadly containing not only different kinds of managers, or in particular football head coaches, but also professional individuals like competitive athletes.

There is enough evidence that risk-taking behavior is different in a professional setting. Specifically, a study suggests that professional portfolio managers act more, but not fully, rationally than non-professionals (Jansson et al., 2020). It could be a general assumption that professionals act more rationally with a lower propensity of risk aversion, fewer cognitive biases, and a lower influence of situational factors.

However, as described in the general chapter above, similar factors seem to shape risk-taking among managers and professionals. Those are examined by different approaches using surveys, experimental data, and empirical data such as sports data.

Hence, other work shows that again within a sample of private bankers and fund managers, prospect theory holds. Thus, financial professionals behave in accordance with the prospect theory rather than the expected utility theory. They exhibit risk aversion for gains and risk-seeking behavior for losses, with utility being concave for gains and slightly convex for losses. While they are averse to losses, this is less pronounced than typically observed in laboratory studies (Abdellaoui et al., 2013). Further related aspects are discussed in the review by Hoskisson et al. (2017). The degree of risk-taking behavior depends on experience and the framing of the situation concerning a reference point. Previous extremely deficient performance reduces risk-taking behavior, although being below the reference point (Chattopadhyay et al., 2001; Hoskisson et al., 2017; Jawahar & McLaughlin, 2001). If the performance is unexpectedly better, however, risk-taking behavior can be induced (Cyert & March, 1963; Hoskisson et al., 2017; March & Shapira, 1992)

Interestingly, risk-taking behavior is connected to the ability to shift blame (Hayward & Shimizu, 2006; Hoskisson et al., 2017). Reference points can also be shaped by their compensation plans, thus influencing their risk-taking behavior (Hoskisson et al., 2017; Wiseman & Gómez- Mejía, 1998). Managers are loss-averse and prefer activities to protect their current wealth compared than risk this for new gains. Consequently, managerial decisions are influenced by their wealth, leading to a more risk-averse behavior and a more risk-tolerant behavior when facing a potential loss of employment (Hoskisson et al., 2017; Larraza-Kintana et al., 2007). The authors suggest determining the reference points of managers because they vary across managers. For instance, one manager could perceive a situation as a gain, whilst another could perceive the same situation as a loss (Hoskisson et al., 2017).

Using sports data in economic analysis can benefit because parallels can be drawn between professional managers and athletes. McFall and Rotthoff (2020) assess that the risk-taking behavior of professional athletes, here professional golf players, is like one of the economic agents. The risk-taking behavior is dynamic throughout the tournament. The authors find evidence for the superstar effect, which also holds in basketball (Lackner, 2016; Lackner, 2023), meaning that the competitors adapt their risk-taking behavior in dependence on a superstar present. Risk-taking behavior can be beneficial or harmful (McFall and Rotthoff, 2020). Further research with golf data provides evidence that risk-taking behavior is dependent on the horizon and peer effects, match status, the difficulty of the task (Ozbeklik & Smith, 2017), and the threat of elimination (Adams & Waddell, 2018).

Despite the fact, that professionals face similar situational factors in their regular work, situational factors have an impact on their general and risk-taking behavior. Thus, choking under pressure also exists among professional individuals. Results from professional biathlon suggest that competitive athletes perform worse when performing in front of their home audience (Harb-Wu & Krumer, 2019). In professional basketball, teams that are trailing in terms of the score tend to exhibit higher levels of risk-taking behavior (Grund et al., 2010). As examined in American football in the NFL, rivalry also increases risk-taking behavior (To et al., 2018). Peer effects also exist in National Association for Stock Car Auto Racing (NASCAR) races (Bothner et al., 2007).

Prior experiences matter as well. Managers show more risk-taking behavior when experienced fatal but not extremely negative consequences. Contrary, managers show more risk-averse behavior when extremely negative results were obtained (Bernile et al., 2017). If facing a fatal event in the same domain, risk aversion increases (Guiso et at., 2018).

According to Barrero (2021), three characteristics apply to managers. First, managers are not over-optimistic, which means, their forecasts do not exceed the realizations. Second, managers are overprecise, therefore they underestimate future growth volatility. And lastly, managers overextrapolate, as a result, their forecasts are too optimistic after positive shocks and too pessimistic after negative shocks. Overextrapolation and overprecision lead managers to overreact to shocks. Thus, they are not free of cognitive biases. Overconfidence is also present in professionals. For instance, Broihanne et al. (2014) examine managerial overconfidence and find that financial professionals are overconfident and higher overconfidence is related to higher risk-taking behavior. In a meta-analysis, Burkhard et al. (2022), however, assess that managerial overconfidence is beneficial for a firm's performance.

In conclusion, the similarity between managerial risk-taking and general risk-taking underscores the importance of further analysis to deepen the understanding of the underlying factors, decision-making processes, and outcomes associated with risk-taking behavior in managerial contexts.

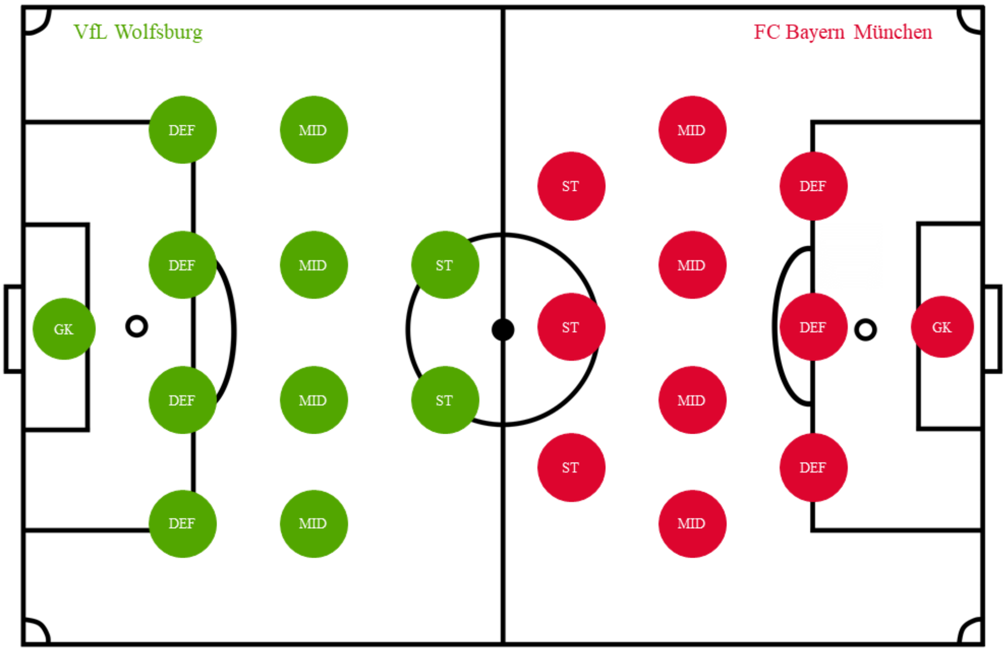
3.2 Football as a Context of Managerial Risk-Taking

Football can be seen as a context of managerial risk-taking because, similar to business managers, club managers, but also head coaches, act in a professional and competitive environment. Football managers' decisions, like choosing the team and tactics, are connected to uncertainties and risks. With their actions, they lead the team and contribute significantly to success or failure (Kleinknecht & Würtenberger, 2021). Furthermore, football can be seen as a natural experiment (Ferraresi & Gucciardi, 2022; Scoppa, 2021), thus, one can argue that therefore external validity is given. Compared to business data, head coach decisions can be better observed, for instance, which player to put up in the team, leading to much more data (Cermak, 2021).

Football players and head coaches show comparable risk-taking behavior as general managers. For example, their actions are influenced by the situation. An important situational aspect is the social pressure induced by the audience (Ferraresi & Gucciardi, 2022; Scoppa, 2021). Additionally, other factors that influence risk-taking behavior exist. Football head coaches also face a potential loss of employment if their performance is not satisfactory (Kleinknecht & Würtenberger, 2021). Thus, head coaches must weigh up their decisions to succeed.

The head coach and his team undertake an analysis of their upcoming opponent's strengths and weaknesses before each game. Subsequently, they determine the starting formation, select the players for the starting eleven, and develop a strategic plan for the game (Cermak, 2021; Gambarelli et al., 2019). Those decisions contain information on the risk-taking preferences and decisions the head coach is willing to take. To be more precise, risk-taking behavior can be seen as follows. The head coach decides on an initial game system and a starting formation. The starting formation is specified by three digits, for example, 4-3-3. The first digit indicates the number of defenders, the second digit the number of midfielders, and the last digit the number of strikers. Figure 2.1 contains an exemplary initial starting formation of the match VfL Wolfsburg versus FC Bayern München, played on the 8th matchday of the 2018/19 season in the German *Bundesliga*. On the left side in green one can see the strategic formation of VfL Wolfsburg, containing four defenders, four midfielders, and two strikers, that is, a 4-4-2. The formation of FC Bayern München on the right side in red is a 3-4-3, respectively. A higher number of midfielders and strikers is associated with a higher offensive formation. This can be seen as a higher willingness to take risks (Bartling et al., 2015; Bucciol et al., 2019; Grund & Gürtler, 2005). In this example, the head coach of FC Bayern München, Niko Kovac, shows, compared to the opponents' coach, Bruno Labbadia, a higher risk-taking behavior in terms of the starting formation.

Figure 3.1: *Starting formation of the match VfL Wolfsburg vs. FC Bayern München*



Source: Own representation based on Cermak (2021) and Olympia-Verlag (2023)

The players can be swapped during the game. Per team and game, there is a substitution allowance of three players.[1] This means that coaches have the opportunity to substitute up to three new players for the ones playing from the beginning of the game. Those substitutions can be done to replace injured or exhausted players, and players can be spared for upcoming important matches, however, they can also reflect strategic decisions such as substituting a striker for a defender to induce a higher pressure in the game (Bartling et al., 2015).

Thus, managerial risk-taking in professional football can be observed in those revealed decisions regarding the initial formation setup and the strategic substitutions within the game (Bartling et al., 2015; Bucciol et al., 2019; Grund & Gürtler, 2005).

[1] This is true for the data within the data set. Following the COVID pandemic, FIFA slightly adjusted the football rules to allow for up to 5 substitutions in three distinct substitution windows.

The following three subchapters briefly present three different approaches to managerial risk-taking in professional football.

3.2.1 Empirical Study on Risk-Taking in Tournaments (Grund & Gürtler, 2005)

Grund and Gürtler (2005) examine risk-taking behavior using data from the German *Bundesliga*. Specifically, the data on starting formation changes and substitutions made during football matches is utilized as a proxy for risk-taking behavior. They hypothesize that the coach of a leading team adapts their in-game strategy by substitutions to a less risky strategy and the coach of a trailing team to a riskier strategy, respectively. Secondly, they assume that head coaches choose a less risky starting formation if teams are ranked similarly in the standings. To evaluate these hypotheses, the authors analyze this using a binary probit model. Specifically, they examine whether coaches make more offensive substitutions when they are losing or tied compared to when they are winning. The authors find that coaches make more offensive substitutions when they are losing or tied compared to when they are winning, indicating that they engage in risk-taking behavior. However, this behavior does not pay off in terms of tournament success. They find that teams with more risk-averse substitution patterns tend to perform better in tournaments. The authors discuss the implications of these findings for principals who want to induce incentives for agents to work hard and identify the ablest agent in a rank-order tournament. They argue that principals should be cautious about inducing too much risk-taking behavior among agents because it can lead to negative consequences such as reduced effort and lower performance.

3.2.2 Expectations as Reference-Point (Bartling et al., 2015)

In their work, Bartling et al. (2015) connect to the work of Grund and Gürtler (2005).

Their paper aims to assess whether players' performance will be influenced by their expectations of the match outcome, and second, whether coaches will make strategic adjustments based on their expectations of the match outcome. To evaluate these hypotheses, the authors use data from the German *Bundesliga* and the English Premier League. Using betting odds as a proxy for ex-ante expectations of match outcomes, they assess how these expectations influenced players' performance and coaches' strategic decisions. The results of the study support both hypotheses. The authors show that risk behavior is not linked to absolute wins or losses, but to whether the result is in line with their prior expectations of the game result. Specifically, they tend to take more risks measured by the yellow and red cards pronounced and offensive substitutions when behind expectations. Overall, this study provides evidence that expectations can serve as reference points for coaches in professional soccer matches.

3.2.3 Effects of Prior Outcomes on Managerial Risk-taking (Bucciol et al., 2019)

Different from Bartling et al. (2019), Bucciol et al. (2019) assess risk-taking concerning the adaption of the starting formation.

The main goal of this study is to investigate whether managerial risk-taking is affected by prior outcomes using data from the Italian Serie A. The authors hypothesize that a coach's decision to alter the initial system of play in a match would significantly depend on having experienced wins or defeats in the recent past. They distinguish between general losses, further consecutive losses as well as heavy and unexpected losses, and the same concerning previous wins. Using probit regression models and controlling for other factors such as team quality and match importance, they find clear evidence that prior outcomes significantly affect managerial risk-taking in this domain. Specifically, coaches are more likely to change their team's formation after experiencing a defeat than after experiencing a win. Additionally, the authors also find that coaches are more likely to change their system of play when facing weaker opponents. Stronger teams are not sensitive to prior outcomes. The findings suggest that coaches are more risk-averse after experiencing a win and more risk-seeking after experiencing a defeat. This could be due to overconfidence after a win or an increased sense of urgency after a defeat. The fact that coaches are more likely to change their system of play when facing weaker opponents suggests that they may be trying to exploit perceived weaknesses in the opponent's defense or take advantage of opportunities for counterattacks.

Overall, this study provides insights into how prior outcomes affect managerial decision-making in professional sports teams and highlights the importance of considering psychological factors when analyzing strategic choices.

3.2.4 Summary

To summarize, Grund and Gürtler (2005) assess the level of risk-taking and risk-reducing substitutions due to game-internal factors like goal difference, whether the game is played at the home stadium, and the difference between the ranking of both opponents. Bartling et al. (2015) also focus on the strategic substitutions in the game itself, but concerning if the actual result is in line with the expected result. Whilst Bucciol et al. (2019) analyze the adjustment of the formation before the game regarding the results of the last games.

Concluding, the three papers propose two distinct kinds of observable risk-taking opportunities in football, risk-taking via initial formation changes and risk-taking via in-game substitutions (Bartling et al., 2015; Bucciol et al., 2019; Grund & Gürtler, 2005).

3.3 Research Question and Hypotheses

This Master's thesis aims to follow up on this work. It is closely related to Bucciol et al. (2019) as well as Grund and Gürtler (2005) and Bartling et al. (2015). It contributes to the research by integrating the aforementioned approaches. This is interesting, that one can observe the level of interaction between those. As elaborated and derived from prospect theory (Kahneman & Tversky, 1979), decisions will be made regarding different reference points. These reference points could be the expectation of the game result, resulting in the risk-taking behavior concerning substitutions (Bartling et al., 2015), but also prior outcomes, resulting in the risk-taking behavior concerning initial formation changes (Bucciol et al., 2019). I expect that those are two different, but not fully distinct kinds of reference points. Earlier results correspond to a backward-facing reference point and expectations to a more forward-facing reference point. This is because the course of the game and the win expectation depends heavily on the opponent. Of course, the win expectation is implicitly also dependent on the previous game results, therefore, it covers the current form of the team. Nevertheless, I assume it to be a more elaborated reference point, since it requires more cognitive effort to analyze the opponent and to build up a winning expectation for the upcoming game, compared to previous, already finished games, it should be more salient during the game.

Since different reference points can interact (Koop & Johnson, 2012), I analyze those on their own and a simple interaction model between both to explore the kind of interaction between them. To analyze the main effects of previous events, the present study focuses solely on prior wins and defeats without further categorization. Bucciol et al. (2019), however, differentiate previous events based on unexpected and heavy victories and defeats, as well as consecutive outcomes. Given the complexity of interpreting the interaction model, the present study avoids further differentiation. Nevertheless, the appendix presents this differentiated approach without providing exact interpretations. An advancement compared to Bucciol et al. (2019) is that this analysis includes the games of the whole season, not only the games from the season start-up to the transfer period. They argue that the team squad could potentially change and that the coaches do not have the same set of alternatives for the team composition. Additionally, the choices made by the coaches are likely affected by considerations over the standings in the season. The tactical decisions in the second half of the season are influenced by the experience the coach had with the team in the first half of the season. Against that, one can argue that coaches influence transfers. They can propose suitable transfers and often they have a veto right in buying or selling players. Therefore, the transfers could also include considerations of the coach, which do not have to be left aside but could likely be seen in the scope of the coach. Hence, it is justifiable to use the data for the whole season. Moreover, the subsequent analysis uses control mechanisms to additionally account for these effects. This opens new methodological opportunities because one could observe how the strategic adjustment will change over the whole season.

Another point is that I use a slightly different methodological framework and the data of the German *Bundesliga*, not the Italian Serie A. Thus, the work allows conclusions to be drawn about the stability of the econometric approach used and additionally, cultural similarities and differences in risk-taking in the Italian and German first soccer leagues and between the head coaches.

To assess the assumptions made above, the hypotheses of the thesis are presented as follows.

To verify the main results made by Bucciol et al. (2019) and following their work integrating the paper of Bartling et al. (2015), the following hypotheses are derived.

One hypothesis following Bucciol et al. (2019) is that prior outcomes affect risk-taking behavior, thus, that previous bad results lead to riskier behavior in the following match. According to Barberis (2013), it is not obvious what a reference point determines. In their analysis, Bartling et al. (2015) state that a reference point can be constituted by a situation that is "psychologically different" (Bartling et al., 2015, p. 2647). As a result, players and coaches may feel pressured or frustrated, which can cause them to exhibit different behaviors that might not always be completely rational (Bartling et al., 2015). This could be the case when considering a loss as a deviation from a good or neutral result. It can be argued that prior outcomes function as an anchor for the results in the following games and thus also constitute a reference point. One way of substantiating this is to use the realization effect (Imas, 2016). Imas (2016) argues that the realization of a loss functions as a natural point for internalizing a negative outcome. With the internalization of the loss, the reference point will be updated, meaning that realized defeats influence the reference point or even constitute one. Consequently, the negative previous outcomes likely influence the decisions before the game as a reference point, leading to the strategy adjustment in terms of the initial starting formation. Based on the discussion, this thesis aims to go a step further and propose that previous outcomes can indeed function as reference points. This leads to Hypothesis 1.

Hypothesis 1:

For decisions before the game, coaches act reference-dependent concerning prior outcomes.

Building up on Bartling et al. (2015), the authors find that head coaches act reference-dependent within the game, concerning the expectations made before the game. They show that risk-taking behavior is increased when behind expectations. This risk-taking behavior arises from the pressure that players and coaches perceive when the outcome is worse than expected. To reverse this outcome, they increase their risk-taking behavior. This is also to be expected when categorizing the results concerning the realization effect (Imas, 2016). The deficit in the game corresponds to an unrealized paper loss that the team tries to compensate for through increased risk-taking behavior. According to Merkle et al. (2021), it would also be expected that this behavior manifests even in the case of unrealized paper gains, as the heightened risk-taking behavior can serve as a cushion against losses.

To follow up on these results, they are firstly aimed to be replicated. Compared to Bartling et al. (2015), data is not available on a minute-by-minute basis, thus, the natural break point of the half-time break is used to determine reference-dependency relative to an expectation-based reference point.

Hypothesis 2:

Coaches act reference-dependent relative to an expectation-based reference point at half-time.

This could be due to a direct influence of the difference in the expected result so that the elaborated reference point will be more present. Nonetheless, as discussed previously, different reference points can interact (Koop & Johnson, 2012). Earlier results persist to exist as a reference point. Through loss aversion and the pressure to succeed, the result of the current and also of the previous games could then step into the foreground, having a potentially higher impact on the risk-taking behavior within the game by interacting. Thus, the risk-taking decisions within the game are influenced. Therefore, the assumption is that previous bad results are related to higher risk-taking behavior, when behind expectations, or in other and more general words, that the reference points about expectation and prior results interact with each other. The interaction can be seen as two different reference points influencing the decision-making process at the same time. This leads to hypothesis 3.

Hypothesis 3:

The reference point concerning prior outcomes interacts with the expectation-based reference point.

Thus, it is expected that coaches will, for example, strategically adjust the formation by substitutions more after previous bad results and if the game is beyond their expectations compared to the situation when only the current match result is worse than expected.

However, Bartling et al. (2019) and Grund and Gürtler (2005) assess that a higher risk-taking behavior does not pay off in terms of tournament success. This can again be stated in terms of the two mechanisms of strategic adaptions before and within the game. Thus, hypothesis 4 states that a higher strategic adjustment is unfavorable, leading to worse results.

Hypothesis 4: Risk-taking in terms of strategic adjustment before and within the game is related to worse outcomes.

The hypotheses will be assessed and evaluated in the following chapters.

4 Methodology

This chapter presents the research design, the analyzed data as well as the methods for the data analysis.

4.1 Data

This subchapter summarizes the data of this thesis. The objective is to provide a comprehensive overview of the dataset employed for the study, including its source, collection methods, and relevant characteristics.

4.1.1 Data Origin

The data set used is unique. I scraped all the data, except the betting odds, from kicker.de. "Kicker" is a leading German sports magazine by the publisher Olympia-Verlag GmbH, Nürnberg (Cermak, 2021; Olympia-Verlag GmbH, 2023). For scraping, I used R via RStudio, and the package *Rvest* for extracting the relevant data. The corresponding betting odds were taken from http://www.football-data.co.uk/germanym.php (Football-Data, 2023) and merged. I used the betting odds from Interwetten because it is a well-known bookmaker (Cermak, 2021).

4.1.2 Data Description

The data set contains information on the games of the German *Bundesliga* from season 2014/15 up to 2018/19. For each game, I have two observations, one containing information on the home team and one on the away team, respectively. Thus, the data set comprises 1,530 games or 3,060 data points. Due to the Covid-19 pandemic, football rules were slightly adjusted. The number of substitutions was increased to five so that ill players could be substituted, and a double load of players will be decreased. To ensure that the data is based on the same rules in all seasons and that there is enough data, the last five complete seasons before the COVID pandemic are used.

I extracted the data and names of all players nominated in the game, thus, the names of all players in the starting eleven, all substitutions, and the names of the players on the bench. The main position for each player is identified, also using the scraped information from kicker (Olympia-Verlag GmbH, 2023), and assigned.

Using a deviation from Bucciol et al. (2019), expectations are not stated in terms of wage differences, but, following Bartling et al. (2015), in terms of the pre-game betting odds. Those reflect the probabilities of the outcomes of the games. It can be assessed that the betting market is, in general, efficient. Thus, the pre-game betting odds can be seen as a reliable measure of expectations (Bartling et al., 2015; Hickman, 2020; Paul & Weinbach, 2005). For instance, betting odds should cover information on the abilities of both teams, the home advantage, the recent performance of each team, attacking and defending abilities, and the abilities of the prior opponents (Dixon & Coles, 1997).

However, explicit win, draw, and loss probabilities are easier to interpret and more convenient to use. It is also suggested that individuals explicitly focus on win and loss probabilities when making uncertain decisions (Zeisberger, 2022). Mostly used and most convenient is to convert betting odds into probabilities by the basic normalization, thus, dividing the inverse odds by the book sum (Bartling et al., 2015; Cermak, 2021; Štrumbelj, 2016). The respective formula is given in Formula 4.1.

Formula 4.1: *Calculation of the expected win probability*

$$\text{ExpectedWinProbability} = \frac{\frac{1}{Odds_{Win}}}{\frac{1}{Odds_{Win}} + \frac{1}{Odds_{Draw}} + \frac{1}{Odds_{Loss}}}$$

From that, one can state whether the half-time or full-time result ended as expected or not. Using a slight refinement in this work, a team is considered to win when the win probability exceeds the loss probability plus an additional margin of 5%. This margin is chosen to better distinguish between teams of roughly equal strength or teams with similar victory expectations. Accordingly, a draw is broader by this margin in this work.

The definition of being in a loss frame by Bartling et al. (2019) is also adopted, although the setting in this work is slightly different. Since Bartling et al. (2019) consider a continuous analysis for each minute of the game, they define that a team is within a loss frame if the team is behind its expectations and at least one goal has been scored in the game. They argue that if the additional constraint of at least one goal scored would be omitted, a favorite team would be in a loss frame right from the beginning of the game. That is the reason, why they impose the additional condition. In this setting, one can argue that the half-time marks a break and thus, functions as an evaluation point for the result. The coaches can recapitulate the current match, the result, and their expectations. An argument can be made that at this point a coach feels the pressure of the unexpected result even if it is still a goalless draw. Therefore, one could also assume that a team is already in a loss frame even with a goalless draw. However, due to comparability, the definition of Bartling et al. (2015) is adopted. As a result, three different cases for being in a loss frame emerge. A team is in a loss frame either if it was supposed to win or if it was supposed to draw but is with at least one goal behind at half-time. The third possibility is that a team is in a loss frame when it is predicted to win, but the score at halftime is a draw with at least one goal each. The concepts of being in a gain or win frame are defined accordingly.

Bucciol et al. (2019) use a dummy variable accounting for whether the initial formation was adjusted and adjusted more defensively or offensively, thus, it does not reflect whether an adaption was strong or not. To represent the strength of risk behavior, I additionally use the *strategy adjustment measure* proposed by Bartling et al. (2015) for the overall change of the initial formation and the substitutions, respectively. This measure includes and weights all strategic changes. Each summand corresponds to the number of strategic changes concerning this type of change. The first position term in each summand states the position of the player which is substituted in and the second one states the position of the player which is substituted out. DefForStr, therefore, means that a defender is substituted in for a striker. Since the "striker for defender" and "defender for a striker" changes represent the strongest strategic adjustment, they enter the formula with double weighting. Negative values correspond to defensive behavior and positive values to offensive behavior.

The formula concerning the initial formation change is given in Formula 4.2. It is renamed for clarity reasons.

Formula 4.2: *Calculation of the formation measure change*

$$\text{FormationMeasureChange} = (-2)\cdot\text{DefForStr} - \text{DefForMid} - \text{MidForStr} + \text{MidForDef} + \text{StrForMid} + 2\cdot\text{StrForDef}$$

To compare the two risk behaviors, the same measure is used for the substitutions and given in Formula 4.3.

Formula 4.3: *Calculation of the substitution measure*

$$\text{SubstitutionMeasure} = (-2)\cdot\text{DefForStr} - \text{DefForMid} - \text{MidForStr} + \text{MidForDef} + \text{StrForMid} + 2\cdot\text{StrForDef}$$

4.2 Research Design

The research design is a trend or panel design within a field experiment. A panel design is present when the same variables are collected over multiple time points with different samples. That holds of this work. The German *Bundesliga* is played in a double round-robin system, which means that every team plays against each other team twice, once at the home stadium and once at the opponents' stadium. For each win, a team will get three points, for a draw one point and no points will be given if a team loses. The aim is to finish as well as possible in the final standings. The first-place winner receives the championship trophy, the *Meisterschale*. Additionally, dependent on the rank, the teams qualify for European competitions. The qualification rules vary for each season and are conditional on the UEFA coefficient for each league. For the respective data set, it is as follows. The first three teams in the league table qualify directly for the UEFA Champions League. The fourth place qualifies for the UEFA Champions League play-off round. The fifth and sixth best teams qualify for the UEFA Europa League and the seventh best team for the UEFA Europa League qualification. It is favorable for the teams to achieve such a qualification because they obtain an additional financial payoff and a higher international reputation. On the contrary, the worst teams play for league preservation. The worst and second-to-worst team in the league will relegate to the second division, the *2. Bundesliga*, and will be replaced by the two best teams out of that league. The third-to-worst team will play relegation play-offs against the third-best team in the *2. Bundesliga*. Accordingly, the composition of the teams changes every season.

4.3 Data Analysis

The data analysis was conducted using RStudio, version '2023.3.0.386' ('Cherry Blossom') with R version 4.2.3 'Shortstop Beagle' (R Core Team, 2023). Additionally, to the base package, I used the following packages. The data was scraped using the package *Rvest* in version 1.0.3 (Wickham, 2022). Graphics are created using *ggplot2*, version 3.4.2 (Wickham, 2016). The summary and regression tables are made using the package *modelsummary* and version 1.3.0 (Arel-Bundock, 2022). The main body of the analysis consists of fixed effects linear regressions. For those, the *felm*-function within package *lfe*, version 2.9-0 (Gaure, 2023), is used.

Fixed effects regressions are used to analyze panel data including the same entities over multiple periods. It especially accounts for unobserved variables that are constant over time but vary between entities. This makes sense when looking, for instance, at the coaches' decisions. As already elaborated in the literature review, individuals generally have a fairly constant risk preference (Frey et al., 2017; Josef et al., 2016). This means that some coaches may be generally more risk-averse and some more risk-seeking. Imposing fixed effects controls for this general risk preference of each trainer, treating it not as random. Fixed effects regressions are widely used in this type of analysis (Bartling et al., 2015; Bourgeon, 2022; Lackner, 2023; Lackner & Sonnabend, 2022). The estimation approach involves utilizing the within transformation and pooled OLS methods (Wooldridge, 2012).

Empirical research does not assess the conditions for hypothesis testing, as can be seen, for instance, in Bartling et al. (2015). The common research practice is the measurement by fiat or measurement without validation. This means that scale levels are assumed to be interval scaled and the prerequisite testing for statistical tests such as regression analyses is omitted (Cermak, 2021).

Some more graphical results and the results of post hoc tests using one-sided non-paired Welch two-sample *t*-tests are presented in Appendix C to E.

All results are by convention reported on the significance levels 10%, 5%, 1%, and 0.1% and rounded on three decimals.

4.3.1 Hypothesis 1 [Prior Outcomes and Risk-taking Before the Game]

Formula 4.4 shows the estimation equation for the fixed effects model.

Formula 4.4: *Fixed effects-estimation equation for Hypothesis 1*

$$Initial\ Formation\ Change_{itsk} = \boldsymbol{X}'_{its}\boldsymbol{\beta} + \boldsymbol{Z}'_{its}\boldsymbol{\gamma} + c_k + \alpha_{is} + \delta_{ts} + \varepsilon_{itsk}$$

The dependent variable $Initial\ Formation\ Change_{itsk}$ represents the change in the initial formation for team i on matchday t in season s with respect to coach k. The initial formation change is measured in four different specifications. In the first specification, a dummy variable measuring if any change occurred, is used. Specification two uses the FormationMeasureChange from Formula 4.2. In the third and fourth specifications, dummy variables accounting for a more defensive or offensive change are being used. To account for the variation within the FormationMeasureChange, a team is considered initially more defensive if the FormationMeasureChange lies within the first quartile. It is considered initially more offensive when the measure lies within the fourth quartile. $\boldsymbol{X}'_{its}$ is the vector including the prior outcomes of a defeat or a win in the previous match. β is the vector of the coefficients for the effects of the corresponding independent variables concerning the prior outcomes. To distinguish between the dependent and the control variables, the vector of covariates $\boldsymbol{Z}'_{its}$ is included. It contains additional control variables with the respective coefficient vector $\boldsymbol{\gamma}$. The additional control variables are used to reduce the omitted variable bias.

Bucciol et al. (2019) account if a team is seen as risk-tolerant or risk-averse, if the game was played at the home stadium, the number of assists made as well as the average salary of the team, the current and the past opponent relative to the season. For coach characteristics, they control if the coach is foreign, new in the team and if the coach is a new one as well as the years the coach is in the Serie A. They include player characteristics such as the average age, the number of foreign players, the number of new players in the team, and their average years in Serie A.

In this specific data set, it is not useful to account if a team is generally risk-tolerant or risk-averse, since some teams can be considered risk-averse and risk-tolerant in two different seasons.[2] Due to fluctuations of coaches and players and proposed risk-taking behavior over different seasons, this is reasonable. Therefore, I propose to control the coaches directly using fixed effects. Consequently, one does also not need to account for proxy variables such as age and experience. The information on the risk-taking attitude of the coach is contained. Instead of using player characteristics, I use performance characteristics as a manager also potentially pays more attention to performance than to his employees.

Thus, the following control variables are used. First, the number of chances in the last game is a proxy variable with information on the predominance in the last game. In general, more offensive players mostly create chances. Thus, if a team had many chances in the last game, but lost, coaches could accept higher risks to increase the number of chances and thus the potential to win in the following game. One could also think about including the goal difference in the last game, however, this is assumed to be highly correlated with the number of chances in the previous match. Additionally, one should account if a match is played at the home stadium or at the opponents' because a friendly or unfriendly audience is said to have an impact on the own performance and risk-taking behavior (Baumeister & Steinhilber, 1984; Bucciol et al.,

[2] In the specific data set for example, Bayern Munich would be considered risk-averse in season 2014/15, but risk-tolerant in seasons 2015/16 up to season 2017/18. In that period, Bayern Munich had five different coaches (Josep "Pep" Guardiola from 2014/15 to 2015/16, Carlo Ancelotti from 2016/17 to 2017/18, and the three interim coaches Willy Sagnol, Josef "Jupp" Heynckes and Franz-Peter Hermann in 2017/18).

2019). One should also account for the standings before the game because in general, coaches could be less willing to take risks against better opponents in terms of the table situation, thus, including their own and the opponents' standings after the last match in the analysis is reasonable. c_k represents the coach fixed effect, capturing the time-invariant and team-invariant coach-specific factors that may affect the formation change. This is because, as elaborated, risk-taking is a relatively stable personality trait, at least over a short period of five years (Frey et al., 2019). Therefore, each coach has a general risk-taking preference, which should be seen as fixed and to be controlled over the analysis. Hence, using this as a fixed effect also accounts for the fact that a coach transfers to another team in the *Bundesliga*.

α_{is} represents the team-by-season and δ_{ts} the matchday-by-season fixed effects, capturing the time-varying factors that may affect the formation change. The team-season fixed effect stems from the fact that the team squad changes over each year, thus, coaches each year have different possibilities to set up the formations and to substitute. Matchday-season fixed effects are used, because risk-taking is influenced by the exact table situation on each match day of the season, which is of course different in each season. ε_{itsk} is the error term, representing the random variation in the dependent variable not explained by the independent and control variables and the fixed effects.

Additionally, one should use clustered, heteroskedasticity-robust standard errors. Clustered standard errors account for situations where data within different groups are not independently and identically distributed, for instance, because the decisions of a coach in the previous match are correlated with the decisions of the same coach in the upcoming game. Thus, clustering standard errors on the coach level is one possibility to account for this. Another approach is clustering on the average treatment effects proposed by Abadie et al. (2022), which is not done in this particular work. Clustered standard errors on the coach level are calculated within the whole thesis.

4.3.2 Hypothesis 2 [Expectations and Risk-taking within the Game]

Bartling et al. (2015) use the differentiation between being in a loss and gain frame as one possible specification, thus, this is adapted here. In their analysis, they account for the following. As control variables, they include the exact goal difference at present and substitutions as previous match events. Additionally, they include minute fixed effects and team-match fixed effects. Thus, they consider matches to be independent of each other. To better incorporate this into this framework regarding risk-taking between consecutive matches, the specification is adapted here, as can be seen in Formula 4.5.

Formula 4.5: *Fixed effects-estimation equation for Hypothesis 2*

$$Substitutions_{itsk} = \boldsymbol{X}'_{its}\boldsymbol{\beta} + \boldsymbol{Z}'_{its}\boldsymbol{\gamma} + c_k + \alpha_{is} + \delta_{ts} + \varepsilon_{itsk}$$

The estimation equation in Formula 4.5 is nearly the same as in Formula 4.4. The dependent variable $Substitutions_{itsk}$ represents the in-game substitution measures for team i on matchday t in season s with respect to coach k. For the substitution measure, three different specifications are utilized. Specification one uses the SubstitutionMeasure from Formula 4.3. Specifications two and three additionally use two dummy variables if the overall substitutions are more defensive or offensive. Once again, the first and fourth quartiles are used as indicators of more defensive and more offensive behavior. Furthermore, $\boldsymbol{X}'_{its}$ is the vector of independent variables. In this estimation equation, the two independent variables are represented by dummy variables indicating whether the team is a loss frame or a win frame with the corresponding coefficient vector $\boldsymbol{\beta}$. Additionally, the vector of control variables $\boldsymbol{Z}'_{its}$ is increased. In general, substitutions are, as already explained, made in the second half of the match. Of course, the exact result at half-time is a leading factor for strategic risk-taking behavior. Consequently, one should account for the result at half-time to control for the scarcity of the result. This is done by using the goal difference at half-time as a fifth control variable. All other variables are identically defined as above.

4.3.3 Hypothesis 3 [Interaction of both Reference Points]

By incorporating the estimations from Hypothesis 2 and integrating the concepts of Hypothesis 1 and Hypothesis 2, the estimation equation for Hypothesis 3 is specified as Formula 4.6.

Formula 4.6: *Fixed effects-estimation equation for Hypothesis 3*

$$Substitutions_{itsk} = \boldsymbol{X}'_{its}\boldsymbol{\beta} + \boldsymbol{Z}'_{its}\boldsymbol{\gamma} + c_k + \alpha_{is} + \delta_{ts} + \varepsilon_{itsk}$$

Again, the dependent variable is $Substitutions_{itsk}$, representing the team i's substitutions measure on matchday t in season s with respect to coach k. The specifications remain unchanged compared to the previous situation. $\boldsymbol{X}'_{its}$ now includes the main effect independent variables representing the prior outcomes in the past game as already defined, the main effects independent variables representing the team being in the halftime loss frame and halftime win frame and the interaction effects between the halftime loss frame and halftime win frame, and the prior outcomes, respectively, for team i on matchday t and season s. Further variables are exactly defined as in Formula 4.5.

4.3.4 Hypothesis 4 [Impact on Outcomes]

In the last specifications, the effects of the strategic changes and the risk-taking behavior on the match outcomes are evaluated, thus, a productivity analysis is made. Formula 4.7 shows the estimation equation for the fixed effects model.

Formula 4.7: *Fixed effects-estimation equation for Hypothesis 4*

$$Outcomes_{itsk} = \boldsymbol{X}'_{its}\boldsymbol{\beta} + \boldsymbol{Z}'_{its}\boldsymbol{\gamma} + c_k + \alpha_{is} + \delta_{ts} + \varepsilon_{itsk}$$

$Outcomes_{itsk}$ is the dependent variable, representing the match outcome for team i on matchday t in season s with respect to coach k. Match outcomes can be measured by the points achieved in the match. Furthermore, they can be measured in terms of the goal difference, including the scarcity of the result. A team is superior to another team if the goal difference is higher. On the other hand, a goal difference can also include a discouragement effect. Both measures are used in the literature (Bartling et al., 2019) and are therefore included in two distinct specifications. Additionally, dummy variables concerning if a team won or won a draw in the game are analyzed (Bucciol et al., 2019). Thus, to compare the results, all four specifications are presented. The dependent variables from 4.3.1 to 4.3.3 are the independent variables used here to detect the impact on productivity. Using the same notation as above, $\boldsymbol{X}'_{its}$ is the vector including independent variables representing the strategic initial formation changes and the independent variables representing the strategic substitutions with the corresponding coefficient vector $\boldsymbol{\beta}$.

The other variables remain mostly as defined. One difference is that the result manifests itself after the game is completed. Thus, it is dependent on the number of chances in the current game rather than in the previous game. Therefore, the control variable chances in the previous match become chances in the current match within the vector of covariates $\boldsymbol{Z}'_{its}$.

To not only capture the overall effect of the formation measure change and the substitution measure but to distinguish between each strategic adjustment, the number of initial changes and substitutions is used in the robustness check in Chapter 6.2. Different approaches are to use the number of each different substitution possibility, thus, for example, the number of substitutions of a striker for a defender as independent variables.

5 Descriptive Evidence

This chapter summarizes the descriptive evidence of the data analysis.

5.1 Descriptive Statistics

Table 5.1 contains the descriptive statistics of the relevant variables used in the data analysis.

Table 5.1: *Descriptive statistics*

	Minimum	Median	Mean	Maximum	N
Prior Bad Results					
Defeat in past match	0	0	0.374	1	1110
Prior Good Results					
Win in past match	0	0	0.374	1	1110
Loss frame					
Being in a loss frame at half-time	0	0	0.171	1	509
Win frame					
Being in a win frame at half-time	0	0	0.171	1	509
Formation change					
Any initial formation change	0	1	0.582	1	1730
Formation measure change	−5	0	−0.001	5	-
More defensive initial formation change	0	0	0.074	1	219
More offensive initial formation change	0	0	0.075	1	222
Number of defensive changes	0	0	0.332	3	987
Number of offensive changes	0	0	0.324	3	962
Substitutions					
Substitution measure	−5	0	−0.019	3	-
More defensive substitutions	0	0	0.136	1	404
More offensive substitutions	0	0	0.114	1	340
Number of defensive substitutions	0	1	0.662	3	1967
Number of neutral substitution	0	1	1.000	3	2971
Number of offensive substitution	0	1	0.746	3	2216
Outcome measures					
Points	0	1	1.374	3	-
Goal difference	−8	0	0.000	8	-
Win dummy	0	0	0.374	1	1110
Win or draw dummy	0	1	0.626	1	1859
Control variables					
Chances in past match	0	5	5.330	19	-
Chances in current match	0	5	5.352	19	-
Goal difference at half-time	−5	0	0.000	5	-
Table standing after past match	1	9	9.493	18	-
Table standing of the opponent after past match	1	9	9.493	18	-
Home playing	0	0	0.500	1	1485
Teams					
Number of Teams	-	-	-	-	23
Coaches					
Number of Coaches	-	-	-	-	67

Note:
N = 2,970

Source: Own representation

The data set contains 3,060 data points, two for each match considered. The number of observations is 2,970 because defeats and wins in the past match can only be considered after the second matchday, thus, the first matchday of each season is omitted. The data includes 23 teams and 67 coaches. In Appendix A, all coaches, and in Appendix B, all teams are displayed.

It should be mentioned that the seasons are considered individually. This means that the result from the last match of the previous season is not carried over to the next season, thus, each season is completed by itself. This is done, among other things, because the composition of the team changes every season.

The data includes 1,110 losses (37.4 %) or wins, respectively. In 509 cases (17,1 %), a team was in a loss or win frame at half-time.

The most frequent formation used is the 4-4-2 formation, which has been played 802 times (or in 26.21 % of the cases) within the data set. Other often played formations are, sorted by descending number, 4-5-1 (played 446 times or in 14.6 % of all cases), 5-3-2 (played 429 times or in 14.0 % of all cases), and 4-3-3 (played 304 times or in 9.9 % of all cases).

On average, the formation measure change and the substitution measure are nearly zero, thus, the change imposed by the coach before and within the game is, on average over all teams and seasons, neutral. Out of the 2,970 data points, 1,730, that is, over half of all, include a formation adaption between two games. In 987 cases, the change was defensive, in slightly fewer cases, 962, the change was offensive. Considering the substitutions, some more offensive substitutions are made compared to defensive substitutions, but neutral substitutions represent the highest share.

5.2 Graphical Evidence

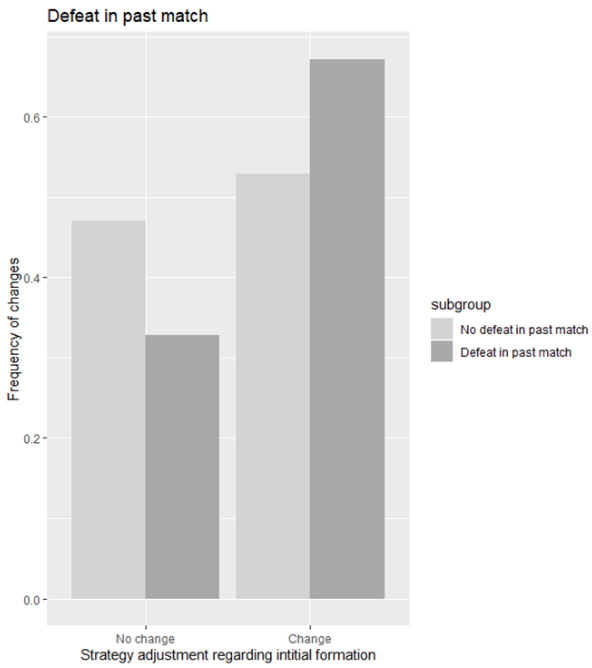
Chapter 5.2 presents graphical evidence concerning the first three hypotheses. The variables of interest are defeats and wins in the previous match as well as being in a loss frame or a win frame in the current match. The results for unexpected and heavy previous following the notion of Bucciol et al. (2019) as well as all corresponding *t*-tests can be found in Appendix C to E.

5.2.1 Hypothesis 1 [Prior Outcomes and Risk-taking before the Game]

This subchapter presents the graphical results concerning Hypothesis 1. It assesses the effects of previous game results on the change of the starting formation.

Figure 5.1 illustrates the occurrence of formation changes in relation to defeats and no defeats. It can be seen that formation changes are more often conducted after a defeat than after a win or draw.

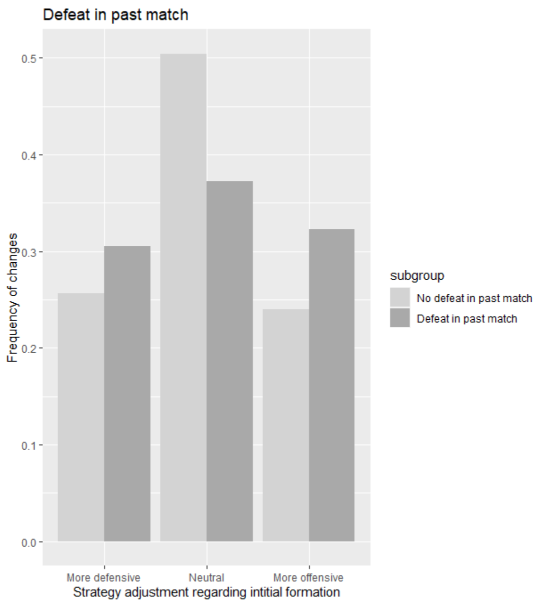
Figure 5.1: *Fraction of formation changes following a prior defeat*



Source: Own representation

Figure 5.2 displays the form of adjustment, which is if the formation was adjusted strategically defensive, neutral, or offensive. One must mention that this does not reflect how strict the strategic adjustment is, therefore, it does not include information about, if the coaches only slightly adjusted or changed the formation towards a more offensive or defensive formation, by, for example, replacing a defender with a midfielder, or drastically. Neutral adjustment means either no change of the formation at all or a strategically neutral formation change.

Figure 5.2: *Fraction of strategic initial formation changes concerning a prior defeat*

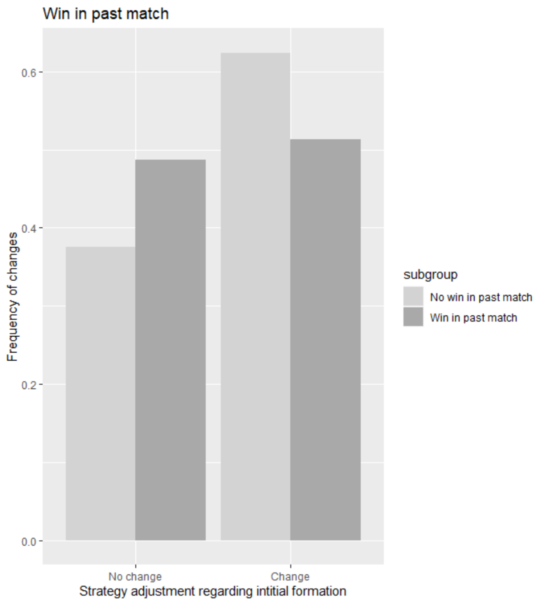


Source: Own representation

In both subgroups, the highest fraction of strategic adjustment is neutral changes. The fraction between more defensive and more offensive strategic formation changes is approximately the same in both subgroups. It is around 25 % for the teams winning or drawing the last game and around 30 % for the teams losing their last game. Consequently, one also obtains that the teams change more defensively and more offensively after a defeat.

Further analysis is devoted to the effects of positive prior outcomes on the types of initial formation changes. Figure 5.3 shows the fractions of formation changes after a win in the last game compared to no win in the last game.

Figure 5.3: *Fraction of initial formation changes concerning a prior win*



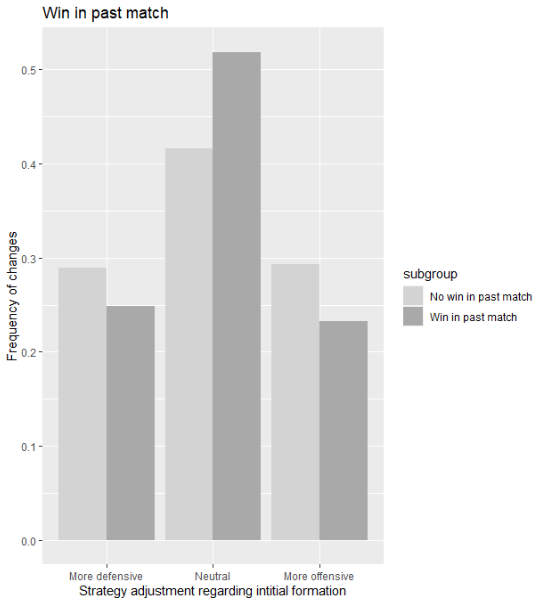
Source: Own representation

After wins in the previous game, almost half of the coaches change their formation. However, coaches change their formation less often than if they did not win in the previous game.

Figure 5.4 then shows the distribution among the individual strategic changes.

What is striking to see is that coaches change more often neutrally and less often defensively or offensively after a win than after a draw or loss.

Figure 5.4: *Fraction of strategic initial formation changes concerning a prior win*

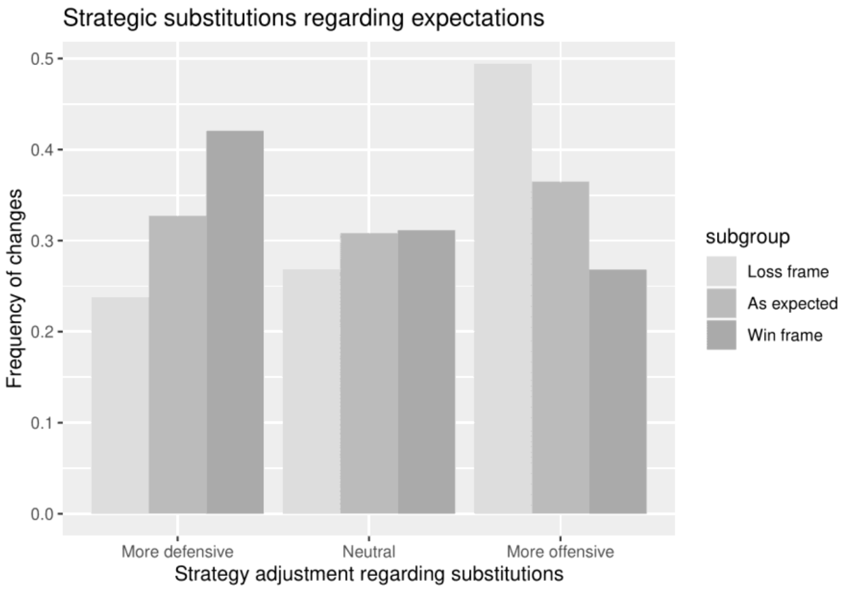


Source: Own representation

5.2.2 Hypothesis 2 [Expectations and Risk-taking within the Game]

This subsection presents the graphical results concerning Hypothesis 2 about the expectations as reference points and the influence on the risk-taking within the game.

Figure 5.5: *Fraction of substitutions concerning the deviation of expectations*



Source: Own representation

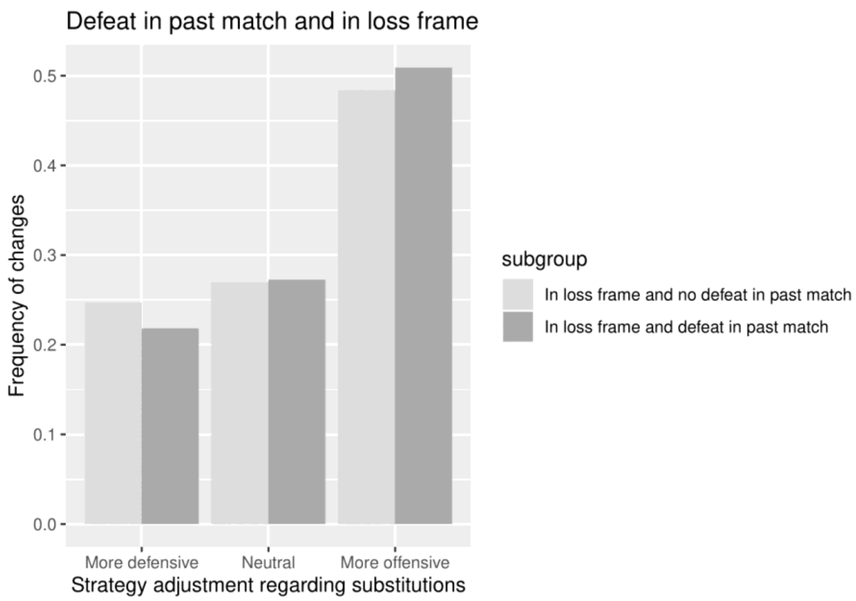
Figure 5.5 presents the fractions of substitutions when below and above the a priori expectation and in line with the expectation. In general, coaches substitute more defensively, when in a win frame, and more offensively, when in a loss frame.

5.2.3 Hypothesis 3 [Interaction of both Reference Points]

The graphical findings regarding Hypothesis 3 are as follows. First are the graphical results regarding defeats in terms of unexpectedly bad and unexpectedly good half-time results, followed by the same findings for wins in the previous game.

Figure 5.6 graphically depicts the results in terms of previous defeats and unexpectedly poor mid-term results.

Figure 5.6: *Fraction of substitutions concerning a prior defeat and being in a loss frame*

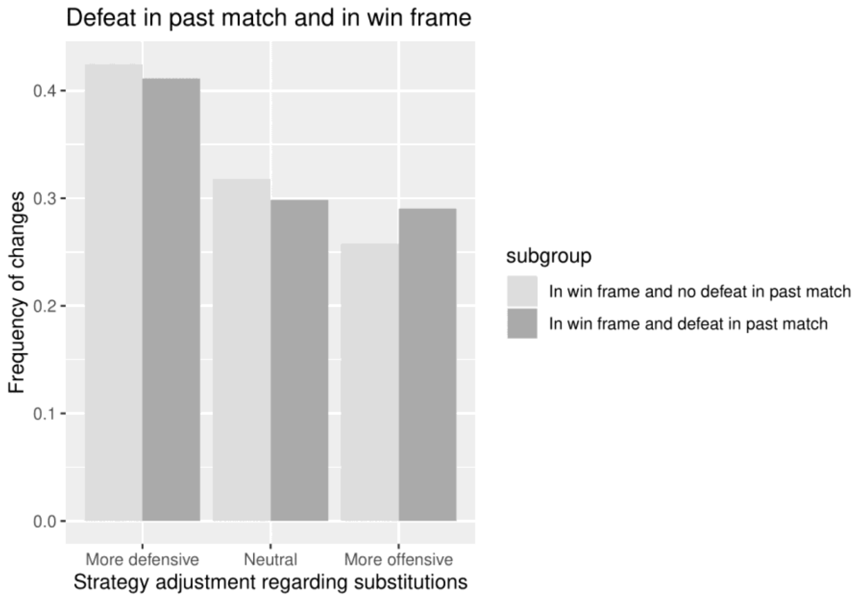


Source: Own representation

One can see that coaches are less likely to substitute defensively when being in a loss frame in the current game and have lost the last game than when they are in a loss frame and have not lost the last game. In contrast, the percentage of offensive changeovers is higher in this subgroup.

The next results concerning defeats as prior outcomes and unexpectedly good game results are given in Figure 5.7.

Figure 5.7: *Fraction of substitutions concerning a prior defeat and being in a win frame*

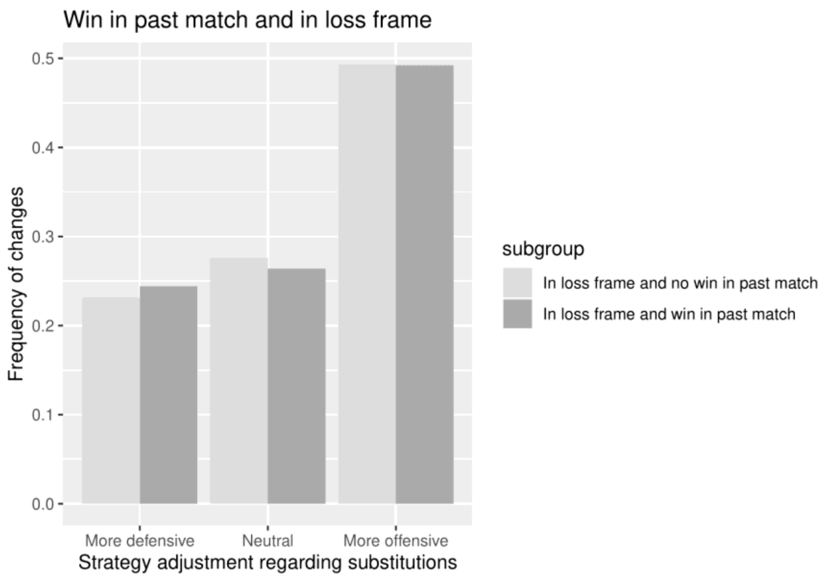


Source: Own representation

When faced with a halftime score above expectations, coaches generally substitute most defensively. However, they change less neutrally and more offensively when in a win frame and when they lost in the last game than when in a win frame and when they won or drew the last game.

From now on, the setting revolves around the victories in the previous game. If a team won the previous game and faces an unexpectedly bad result in the current game, coaches change slightly to be more defensive and less neutral, as Figure 5.8 shows.

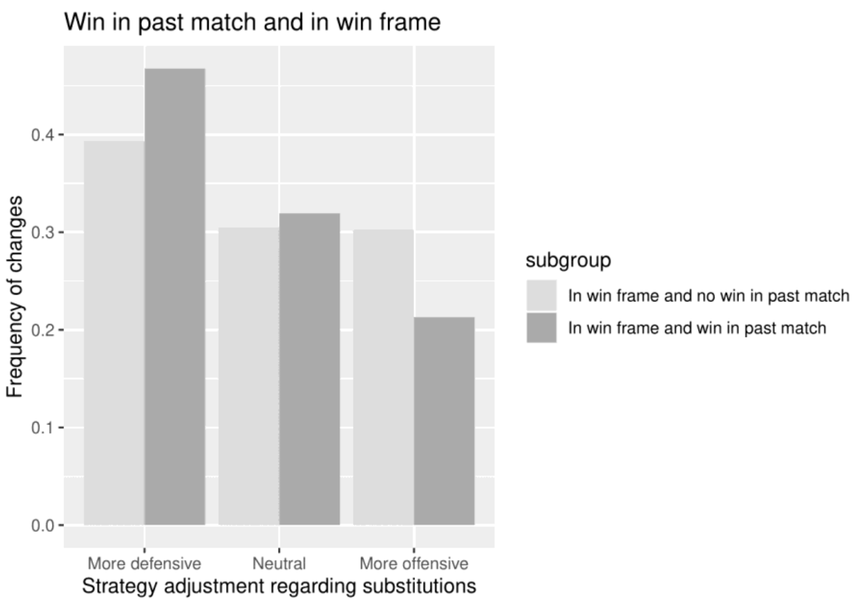
Figure 5.8: *Fraction of substitutions concerning a prior win and being in a loss frame*



Source: Own representation

This graphical subsection concludes with the analyses in terms of prior good results and being in a win frame at half-time.

Figure 5.9: *Fraction of substitutions concerning a prior win and being in a loss frame*



Source: Own representation

Figure 5.9 shows that coaches whose team is playing better than expectations and has won the game before are more likely to change defensively, and less likely to change offensively than a coach whose team is playing better than expectations and has not won the game before.

Thus, graphically, there seems to be an interaction between the two different mechanisms, influencing risk-taking behavior by substitutions.

6 Results

Chapter 6 covers the results of the regression analysis. This is divided into the main regression results and the results of robustness analysis.

6.1 Regression Analysis

First, the results of the main regressions are presented.

6.1.1 Hypothesis 1 [Prior Outcomes and Risk-taking before the Game]

To explore the overall interaction within a regression model, the following fixed effects model is used. Table 6.1 states the result of this fixed effects model.

The dependent variable in regression (1) is a dummy variable, if any initial formation changes, even a strategically neutral one, occurs. It follows that if a defeat occurred in the previous game, *ceteris paribus*, coaches adapt the initial formation in the next game significantly more often compared to the reference category draw in the previous game (ß = 0.126, SE = 0.022, $p < 0.001$). The exact interpretation would be that a defeat in the past match corresponds to a 12.6-percentage point increase in the probability of observing initial formation changes compared to a draw in the previous game. On the contrary and assessing previous good results, previous wins are not related to significantly more initial formation changes (ß = −0.030, SE = 0.023, p = n.s.).

Table 6.1: *Fixed effects regression concerning initial formation changes*

	(1)	(2)	(3)	(4)
	Any change	Formation measure change	More defensive	More offensive
Prior Bad Results				
Defeat in past match	0.126***	0.071	0.018	0.054***
	(0.022)	(0.050)	(0.013)	(0.014)
Prior Good Results				
Win in past match	−0.030	0.055	0.003	0.015
	(0.023)	(0.062)	(0.015)	(0.012)
Control Variables				
Table standing after past match	−0.001	−0.002	0.001	0.000
	(0.005)	(0.005)	(0.001)	(0.002)
Table standing of the opponent after past match	−0.005**	0.013**	−0.002**	0.002+
	(0.002)	(0.004)	(0.001)	(0.001)
Home playing	−0.019	0.180**	−0.031**	0.020+
	(0.014)	(0.059)	(0.011)	(0.011)
Chances in past match	−0.014***	−0.026***	−0.001	−0.007***
	(0.004)	(0.007)	(0.002)	(0.002)
Fixed Effects				
Fixed Effects: Coach	x	x	x	x
Fixed Effects: Team x Season	x	x	x	x
Fixed Effects: Matchday x Season	x	x	x	x
Characteristics				
Num.Obs.	2970	2970	2970	2970
R2	0.177	0.072	0.115	0.133
Std.Errors	by: Coach	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: Own representation

One should also interpret the significant control variables. The worse the table standing of the opponent after the past match, the fewer initial changes happen (ß = −0.005, SE = 0.002, p < 0.01). Additionally, chances in the past match are highly significant and negatively related to initial changes (ß = −0.014, SE = 0.004, p < 0.001), meaning that more chances in the past match are also related to fewer initial changes.

When looking at the overall initial formation measure of the change in specification (2), no significant effects are found. Considering the control variables, the higher, thus the worse, the table standing of the opponent after the past match, the more offensive the formation measure change (ß = 0.013, SE = 0.004, p < 0.01). Playing at the home stadium is also related to a more offensive formation adaption (ß = 0.180, SE = 0.059, p < 0.01). More chances in the past match correspond to a more defensive adaption (ß = −0.026, SE = 0.007, p < 0.001).

Specifications (3) and (4) consider the dummy variables of more defensive and offensive initial changes based on the first and fourth quartile, respectively. Hence, specification (3) aims to answer the question, of whether the variables are linked to more defensive changes. The same holds for specification (4) concerning only offensive changes.

According to regression (3), defeats and wins in the past match are not significantly linked to more defensive behavior. The results of the control variables are that a higher table standing of the opponent after the past match is related to less defensive formation changes (ß = −0.002, SE = 0.001, $p < 0.01$). Playing at the home stadium is also related to less defensive formation adaption (ß = −0.031, SE = 0.011, $p < 0.01$).

From specification (4) one obtains that if a defeat occurred in the last game, coaches adapt the initial formation in the current game more often offensively (ß = 0.054, SE = 0.014, $p < 0.001$). The higher the table standing of the opponent after the past match, the higher the fraction of more offensive formation changes (ß = 0.002, SE = 0.001, $p < 0.10$). Again, playing at home corresponds to more offensive initial changes (ß = 0.020, SE = 0.011, $p < 0.10$) and more chances in the past match to less offensive adaptions (ß = −0.007, SE = 0.002, $p < 0.001$).

Overall, defeats correspond in general to more offensive initial adaptions. Wins in general do not influence risk-taking behavior before the next match.

6.1.2 Hypothesis 2 [Expectations and Risk-taking within the Game]

This subsection presents the results concerning hypothesis 2 about the expectations as reference points and the influence on the risk-taking within the game.

Table 6.2 shows the results of the fixed effects regression of being in a loss or win frame, thus, being behind or above expectations at half-time on the substitutions, and therefore on the overall strength of defensive and offensive substitutions.

Table 6.2: *Fixed effects regression concerning substitutions*

	(5)	(6)	(7)
	Substitution measure	More defensive	More offensive
Unexpected Results			
Being in a loss frame at half-time	0.239***	−0.033+	0.041+
	(0.067)	(0.018)	(0.025)
Being in a win frame at half-time	−0.152*	0.009	−0.029+
	(0.070)	(0.022)	(0.016)
Control Variables			
Table standing after past match	0.031**	−0.003	0.005+
	(0.010)	(0.003)	(0.003)
Table standing of opponent after past match	−0.002	0.000	0.000
	(0.004)	(0.001)	(0.001)
Home playing	−0.111*	−0.003	−0.023*
	(0.048)	(0.015)	(0.010)
Chances in past match	−0.018+	0.000	−0.004
	(0.010)	(0.003)	(0.002)
Goal difference at half-time	−0.194***	0.037***	−0.033***
	(0.025)	(0.008)	(0.007)
Fixed Effects			
Fixed Effects: Coach	x	x	x
Fixed Effects: Team x Season	x	x	x
Fixed Effects: Matchday x Season	x	x	x
Characteristics			
Num.Obs.	2970	2970	2970
R2	0.193	0.142	0.132
Std.Errors	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: Own representation

The dependent variable of regression (5) is the overall substitution measure in the present game. It follows that coaches substitute highly significantly more offensively if being in a loss frame, which is if the half-time result is below their expectations (ß = 0.239, SE = 0.067, $p < 0.001$). On the contrary, coaches substitute more defensively if they are within a win frame, more precisely, if the intermediate result is above their expectations (ß = −0.152, SE = 0.070, $p < 0.05$). Observing the effects of the control variables, one sees that teams with a higher table standing, thus worse teams, substitute significantly more offensive (ß = 0.031, SE = 0.010, $p < 0.01$). If the match takes place at the home stadium, coaches substitute significantly more defensively (ß = −0.111, SE = 0.048, $p < 0.05$). This is also the case after more chances in the previous match (ß = −0.018, SE = 0.010, $p < 0.10$) and a higher goal difference at half-time (ß = −0.194, SE = 0.025, $p < 0.001$).

Specifications (6) and (7) concern the dummy variables of more defensive and offensive substitutions, respectively. In specification (6), being in a loss frame at half-time corresponds to less defensive behavior (ß = −0.033, SE = 0.018, $p < 0.10$). A higher goal difference at half-time is related to more defensive substitutions (ß = 0.037, SE = 0.008, $p < 0.001$).

For the offensive substitutions in the specification (7) one can state that coaches substitute more offensively after an unexpectedly bad half-time result (ß = 0.041, SE = 0.025, $p < 0.10$) and less offensively after an unexpectedly good half-time result (ß = −0.029, SE = 0.016, $p < 0.10$). Again, one sees that teams with a higher table standing substitute significantly more offensive (ß = 0.005, SE = 0.003, $p < 0.10$). Less offensive substitutions occur when the match is played at home (ß = −0.023, SE = 0.010, $p < 0.01$) and the higher the goal difference at half-time is (ß = −0.033, SE = 0.007, $p < 0.001$).

Summing up the results of Hypothesis 2, one can see that, in general, coaches substitute more offensively when being in a loss frame, that is, facing an unexpectedly bad half-time result, and more defensively when being in a win frame, that is, facing an unexpectedly good half-time result.

6.1.3 Hypothesis 3 [Interaction of both Reference Points]

This subsection provides the findings regarding Hypothesis 3. Table 6.3 includes the concerning fixed effects regression. This specification used does not only include all interaction terms between the prior outcomes and the half-time result relative to the expectations but also the lower-order main effects. As a result, the effects of prior outcomes themselves on the substitutions within the game are included in the regression and can be explored. Thus, one can also state if the prior outcomes have a direct influence on the substitutions in the game. Additionally, compared to the results regarding hypothesis 2, one can detect if the main effects are indeed significant influences or if the interaction terms are the leading drivers concerning substitutions within the game. The results are interpreted with respect to the reference category, which is a team that drew the last game, and which plays as expected in the current game. Regression specification (8) follows that a defeat in the last game corresponds to a higher defensive substitutional change in terms of the substitution measure, however, this is not significant (ß = −0.144, SE = 0.089, p = n.s.). Interestingly, the main effects concerning the loss and win frame fall below the significance threshold, which is a clear difference compared to the specification (5). The correspondence between a loss in the last game and being in a loss frame in the current game is significantly positive. Hence, facing a loss in the last game and being in the loss frame, is related to an around 0.4-point increase in the substitution measure (ß = 0.347, SE = 0.163, $p < 0.05$). Concerning the control variables, one obtains that the higher, thus the worse, the standing after the past match, the higher the substitution measure, thus the more offensive (ß = 0.038, SE = 0.011, $p < 0.001$). Home matches (ß = −0.096, SE = 0.049, $p < 0.10$), more chances in the past match (ß = −0.027, SE = 0.011, $p < 0.05$), and a higher goal difference at half-time are linked to more defensive behavior (ß = −0.192, SE = 0.025, $p < 0.001$).

Regarding the dummy variable of defensive substitutions in the specification (9), neither significant main effects nor significant interaction effects are found. Also, the main effects of being in a loss frame or win frame are neither significant in the specification (9) nor in regression (10). The control variable of the table standing after the past match is related to fewer defensive substitutions (ß = −0.005, SE = 0.003, $p < 0.10$). Furthermore, coaches substitute more defensively with a higher goal difference at half-time (ß = 0.036, SE = 0.008, $p < 0.001$).

Table 6.3: *Fixed effects regression concerning substitutions*

	(8)	(9)	(10)
	Substitution measure	More defensive	More offensive
Prior bad results			
Defeat in past match	−0.144	0.019	−0.020
	(0.089)	(0.022)	(0.019)
Prior good results			
Win in past match	0.093	−0.030	0.027
	(0.070)	(0.020)	(0.019)
Unexpected results			
Being in a loss frame at half-time	0.043	−0.002	−0.014
	(0.115)	(0.032)	(0.045)
Being in a win frame at half-time	−0.083	0.006	0.001
	(0.101)	(0.038)	(0.027)
Loss frame x prior bad result			
Loss frame x Defeat in past match	0.374*	−0.038	0.118*
	(0.163)	(0.038)	(0.055)
Loss frame x prior good result			
Loss frame x Win in past match	0.132	−0.037	0.028
	(0.122)	(0.032)	(0.042)
Win frame x prior bad result			
Win frame x Defeat in past match	−0.002	0.003	−0.036
	(0.150)	(0.050)	(0.031)
Win frame x prior good result			
Win frame x Win in past match	−0.185	0.005	−0.040
	(0.150)	(0.061)	(0.033)
Control Variables			
Table standing after past match	0.038***	−0.005+	0.007*
	(0.011)	(0.003)	(0.003)
Table standing of the opponent after past match	−0.002	0.000	0.000
	(0.004)	(0.001)	(0.001)
Home playing	−0.096+	−0.008	−0.020*
	(0.049)	(0.016)	(0.010)
Chances in past match	−0.027*	0.003	−0.005*
	(0.011)	(0.003)	(0.002)
Goal difference at half-time	−0.192***	0.036***	−0.033***
	(0.025)	(0.008)	(0.007)
Fixed Effects			
Fixed Effects: Coach	x	x	x
Fixed Effects: Team x Season	x	x	x
Fixed Effects: Matchday x Season	x	x	x
Characteristics			
Num.Obs.	2970	2970	2970
R2	0.197	0.145	0.137
Std.Errors	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own representation

The results for offensive substitutions are given in specification (10). Concerning the main effects, no significant influences can be detected. Concerning the interaction effects, again, facing a loss in the last game and being in the loss frame corresponds to more offensive substitutional behavior (ß = 0.118, SE = 0.055, $p < 0.05$). The control variable of the table standing after the past match is related to more offensive substitutions (ß = 0.007, SE = 0.003, $p < 0.05$). Home matches are linked to less offensive behavior (ß = −0.020, SE = 0.010, $p < 0.05$). Similarly, as above, more chances (ß = −0.005, SE = 0.002, $p < 0.05$) and a higher goal difference at half-time correspond to a less offensive substitutional behavior (ß = −0.033, SE = 0.007, $p < 0.001$). Overall, one sees the following. A defeat, in general, is related to more defensive substitutions in terms of the substitution measure compared to a previous draw, a previous win to more offensive in-game behavior. This, however, may change if the result at half-time does not match the pre-game expectation. The presence of a previous defeat has a negative impact on substitutions. Additionally, being in a loss frame at half-time has a slightly positive relationship with substitutions. However, the interaction between these two variables has a strong positive effect. This suggests that the combined influence of the variables is the primary driver of the relationship, indicating the presence of an interaction effect.

The conclusion is that prior results and the interaction between prior results and deviations from the expected results are partially significantly related to the risk-taking behavior measured by substitutions within the game.

6.1.4 Hypothesis 4 [Impact on Outcomes]

The subsection covers the findings related to Hypothesis 4. It aims to examine the link between risk-taking behavior and its influence on the outcomes of the game.

Table 5.5 presents the productivity analysis of the risk-taking behavior, thus, it includes the fixed effects regression regarding the risk-taking behavior on the game outcomes.

Specification (11) states that stronger initial offensive substitutions are related to a highly significant decrease in the points achieved in the game (ß = −0.173, SE = 0.041, p < 0.001). Moreover, stronger offensive in-game substitutions correspond to fewer points (ß = −0.211, SE = 0.016, p < 0.001).

Table 6.4: *Fixed effects regression concerning game outcomes*

	(11)	(12)	(13)	(14)
	Points	Goal difference	Win	Win or Draw
Initial formation changes				
Any initial formation change	0.020	−0.064	0.012	−0.004
	(0.035)	(0.040)	(0.014)	(0.014)
Formation measure change	−0.173***	−0.185***	−0.048**	−0.078***
	(0.041)	(0.046)	(0.016)	(0.016)
Substitutions				
Substitution measure	−0.211***	−0.133***	−0.068***	−0.076***
	(0.016)	(0.019)	(0.006)	(0.006)
Control Variables				
Table standing after past match	−0.100***	−0.089***	−0.035***	−0.030***
	(0.010)	(0.012)	(0.004)	(0.003)
Table standing of the opponent after past match	0.045***	0.058***	0.014***	0.017***
	(0.003)	(0.004)	(0.001)	(0.001)
Home playing	0.196***	0.214***	0.059***	0.077***
	(0.036)	(0.041)	(0.014)	(0.012)
Chances in current match	0.096***	0.178***	0.036***	0.024***
	(0.008)	(0.008)	(0.003)	(0.003)
Goal difference at half-time	0.404***	0.806***	0.133***	0.137***
	(0.017)	(0.027)	(0.006)	(0.008)
Fixed Effects				
Fixed Effects: Coach	x	x	x	x
Fixed Effects: Team x Season	x	x	x	x
Fixed Effects: Matchday x Season	x	x	x	x
Characteristics				
Num.Obs.	2970	2970	2970	2970
R2	0.547	0.632	0.481	0.468
Std.Errors	by: Coach	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: Own representation

Considering the control variables, a higher table standing after the past match corresponds to fewer points (ß = −0.100, SE = 0.010, p < 0.001). A higher table standing of the opponent after the past match (ß = 0.045, SE = 0.003, p < 0.001), playing at home (ß = 0.196, SE = 0.036, p < 0.001), more chances in the current match (ß = 0.096, SE = 0.008, p < 0.001), as well as a higher goal difference at half-time, are related to more achieved points (ß = 0.404, SE = 0.017, $p < 0.001$).

In the context of the goal difference and specification (12), similar results are found. Stronger offensive initial formation changes measured by the variable formation measure change go along with a lower goal difference (ß = −0.185, SE = 0.046, $p < 0.001$), so do stronger offensive substitutions (ß = −0.133, SE = 0.019, $p < 0.001$). The control variables in this specification again are highly significant and show the same orientation and a similar magnitude of the effect. Interestingly, the ß-coefficient in the points regression is higher for the substitution measure compared to the initial formation measure change, leading to the conclusion that the main influence comes from in-game substitutions. However, the propensity shifts when considering the goal difference.

Considering the dependent dummy variables specified in equations (13) and (14), the signs and the effects of the independent and control variables themselves do not change and are at least strongly significant.

Thus, initial and within-game defensive changes are related to a better game outcome in terms of points, whilst more offensive changes are related to worse game outcomes.

6.2 Robustness check

This subsection contains a robustness check of the regression analysis. It can be done to evaluate whether the direction and strength of the effect hold under modifications and other specifications of the regression analysis as well as to assess the model quality in terms of the coefficient of determination. Here, dependent variables with the same informational content are used. The estimation equations in Chapter 4.3 are formulated in general terms and continue to hold in this robustness check.

Table 5.6 includes the results of the robustness check about hypothesis 1. Instead of using the strength of the positive and negative initial formation changes, this regression uses the number of defensive changes in the specification (3') and offensive ones in the specification (4').

Table 6.5: *Fixed effects regression concerning initial formation changes*

	(3')	(4')
	Number of initial defensive changes	Number of initial offensive changes
Prior Bad Results		
Defeat in past match	0.066**	0.098***
	(0.024)	(0.025)
Prior Good Results		
Win in past match	−0.045+	−0.003
	(0.027)	(0.028)
Control Variables		
Table standing after past match	0.002	−0.004
	(0.004)	(0.004)
Table standing of the opponent after past match	−0.007***	0.002
	(0.002)	(0.002)
Home playing	−0.087***	0.056*
	(0.023)	(0.025)
Chances in past match	0.000	−0.019***
	(0.003)	(0.004)
Fixed Effects		
Fixed Effects: Coach	x	x
Fixed Effects: Team x Season	x	x
Fixed Effects: Matchday x Season	x	x
Characteristics		
Num.Obs.	2970	2970
R2	0.102	0.118
Std.Errors	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: Own representation

It can be seen in the specification (3') that significantly more defensive initial changes are made after a loss (ß = 0.066, SE = 0.024, $p < 0.01$). If the result of the last game was a win, coaches change to fewer defensive players in the initial formation (ß = –0.045, SE = 0.027, $p < 0.10$). Furthermore, the control results state that the higher the table standing of the opponent after the past match, the fewer defensive players are initially switched (ß = −0.007, SE = 0.002, $p < 0.001$). Home matches also correspond to fewer initial defensive changes (ß = −0.087, SE = 0.023, $p < 0.01$).

If a defeat occurred in the last game, coaches change highly significantly more offensive players in the initial formation (ß = 0.098, SE = 0.025, $p < 0.01$), as seen in the specification (4’). Wins are not significantly related to a higher number of offensive changes (ß = −0.003, SE = 0.028, p = n.s.). Additionally, home games are related to more initial offensive changes (ß = 0.056, SE = 0.025, $p < 0.05$), and the number of chances in the previous match is negatively linked to the number of offensive changes (ß = −0.019, SE = 0.004, $p < 0.001$).

The specifications show similar significant regressors compared to the regressions (1) to (4), with the sign and magnitude of these significant regressors aligning in the same direction. The results of (3’) and (4’) state that a prior defeat corresponds to more offensive and more defensive changes, but with a tendency of overall more offensive changes. This is because the coefficient regarding the number of offensive changes is higher than the coefficient regarding the number of defensive changes and the standard errors are comparable. Thus, one nearly obtains the same results from regressions (1) to (4).

Table 5.7 shows the results of the robustness check about hypothesis 2. Again, instead of using the strength of the substitutions, this robustness check uses the number of defensive substitutions in (6’) and offensive substitutions in (7’).

The results of specification (6’) state that coaches substitute significantly fewer defensive players if they are in a loss frame at half-time (ß = –0.079, SE = 0.036, $p < 0.05$). The higher the table standing after the past match, the fewer defensive substitutions (ß = −0.012, SE = 0.005, $p < 0.05$). The goal difference at half-time is positively related to the number of defensive substitutions (ß = 0.079, SE = 0.014, $p < 0.001$).

Regarding the number of offensive substitutions and specification (7’), one obtains that more offensive substitutions are made if being in a loss frame (ß = 0.118, SE = 0.045, $p < 0.05$) and fewer offensive ones if being in a win frame (ß = –0.073, SE = 0.031, $p < 0.05$). Home matches are related to fewer offensive substitutions (ß = −0.101, SE = 0.020, $p < 0.001$), as is the number of chances in the previous match (ß = −0.015, SE = 0.006, $p < 0.05$) and the goal difference at half-time (ß = −0.108, SE = 0.014, $p < 0.001$).

Table 6.6: *Fixed effects regression concerning substitutions*

	(6')	(7')
	Number of defensive substitutions	Number of offensive substitutions
Unexpected Results		
Being in a loss frame at half-time	−0.079*	0.118*
	(0.036)	(0.045)
Being in a win frame at half-time	0.041	−0.073*
	(0.047)	(0.031)
Control Variables		
Table standing after past match	−0.012*	0.010
	(0.005)	(0.006)
Table standing of opponent after past match	0.001	0.000
	(0.002)	(0.002)
Home playing	0.014	−0.101***
	(0.028)	(0.020)
Chances in past match	0.005	−0.015*
	(0.005)	(0.006)
Goal difference at half-time	0.079***	−0.108***
	(0.014)	(0.014)
Fixed Effects		
Fixed Effects: Coach	x	x
Fixed Effects: Team x Season	x	x
Fixed Effects: Matchday x Season	x	x
Characteristics		
Num.Obs.	2970	2970
R2	0.166	0.202
Std.Errors	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own representation

Because a stronger defensive substitution results in a stronger negative value in the substitution rating, the signs of regressions (6) and (6') are reversed. When comparing all specifications, more or increasingly strict defensive substitutions are made if the result at half-time is better than expected. Additionally, substitutions are more or strictly offensive if the half-time result is worse than expected. Thus, the results are consistent and robust and show the same results within the regressions.

Table 5.8 presents the results regarding hypothesis 3, again with the number of substitutions as a variation for the robustness test.

The results of specification (9') are as follows. If facing a defeat in the previous game, coaches substitute more defensive players (ß = 0.086, SE = 0.049, $p < 0.10$). The results of the interaction terms state that fewer defensive players are substituted if the team lost the last game and if the standing at half-time is worse than expected (ß = –0.253, SE = 0.076, $p < 0.01$). Considering the control variables, worse-ranked tend to make fewer defensive substitutions (ß = −0.015, SE = 0.005, $p < 0.01$). More chances in the previous match are related to a higher number of defensive substitutions (ß = 0.010, SE = 0.006, $p < 0.10$). Again, the higher the goal difference at half-time, the more defensive substitutions (ß = 0.078, SE = 0.014, $p < 0.001$).

In the case of specification (10') and the number of offensive substitutions, considering the main effects, no significant relationships are found. Furthermore, the interaction results also show no significant relationships. However, the control variables state significant relationships. A higher, thus worse, table standing after the past match is related to more offensive substitutions (ß = 0.013, SE = 0.006, $p < 0.05$). Negative relationships are found regarding home playing (ß = −0.096, SE = 0.022, $p < 0.001$), more chances in the past match (ß = −0.018, SE = 0.007, $p < 0.01$), and a higher goal difference at half-time (ß = −0.107, SE = 0.014, $p < 0.001$).

Altogether, the results are consistent with the results from regressions (8) to (10). Again, the main effects of a team being in a win frame or loss frame are below the significance threshold. In nearly all specifications, prior outcomes and the interaction between prior outcomes and observing an unexpectedly good or bad half-time result influences risk-taking behavior. In almost all cases, the presence of a loss frame and prior defeat is associated with an increase in offensive behavior.

Table 6.7: *Fixed effects regression concerning substitutions*

	(9')	(10')
	Number of defensive substitutions	Number of offensive substitutions
Prior bad results		
Defeat in past match	0.086+	−0.046
	(0.049)	(0.047)
Prior good results		
Win in past match	−0.060	0.007
	(0.042)	(0.040)
Unexpected results		
Being in a loss frame at half-time	0.052	0.072
	(0.053)	(0.083)
Being in a win frame at half-time	−0.002	−0.029
	(0.064)	(0.073)
Loss frame x prior bad result		
Loss frame x Defeat in past match	−0.253**	0.071
	(0.076)	(0.112)
Loss frame x prior good result		
Loss frame x Win in past match	−0.086	0.045
	(0.064)	(0.084)
Win frame x prior bad result		
Win frame x Defeat in past match	−0.013	−0.054
	(0.080)	(0.090)
Win frame x prior good result		
Win frame x Win in past match	0.131	−0.065
	(0.092)	(0.107)
Control Variables		
Table standing after past match	−0.015**	0.013*
	(0.005)	(0.006)
Table standing of the opponent after past match	0.001	0.000
	(0.002)	(0.002)
Home playing	0.005	−0.096***
	(0.029)	(0.022)
Chances in past match	0.010+	−0.018**
	(0.006)	(0.007)
Goal difference at half-time	0.078***	−0.107***
	(0.014)	(0.014)
Fixed Effects		
Fixed Effects: Coach	x	x
Fixed Effects: Team x Season	x	x
Fixed Effects: Matchday x Season	x	x
Characteristics		
Num.Obs.	2970	2970
R2	0.172	0.203
Std.Errors	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own representation

The last robustness check is concerning the risk-taking behavior and the game outcomes. Instead of using the points achieved or the goal difference in the game as in regressions (11) and

(12), this robustness check uses a dummy variable for a win in (11') and win or draw (12'). The results are given in Table 5.9.

Table 6.8: *Fixed effects regression concerning game outcomes*

	(11')	(12')	(13')	(14')
	Points	Goal difference	Win	Win or Draw
Initial formation changes				
Any initial formation change	−0.075	−0.002	−0.024	−0.027
	(0.057)	(0.074)	(0.021)	(0.024)
Number of defensive changes	0.189***	0.060	0.062**	0.065**
	(0.052)	(0.056)	(0.021)	(0.022)
Number of offensive changes	−0.006	−0.159+	0.009	−0.025
	(0.070)	(0.081)	(0.025)	(0.027)
Substitutions				
Number of defensive substitutions	0.303***	0.182***	0.127***	0.049***
	(0.036)	(0.043)	(0.015)	(0.011)
Number of neutral substitution	0.142***	0.110*	0.078***	−0.014
	(0.040)	(0.050)	(0.016)	(0.017)
Number of offensive substitution	−0.129***	−0.097*	−0.010	−0.109***
	(0.032)	(0.045)	(0.013)	(0.013)
Control Variables				
Table standing after past match	−0.101***	−0.089***	−0.035***	−0.031***
	(0.009)	(0.012)	(0.004)	(0.003)
Table standing of the opponent after past match	0.045***	0.058***	0.014***	0.017***
	(0.003)	(0.004)	(0.001)	(0.001)
Home playing	0.188***	0.207***	0.057***	0.074***
	(0.036)	(0.040)	(0.014)	(0.013)
Chances in current match	0.095***	0.177***	0.036***	0.023***
	(0.008)	(0.008)	(0.003)	(0.003)
Goal difference at half-time	0.411***	0.809***	0.137***	0.137***
	(0.017)	(0.027)	(0.006)	(0.008)
Fixed Effects				
Fixed Effects: Coach	x	x	x	x
Fixed Effects: Team x Season	x	x	x	x
Fixed Effects: Matchday x Season	x	x	x	x
Characteristics				
Num.Obs.	2970	2970	2970	2970
R2	0.545	0.632	0.484	0.467
Std.Errors	by: Coach	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: Own representation

Specification (11') states that one more initial defensive substitution is related to a highly significant increase in the points achieved in the game (ß = 0.189, SE = 0.052, p < 0.001). Moreover, more defensive substitutions correspond to more points (ß = 0.303, SE = 0.036,

$p < 0.001$). Additionally, neutral substitutions also go hand in hand with more points (ß = 0.142, SE = 0.040, $p < 0.001$), but contrary, offensive substitutions go along with fewer points (ß = −0.129, SE = 0.032, $p < 0.001$). Interpreting the control variables yields that the higher the table standing after the past match, the lower the number of points (ß = −0.101, SE = 0.009, $p < 0.001$). Positive relationships to the number of points are a higher table standing of the opponent after the past match (ß = 0.045, SE = 0.003, $p < 0.001$) if the match is played at home (ß = 0.188, SE = 0.036, $p < 0.001$), more chances in the current match (ß = 0.095, SE = 0.008, $p < 0.001$) and a higher goal difference at half-time (ß = 0.411, SE = 0.017, $p < 0.001$).

Regarding the goal difference and specification (12'), similar results are found. One offensive initial formation change goes along with a lower goal difference (ß = −0.159, SE = 0.081, $p < 0.10$). Additionally, one more defensive substitution corresponds to a higher goal difference (ß = 0.182, SE = 0.043, $p < 0.001$), as well as neutral substitutions (ß = 0.110, SE = 0.050, $p < 0.05$). Offensive substitutions, however, are related to a worse goal difference (ß = −0.097, SE = 0.045, $p < 0.05$). The control variables do not change their significance or propensity.

In regression (13'), one can see that one more initial defensive change corresponds to a better outcome, to be more precise, one more initial defensive change goes along with a 6.2 percentage point increase in the fraction of wins (ß = 0.062, SE = 0.021, $p < 0.01$). If coaches substitute one more defensive player within the game, however, corresponds to a nearly 13-percentage point increase in the fraction of wins (ß = 0.127, SE = 0.015, $p < 0.001$), thus, the estimate is twice as high, meaning that the effect is stronger for in-game defensive changes. Also, more neutral substitutions correspond to a higher fraction of wins (ß = 0.078, SE = 0.016, $p < 0.001$). The effects of the control variables again do not change in regression (13') or (14').

The significance for the neutral substitutions, however, changes in regression (14'). Again, it is that the number of defensive initial changes is related to a higher fraction of wins and draws (ß = 0.065, SE = 0.022, $p < 0.01$), so is the number of defensive substitutions (ß = 0.049, SE = 0.011, $p < 0.001$). Furthermore, it can be seen that more offensive substitutions go hand in hand with a lower fraction of wins and draws (ß = −0.109, SE = 0.013, $p < 0.001$).

Thus, specifications (11) to (14) and (11') to (14') show nearly the same effects of the regressors on points and the win dummy. The results are robust in the sense that the effects are similar in both specifications. The ß-coefficient in the regression (11') to (13') is higher for defensive substitutions compared to initial defensive changes, leading to the conclusion that the main influence comes from in-game substitutions. However, initial formation changes also have an impact on the game outcome. Thus, initial and within-game defensive changes are related to a better game outcome in terms of points, whilst more offensive changes are related to worse game outcomes.

6.3 Summary

One can conclude the following results regarding strategic decisions. When only considering the results of the main effects regressions in chapters 5.2.1 and 5.2.2, indeed, those main effects on their own are significant predictors for strategic changes before and within the game.

Concerning hypothesis 1, defeats correspond to more initial strategical adjustment, in general to a more offensive behavior in terms of initial changes compared to the matches without a prior defeat. Looking at positive prior outcomes, wins are not substantially and significantly related to initial strategical and formational changes.

Regarding hypothesis 2 and focusing solely on the results presented in chapter 5.2.2, encountering an unexpectedly negative halftime outcome is associated with an increase in offensive substitutional changes, whereas experiencing an unexpectedly positive halftime outcome is linked to an increase in defensive substitutional changes.

This, however, does not hold, when including the interaction terms in Hypothesis 3. Additionally, one obtains the relation between prior results and the substitutions within the game. A defeat in the last game is associated with stronger defensive substitutions. Wins go hand in hand with stronger offensive substitutions. The results concerning the interactions suggest that there exist some relationships between previous results, the result is relative to the expectation, and the substitutions within the game. If a loss occurred in the past match and the half-time result is unexpectedly bad, coaches tend to substitute more offensively.

Concerning Hypothesis 4 one can conclude that risk-taking behavior concerning defensive initial and in-game formation changes is related to better game outcomes for example in terms of the points achieved. The coefficient for the number of defensive in-game substitutions is higher compared to the number of defensive initial changes, meaning that the relation to more points is higher for in-game substitutions. Overall, more offensive, thus riskier, substitutions go hand in hand with fewer points and worse game outcomes.

7 Discussion

This chapter summarizes the main findings of the results section and categorizes them concerning the literature. Subsequently, the work is critically reviewed, and the limitations of the work are presented. This chapter ends with recommendations for further research as well as possible implications.

7.1 Conclusions

Hypothesis 1 regarding the reference-dependency to prior outcomes for subsequent decisions can be underpinned. Coaches change their strategy based on the previous results they experienced. The main drivers are defeats as prior bad outcomes. Prior good results do not significantly influence strategic behavior.

Hypothesis 2 can, in this work, only be supported when focusing on the first-order main effects concerning a loss frame or win frame and leaving prior outcomes and the interactions with prior outcomes beside. Including those, yields a change in the significant effects. Therefore, interestingly, Hypothesis 2 should be rejected for the more general Hypothesis 3. Hypothesis 3 can be substantiated because indeed the interactions between the mechanisms of previous outcomes and if the teams are above or below expectations are the main drivers for in-game risk-taking behavior. Being exposed to a loss in the last game and behind the expectations in the current game yields a significantly more offensive, thus riskier, strategy adaption.

Hypothesis 4 can also be supported. A more defensive, thus, more risk-averse behavior is related to better game outcomes. This holds for more risk-averse changes before and within the game. A more offensive, hence, riskier, behavior is related to worse game outcomes measured by for example the points achieved, meaning that risk-taking does not pay out. Here, it is not appropriate to use a causal interpretation. For example, it is not allowed to follow that more defenders increase the probability of scoring a goal. Different possible explanations are discussed in the following subchapter.

7.2 Reference to Theory and Classification of the Results

Prospect theory suggests that individuals act reference-dependent when making decisions under uncertainty. Especially, losses are given a higher weight compared to wins (Kahneman & Tversky, 1979). Following that, coaches are expected to be more sensitive to previous losses compared to previous wins. The findings support this expectation. In accordance with the results of Bucciol et al. (2019), the results of the present work show that after a defeat, more offensive adaption takes place. Contrary, after a win, less defensive and less offensive behavior happens. There is strong evidence that, overall, risk-taking is increased after a previous defeat. This aligns with the reference-dependent nature of risk-taking proposed by prospect theory (Kahneman & Tversky, 1979), underpinning that previous outcomes can act as reference points. Imas (2016) suggests that individuals tend to decrease their risk-taking behavior after experiencing a realized loss, while they increase risk-taking following a paper loss. According to the author, realization occurs with the transfer of points and thus, directly after the match finishes. Therefore, one would expect that risk-taking decreases after a previous loss. However, this is not the case. Overall, coaches tend to take higher risks after previous bad outcomes. One suitable explanatory approach in terms of Imas (2016) is that the mental account is not directly closed after the previous game but with the start of the new match. In the laboratory experiments of the author, there is only a short period between each round of games, thus, there is no substantial difference between the end of the previous and the start of the new round. This is different in the field experiment of football. Usually, there is one week between two consecutive league matches, and therefore, coaches have time to recapitulate and analyze the previous game and must prepare for the upcoming match. Furthermore, situational mechanisms are present, thus, the social pressure and the pressure to win are exercised by fans and the media. This includes the time until the formation of the starting lineup of the future game. All of this is associated with a high mental load, meaning that the mental account is not directly closed after the past match, but after the starting formation is set up and with the kickoff of the new game. This can be supported by the fact that previous results function as a reference point up to the beginning of the new game, meaning that the negative last result is a reference that is more salient and can be recalled up until the new initial starting eleven is set up. Consequently, the bracket of prior outcomes is not closed, the loss is not internalized, and the reference point is not updated. Coaches would be in the same mental account as in the match before when setting up the initial formation, leading to more offensive strategies. The start of the game then constitutes a completely new situation where the reference point is updated (Imas, 2016). As a result, realization in the field of football could not be seen as the transfer of points at the end of the match. Instead, it happens at the beginning of the next round of play as this constitutes a natural psychological break point between two matches, and the focus changes to the new game situation. This interpretation can be supported by further results. Initial formation changes are positively linked to the opponents' standing before the match, whilst in-game substitutions depend, also positively, on the own standings. This also consolidates the discussion about the internalization of the loss. It occurs because the earlier loss has not yet been psychologically processed when the starting lineup is formed and is therefore not yet internalized. For this reason, the coaches do not set up the starting formation based on their ability, expressed in the current table situation, but based on the table situation of the opponent. It changes as soon as the game starts, because then the realization of the previous loss occurs, which means that from this point on the own skill becomes more important.

After a win, there is no substantial adaption of the initial strategy supporting the well-known phrase "Do not change a winning team" (Bucciol et al., 2019, p. 6). This can be explained because wins, on the other hand, are directly internalized after the previous match (Merkle et al., 2021) leading to no change in terms of strategy. One can argue that, as elaborated, losses need more time to be processed, whilst wins do not.

Regarding Hypothesis 2, prospect theory would suggest an increase in risk-taking behavior, if the half-time result is below expectations (Kahneman & Tversky, 1979). This is because individuals perceive being behind expectations as a loss, and due to loss aversion, they tend to behave riskier trying to turn the result (Bartling et al., 2015; Kahneman & Tversky, 1979). The results of this work show this and are in line with Kahneman and Tversky (1979) and Bartling et al. (2015). Furthermore, they are consistent with Imas (2016) if one considers being in a loss frame as an unrealized paper loss.

When wins are considered, the results seem to contradict the realization effect for wins as in Merkle et al. (2021), who state that risk-taking is increased when facing paper wins. However, the results of this work show the contrary. This difference can be explained due to the unexpectedness. In terms of the realization effect, it could be that the mental account at half-time could be closed already when above expectations. The coaches could feel confident to keep this result and already check off the game and internalize the win, leading to a decrease in risk-taking behavior (Merkle et al., 2021). However, this does not seem reasonable. According to prospect theory, a half-time result above expectations is expected to be related to a decrease in risk-taking behavior. This can be substantiated, because outcomes above expectations can be seen as unexpected gains, leading individuals to exhibit risk-averse behavior to secure the win (Kahneman & Tversky, 1979). The result of this work underpins that assertion. It is in line with the results of Bartling et al. (2015).

Considering Hypothesis 3 about the combined effects of prior outcomes and expectations, the results are not directly in line with the work of Bucciol et al. (2019) and Bartling et al. (2015). First, taking the main effects into account, previous losses decrease risk-taking within the game. This can again be substantiated in terms of prospect theory and loss aversion (Kahneman & Tversky, 1979). To minimize the potential for additional losses, coaches may adopt more defensive substitutions, exhibiting lower levels of risk-taking within the game. In terms of the realization effect, this can also be explained, because after a realized loss the mental account will be closed, and individuals avoid risk (Imas, 2016). Following wins, risk-taking is not significantly influenced, strengthening the results of Merkle et al. (2021).

Regarding the interaction terms, Imas (2016) and Merkle et al. (2021) state that only observing a paper win or paper loss should influence the risk-taking behavior, because the mental account is closed after the realization. Thus, no significant interactions between them should be detected. This is, however, not the case here. The main driver for the strength of strategic decisions in the game is not the difference between the expected and the actual result, but rather the interactions between the expectations and prior results. If one assumes a constant condition where the result is not as expected, it can be observed that risk-taking is higher if a previous defeat occurred. This is a clear difference from the main effect stating that risk-taking within the game is reduced after prior defeats.

The mechanism can be discussed as follows with respect to prospect theory (Kahneman & Tversky, 1979). The increased risk behavior is caused by loss aversion. This is more pronounced because not only is the outcome of the current game unexpectedly bad, therefore a paper loss in terms of Imas (2016), but the last game has already been lost. Thoughts continue to hang on the last defeat (Kahneman & Tversky, 1979), making them more salient in the situation when facing a further potential defeat. Furthermore, coaches may feel compelled to take greater risks to meet the expectations of fans or media or alleviate perceived pressure, especially following defeats. All of this manifests itself in increased risk-taking behavior, supporting the assertion that previous results and expectations about the game function as reference points that can interact with each other and jointly influence risk-taking behavior.

In conclusion, I find important results by integrating those different approaches which cannot be directly explained in terms of Bartling et al. (2015), Bucciol et al. (2019), Imas (2016), and Merkle et al. (2021). The results overall show that prospect theory can also be applied in the context of managerial risk-taking within the field of football and that the realization effect can play out differently in different contexts and conditions. While the realization effect is usually associated with a decrease in risk-taking behavior following a loss realization, it can lead to the opposite reaction in certain situations. It highlights the dynamic nature of the realization effect and how it can evolve over the course of the game. These findings emphasize the complexity and multifaceted nature of the prospect theory and the realization effect in the context of coaches' risk-taking behavior.

Concerning Hypothesis 4, the productivity analysis of Bucciol et al. (2019) states that a more defensive, thus risk-averse, strategy adaption before the match leads to worse outcomes. This is a clear difference compared to the findings presented here, where defensive initial changes and defensive substitutions indeed go hand in hand with better match outcomes. The results at hand are in line with the results of Bartling et al. (2015) stating that defensive substitutions are productive and with Grund and Gürtler (2005) stating that risk-taking does not pay off. This could be due to different mechanisms. On the one hand, more defensive substitutions to secure the lead and win could be successful. On the other hand, more offensive substitutions to turn the result could be unsuccessful, therefore, no catch-up effect can be found. Additionally, more offensive behavior could also be harmful when the team becomes too weak defensively, which can lead to counter goals. This could also be stated in terms of myopic loss aversion (Eriksen & Kvaløy, 2014; Thaler et al., 1997), whereby coaches may make substitutions to try to turn the game around and avoid an immediate loss. This may be effective in the short term, but harmful overall.

To conclude, this thesis can link the work regarding previous outcomes and expectations to the risk-taking behavior of managers using field data from professional football. To my knowledge, it is the first being able to disentangle the discussed mechanisms and link them to broader literature. It can be underpinned that previous bad outcomes and expectations could function as reference points that interact with each other. This work is capable of connecting and integrating the results into the literature on prospect theory, the realization effect, and mental accounting. It finds a consistent way to determine the application of prospect theory and when the realization effect occurs in football.

7.3 Limitations

The data include high heterogeneity, that is, many unknown variables, and situations. The analysis does not account for situations that happened between the beginning of the match and halftime. Thus, it could be the case that the realization effect manifests itself in a different way as discussed above. Teams may perform better after a loss, which results in a better halftime score, which in turn then leads to safer behavior through substitution. However, this does not correspond to the results of other research, according to which teams do not perform better after defeats (Bucciol et al., 2019).

Additionally, rivalry (To et al., 2018) or other factors such as the underdog effect (Nurmohamed, 2020) could shape and influence risk-taking in professional football.

It must be critically appreciated that the information on previous results is already implicit in the expectations (Dixon & Coles, 1997). The author is not aware of any formula for determining betting odds, which is why it was academically assumed in this paper that the betting odds are implicitly calculated on the information concerning the current opponent rather than on the current form and prior outcomes. However, this could also be wrong and the current form and therefore the previous results could already have a strong weight in the odds calculation. Therefore, the results may also state that there is no shift or interaction in the reference point but be discussed and ranked in such a way that the earlier results are overweighted in the expectation of the new match. This would result in less of an interaction between the earlier outcomes and the expectations and much more of an overweighting of earlier outcomes within the expectation. Consequently, the approach used might not be as well suited to represent this effect. To my knowledge, however, there is no recognized way to disentangle these effects in any other way. This would be feasible, in particular, with a prediction model to determine the weighting of the factors of the betting odds and to perform the analyses based on this.

This analysis also does not allow any conclusions to be drawn about player characteristics, performance, and quality. Most players can play in different positions. Hence, it is not captured whether a player plays on his main or any alternative position. Furthermore, no distinction is made between defensive and offensive midfielders, or between center and fullbacks. It can also not be observed whether players change their role of play within the game, thus, if, for instance, defenders or even goalkeepers function as strikers at the end of a game (Grund & Gürtler, 2005; Grund et al., 2010), which heavily influences the strategic risk. Similarly, when a player performs poorly, which contradicts the initial expectations. Some clubs have superstars, in this data set above all Bayern Munich and Borussia Dortmund, whereby a loss of these superstars weighs more heavily and does not allow any conclusions to be drawn about the strategic decision of the coach. Furthermore, players cannot be nominated for matches due to injury or health issues, suspensions and bans, or sanctions due to misbehavior. This adaption of the formation due to these players missing does also not reflect a strategic decision. This analysis accounts only for the consecutive league games and does not account for incidences that happened between the games and they do also not account for games that were played between the league games, for example, national cup games, European cup games, or games with the national team. Player performance matters also in those games. Therefore, one could include those games or the player performances overall games as a control variable.

One must also state limitations regarding the econometric approach. One assumption of the fixed effects regression states that there must not be any collinearity between the independent variables. This could be violated, leading to biased estimates and p-values. Thus, it can be the case that the main effects of a loss frame or win frame are significant, but significance cannot be detected.

Instead of the team-season fixed effect, one could also use a fixed effect accounting for each team in each season half, not in the whole season. This would account for the fact that the team roster changes potentially also in the winter transfer period. Against that, one must argue that the winter transfer period does not directly lie between the first and the second half of the season. Therefore, the fixed effects regression would lead to a potential bias. Distinguishing between the full season is therefore more straightforward. It can also be argued that different control variables should be used, for instance, additional game variables such as possession to control for the superiority and security of a team. It is reasonable to assume, however, that this is highly correlated with the number of chances within the game.

Regarding the econometric approach in Hypothesis 4, one could think about using a more differentiated approach by, for example, explicitly using the offensive substitutions in the loss frame, that is, in the situation when negatively behind expectations, to measure the productivity of those substitutions (Bartling et al., 2015). Since this paper aimed for a more general analysis regarding the productivity of risk-taking in terms of initial and within changes, this method used is appropriate in this setting.

Furthermore, it can be discussed that a Bonferroni-corrected model should be used (Bucciol et al., 2019).

Overall, as mentioned above, the data is influenced by many factors. This increases the risk of an omitted variable bias and thus also that effects appear to be significant but are not. In addition, it is possible that further effects cannot be detected.

7.4 Recommendations and Implications

Based on this work, there exists many more relevant research ideas exist. For this Master's thesis, contrary to Bartling et al. (2015), I used discrete open-source data. It is highly recommended to do the same analysis using proprietary minute-by-minute data as Bartling et al. (2015) use as well as continuous betting odds. This would allow a more accurate conclusion on how the reference points and the effect of realization continuously change over the course of the game.

Furthermore, the analysis can be differentiated as in Bucciol et al. (2019) or Bartling et al. (2015), thus, analyzing underdogs and favorites. Additionally, one can conduct this analysis not on a team level, but on a trainer level, which means analyzing the risk-taking behavior between more risk-averse and more risk-prune managers. This would allow conclusions on high-risk and low-risk individuals, such as Nakavachara et al. (2023) assess in the field of cryptocurrencies.

Bartling et al. (2015) and this paper show that there is a general difference between the perception of expected and unexpected paper losses. This work only examines the interaction between realized losses and unexpected paper losses. One conjecture would be that the interaction effect is stronger for unexpected paper losses than for expected ones. Accordingly, this could be investigated.

The work also has implications for team composition and collaboration. For example, Buckenmaier and Dimant (2021) find that teams with social experiences show more cooperation after wins than after losses. Thus, the present work can also be extended to this end.

The last substitution in football can be seen as an important one in terms of strategic adjustment because after this substitution no more change is possible. Risk-averse coaches could save this substitution to influence the game after all. In that setting, one could think of assessing the number or only the last substitution made.

Another idea is to integrate the utilized setting into a time series approach to analyze how the risk behavior varies over the course of the game and season. This approach not only allows conclusions about the realization effect but also about learning behavior. In addition, it can be analyzed whether teams play differently in the second round based on the experience they gained against the same team in the first round.

According to Jani (2021), social comparison theory states that individuals often compare their performance with a relevant peer group. In doing so, the results of this peer group can also become a reference point. To assess to what extent this is true, it is possible to conduct the present analysis in terms of peer performance rather than previous outcomes or the probability of winning. Additionally, one could assess whether coaches show a higher risk-taking behavior if their opponent or peer group does.

Due to the Covid-19 pandemic, there are now more substitution possibilities. Instead of three substitutions, teams in the *Bundesliga* are now allowed up to five substitutions in three distinct substitution periods. A follow-up question is whether the results presented also hold for five substitution possibilities. Specifically, it is interesting to analyze whether all substitution possibilities are exhausted, and if the strategy is more adjusted by having more flexibility and possibilities to adjust the strategy and substitute, in other words, whether one acts riskier by having the possibility to be riskier. Alternatively, it could be the case that less strategic changing is done because one also has more opportunities to react to game influences and the outcome.

A question derived from a microeconometric direction could be to derive a utility or value function like Kahneman and Tversky (1979) that is accurate in this context. This could be used to assess whether one can actually identify the reference points and whether this function then is kinked and S-shaped in the context, put differently, whether there is the same risk aversion as in experimental studies. Of course, one could do this for any coach or team to evaluate the extent of risk-taking. Based on that, it is possible to calculate Arrow-Pratt measures to quantify the level of risk aversion on a general and individual level.

Going further, one could focus on managerial turnovers and ask the question of whether coaches substitute more if the risk of being sacked is high. A different point of interest could be the managers' or coaches' decisions to form the squad for each season, that is, whether the team roster is balanced or not since this could also reflect a risk-taking decision.

From a gender economic point of view, the differences between male and female managers could be considered. So far, there is no broad research in this area. For example, one object of analysis is the German women's *Bundesliga*. There are both male and female head coaches, currently, there are four women and eight men. It is possible to examine whether women also act less riskily and are more successful than men in this context.

As elaborated earlier, the literature suggests that there are differences in risk-taking behavior between younger and older managers. That could be another interesting research question to analyze.

Likewise, it can be interesting whether there are cultural differences. This work suggests that coaches' risk-taking behavior is similar between the Italian Serie A and the German *Bundesliga*. It is conceivable to examine this also regarding more distant cultures, for example Asian, African, or South American, and to analyze whether managers from these cultures show a similar level of risk-taking behavior or whether they act systematically differently.

Compared to football, handball and basketball are sports that are more dynamic in the sense that goals or points occur much more often. Additionally, the number of substitutions in both sports is unlimited. In basketball, for instance, substitutions are made frequently to reduce the fatigue level of players of the starting five, to account for the current quota of points and the foul situation of each player. Similar to football, substitutions can also be used to adapt the current strategy, for example, by substituting those players into the game who are the best three-point-takers. This allows the setting of this thesis to be analyzed in a more dynamic setting. To be more precise, this could be implemented by assessing reference-dependency after each quarter, the effects of starting five, and team composition and effects if a team is behind expectations.

Related to the field of sports economics, implications may arise from this work, particularly concerning cognitive processing and pre-game and in-game strategy design. However, this thesis does not only have implications for sports economics. If external validity exists, which is left open for discussion here, the work could also be applied to other areas in economics, primarily finance and risk management. Possible views and applications have already been discussed (Barberis, 2013). Furthermore, the work also provides evidence for the principal-agency theory. The coach in the game can be seen as an agent for the club. Understanding the actions of the agent is useful to grasp potential problems in this relationship. Overall, there is still much uncertainty and heterogeneity to explore in this area.

8 Conclusion and Outlook

In conclusion, this Master's thesis has examined the effects of previous and unexpected results on managerial risk-taking behavior in the context of football, using data from the German *Bundesliga*. The study has employed a natural experiment approach, utilizing initial formation changes and substitutions as indicators of risk-taking by football coaches.

The research is grounded on prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) and the realization effect (Imas, 2016), which suggest that individuals exhibit loss aversion and engage in riskier behavior before experiencing a loss. The findings reveal that coaches tend to adopt riskier strategies when determining the initial formation after previous losses but become less risky as the game progresses. This can be stated in terms of the realization effect, that the internalization of previous losses does not take place after the match itself, but as the new match starts. Further explanations have been discussed.

Moreover, this study has extended the work of Bucciol et al. (2019) and incorporated the reference-dependent substitution approach proposed by Bartling et al. (2015). By integrating these perspectives, this research offers a more comprehensive understanding of managerial risk-taking behavior in football.

The implications of these findings extend beyond the realm of sports and have relevance for professional and managerial contexts. The insights gained from this study shed light on the dynamics of risk-taking behavior in high-pressure and competitive environments. Understanding how prior results influence risk-taking decisions can assist managers and decision-makers in various industries to better navigate uncertain situations and optimize their strategic choices.

Furthermore, there are several avenues for further research in this field. Firstly, expanding the analysis to include data from other football leagues or different sports could enhance the generalizability of the findings. Additionally, investigating the long-term consequences of risk-taking behavior on team performance and managerial success would provide valuable insights into the effectiveness of different strategies. Moreover, an analysis of the influence of other contextual factors, such as the importance of the match or the characteristics of the opposing team, could contribute to a more nuanced understanding of managerial decision-making in football. Lastly, individual-level factors, such as the personality traits or experience level of coaches, would offer additional insights into the drivers of risk-taking behavior.

By addressing these research gaps, future studies can further enrich the understanding of managerial risk-taking behavior in the sports context and its broader implications. The insights gained from such research can provide valuable guidance for practitioners and contribute to the development of effective strategies in high-stakes environments beyond the realm of sports.

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Appendix

Appendix A – Teams

Figure A.1: *List of all teams within the data set*

	Overall
	(N=3060)
Teams	
Augsburg	170 (5.6%)
Bayern Munich	170 (5.6%)
Darmstadt	68 (2.2%)
Dortmund	170 (5.6%)
Ein Frankfurt	170 (5.6%)
FC Koln	136 (4.4%)
Fortuna Dusseldorf	34 (1.1%)
Freiburg	136 (4.4%)
Hamburg	136 (4.4%)
Hannover	136 (4.4%)
Hertha	170 (5.6%)
Hoffenheim	170 (5.6%)
Ingolstadt	68 (2.2%)
Leverkusen	170 (5.6%)
M'gladbach	170 (5.6%)
Mainz	170 (5.6%)
Nurnberg	34 (1.1%)
Paderborn	34 (1.1%)
RB Leipzig	102 (3.3%)
Schalke 04	170 (5.6%)
Stuttgart	136 (4.4%)
Werder Bremen	170 (5.6%)
Wolfsburg	170 (5.6%)

Source: Own representation

Appendix B – Coaches

Figure B.1: *List of all coaches within the data set*

	Overall (N=3060)
Coaches	
Ancelotti	40 (1.3%)
Baum	82 (2.7%)
Berndroth	3 (0.1%)
Bosz	32 (1.0%)
Breitenreiter	121 (4.0%)
Dardai	151 (4.9%)
di Matteo	27 (0.9%)
Doll	15 (0.5%)
Dutt	9 (0.3%)
Favre	72 (2.4%)
Frings	18 (0.6%)
Frontzeck	22 (0.7%)
Funkel	34 (1.1%)
Gisdol	92 (3.0%)
Guardiola	68 (2.2%)
Hasenhüttl	102 (3.3%)
Hecking	161 (5.3%)
Hermann	1 (0.0%)
Herrlich	51 (1.7%)
Heynckes	26 (0.8%)
Hjulmand	21 (0.7%)
Hollerbach	7 (0.2%)
Hütter	34 (1.1%)
Ismael	15 (0.5%)
Jonker	16 (0.5%)
Kauczinski	10 (0.3%)
Keller	7 (0.2%)
Klopp	34 (1.1%)
Knäbel	2 (0.1%)
Kohfeldt	58 (1.9%)
Köllner	21 (0.7%)
Korkut	61 (2.0%)
Kovac	111 (3.6%)
Kramny	21 (0.7%)

	Overall (N=3060)
Krösche	4 (0.1%)
Labbadia	90 (2.9%)
Luhukay	19 (0.6%)
Meier	13 (0.4%)
Nagelsmann	116 (3.8%)
Nouri	41 (1.3%)
Rangnick	34 (1.1%)
Ruthenbeck	20 (0.7%)
Sagnol	1 (0.0%)
Schaaf	45 (1.5%)
Schmidt	193 (6.3%)
Schommers	13 (0.4%)
Schubert	45 (1.5%)
Schuster	48 (1.6%)
Schwarz	68 (2.2%)
Skripnik	62 (2.0%)
Slomka	3 (0.1%)
Stefes	1 (0.0%)
Stendel	6 (0.2%)
Stevens	41 (1.3%)
Stöger	135 (4.4%)
Streich	134 (4.4%)
Tedesco	59 (1.9%)
Titz	8 (0.3%)
Tuchel	68 (2.2%)
Veh	37 (1.2%)
Voßler	2 (0.1%)
Walpurgis	24 (0.8%)
Weinzierl	125 (4.1%)
Willig	4 (0.1%)
Wolf	20 (0.7%)
Zinnbauer	23 (0.8%)
Zorniger	13 (0.4%)

Source: Own representation

Appendix C – Further Figures and *t*-tests regarding Hypothesis 1

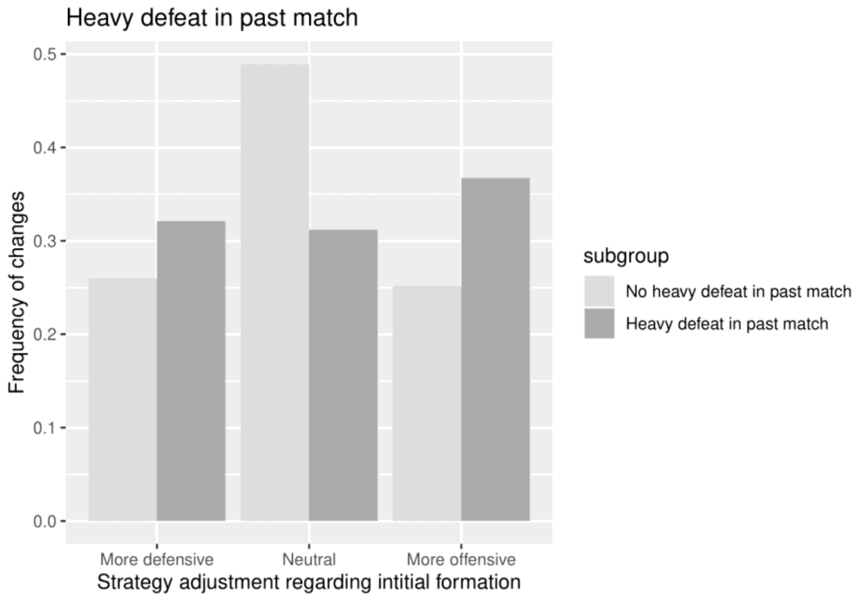
Appendix C presents further figures and the results of the *t*-tests concerning Hypothesis 1.

C.1 Further Figures

To control, if comparable results occur in the case of heavy or unexpected defeats in the prior game, the same analysis is conducted for those variables.

The graphical results concerning a previous heavy defeat are displayed in Figure C.1.

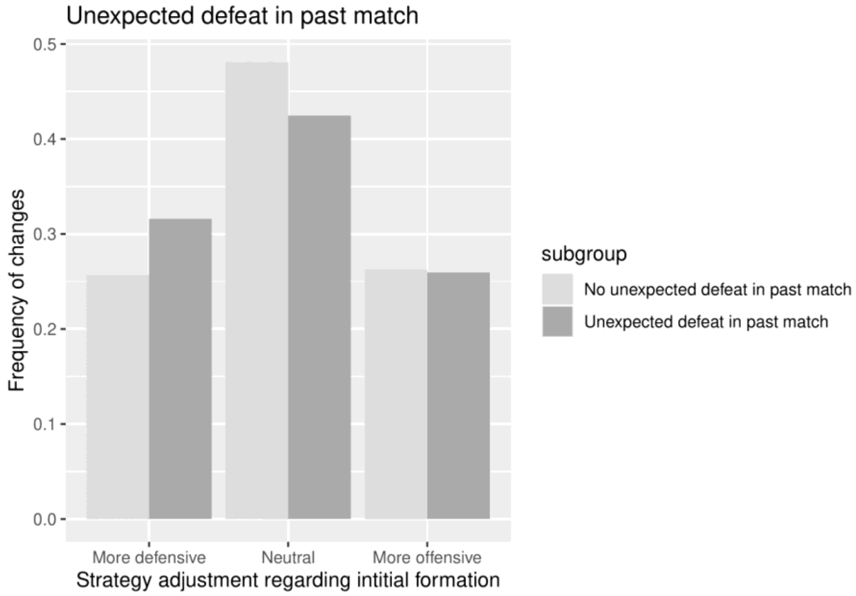
Figure C.1: *Fraction of strategic initial formation changes concerning a previous heavy defeat*



Source: Own representation

Again, one sees that more defensive and offensive changes occur after a team faced a heavy defeat. However, they go more to the extreme and are less neutral.

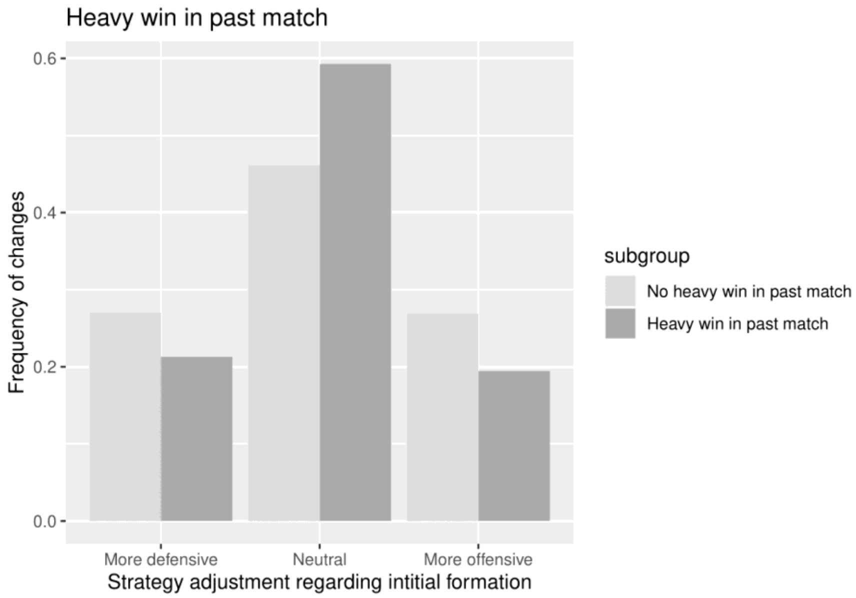
Figure C.2: *Fraction of strategic initial formation changes concerning a previous unexpected defeat*



Source: Own representation

After unexpected defeats, the fraction of offensive changes is nearly balanced in both subgroups, but more defensive substitutions are conducted after the unexpected defeat occurs, as Figure C.2 states.

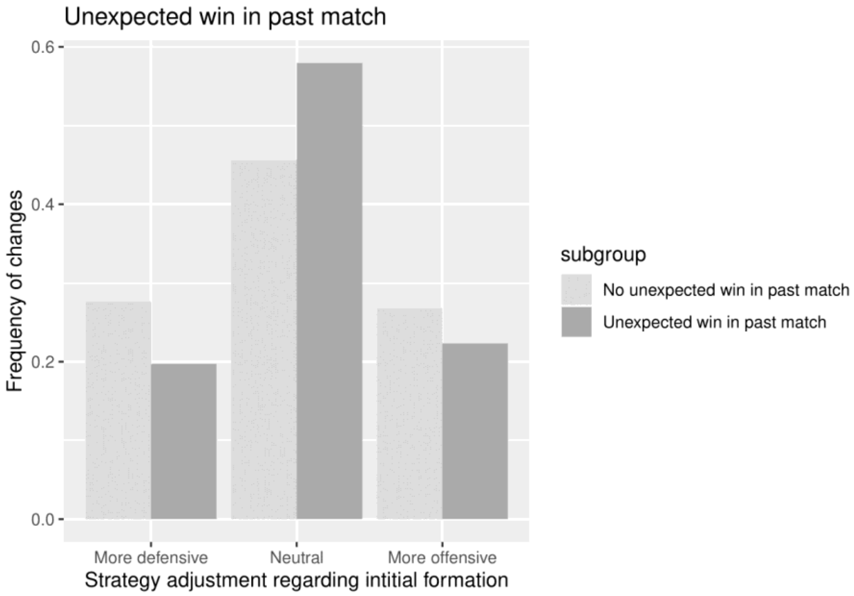
Figure C.3: *Fraction of strategic initial formation changes concerning a previous heavy win*



Source: Own representation

Figure C.3 shows that after heavy wins, much more neutral changes are made.

Figure C.4: *Fraction of strategic initial formation changes concerning a previous unexpected win*



Source: Own representation

In Figure C.4 regarding unexpected wins, a similar pattern can be detected.

C.2 t-tests

In the following, the *t*-test results are displayed.

Table C.1: *t-tests for the fraction of formation changes following a previous defeat*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past defeat, no change	Past defeat, no change	0.490 ± 0.500	0.340 ± 0.474	greater	8.961	2932	[0.122; Inf)	< 0.001	***
No past defeat, change	Past defeat, change	0.510 ± 0.500	0.660 ± 0.474	less	−8.961	2932	(−Inf; −0.122]	< 0.001	***

Source: Own representation

Table C.1 presents the result for, any and even neutral, changes concerning previous losses. Teams, that faced a defeat in the last game (*M* = 0.660; *SD* = 0.474) changed their formation indeed significantly more often than teams, which did not face a defeat in the last game (*M* = 0.510; *SD* = 0.500; *t*(2932) = −8.961; *p* < 0.001).

Table C.2: *t-tests for the fraction of strategic initial formation changes concerning a previous defeat*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past defeat, more defensive	Past defeat, more defensive	0.248 ± 0.432	0.293 ± 0.455	less	−2.903	2697.7	(−Inf; −0.019]	0.002	**
No past defeat, neutral	Past defeat, neutral	0.522 ± 0.500	0.391 ± 0.488	greater	7.691	2864.6	[0.103; Inf)	< 0.001	***
No past defeat, more offensive	Past defeat, more offensive	0.229 ± 0.421	0.316 ± 0.465	less	−5.500	2595.2	(−Inf; −0.061]	< 0.001	***

Source: Own representation

In Table C.2, the *t*-tests concerning strategic initial changes can be seen. Teams, that did not face a defeat in the last game (*M* = 0.248; *SD* = 0.432) changed their formation significantly less often to a more defensive formation than teams, which did face a defeat in the last game (*M* = 0.293; *SD* = 0.455; *t*(2697.7) = −2.903; *p* = 0.002). Neutral lineup changes were significantly more frequent when the team did not lose in the last game (*M* = 0.522; *SD* = 0.500), compared with teams that lost in the last game (*M* = 0.391; *SD* = 0.488; *t*(2864.6) = 7.691; *p* < 0.001). Additionally, fewer offensive strategic adjustments were made, if the team did not face a defeat in the last game (*M* = 0.229; *SD* = 0.421) compared to teams, which lost in the last game (*M* = 0.316; *SD* = 0.465; *t*(2595.2) = −5.500; *p* < 0.001).

To control, if comparable results occur in the case of heavy defeats in the prior game, the same analysis is conducted using prior heavy defeats.

Table C.3: *t-tests for the fraction of strategic initial formation changes concerning a previous heavy defeat*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past heavy defeat, more defensive	Past heavy defeat, more defensive	0.260 ± 0.438	0.321 ± 0.468	less	−2.267	382.01	(−Inf; −0.017]	0.012	*
No past heavy defeat, neutral	Past heavy defeat, neutral	0.489 ± 0.500	0.312 ± 0.464	greater	6.518	401.84	[0.133; Inf)	< 0.001	***
No past heavy defeat, more offensive	Past heavy defeat, more offensive	0.251 ± 0.434	0.367 ± 0.483	less	−4.162	377.01	(−Inf; −0.070]	< 0.001	***

Source: Own representation

This is indeed the case, as can be seen in Table C.3.

Table C.4: *t-tests for the fraction of strategic initial formation changes concerning a previous unexpected defeat*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past unexpected defeat, more defensive	Past unexpected defeat, more defensive	0.257 ± 0.437	0.316 ± 0.465	less	−2.643	645.77	(−Inf; −0.022]	0.004	**
No past unexpected defeat, neutral	Past unexpected defeat, neutral	0.481 ± 0.481	0.425 ± 0.495	greater	2.353	670.57	[0.017; Inf)	0.009	**
No past unexpected defeat, more offensive	Past unexpected defeat, more offensive	0.262 ± 0.440	0.260 ± 0.439	greater	0.122	667.8	[−0.032; Inf)	0.452	n.s.

Source: Own representation

Table C.4 presents the results concerning unexpected defeats. Compared to the case of heavy defeats and defeats in general, offensive changes are not significantly more frequent after the unexpected losses ($t(667.8) = 0.0122$; $p = 0.452$).

Further analysis is devoted to the effects of positive prior outcomes on the types of initial formation changes. This is shown in Table C.5.

Table C.5: *t-tests for the Fraction of initial formation changes concerning a previous win*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past win, no change	Past win, no change	0.385 ± 0.487	0.515 ± 0.500	less	−7.594	2754	(−Inf; −0.102]	< 0.001	***
No past win, change	Past win, change	0.615 ± 0.487	0.485 ± 0.500	greater	7.594	2754	[0.102; Inf)	< 0.001	***

Source: Own representation

Teams, that did not face a win in the last game ($M = 0.615$; $SD = 0.487$) changed their formation significantly more often than teams, which did face a win in the last game ($M = 0.485$; $SD = 0.500$; $t(2754) = 7.594$; $p < 0.001$). This, again, includes also strategically neutral formation changes.

Table C.6: *t-tests for the fraction of strategic initial formation changes concerning a previous win*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past win, more defensive	Past win, more defensive	0.282 ± 0.450	0.236 ± 0.425	greater	3.065	2941.7	[0.021; Inf)	0.001	**
No past win, neutral	Past win, neutral	0.429 ± 0.495	0.546 ± 0.498	less	−6.789	2799.8	(−Inf; −0.088]	< 0.001	***
No past win, more offensive	Past win, more offensive	0.288 ± 0.453	0.218 ± 0.413	greater	4.766	3019.3	[0.046; Inf)	< 0.001	***

Source: Own representation

The breakdown in terms of strategic changes is given in Table C.6. Teams, that did not face a win in the last game (*M* = 0.282; *SD* = 0.450) changed their formation significantly more often to a more defensive formation than teams, which did face a win in the last game (*M* = 0.236; *SD* = 0.425; *t*(2941.7) = 3.065; *p* = 0.001). Neutral lineup changes were significantly less frequent when the team did not win in the last game (*M* = 0.429; *SD* = 0.495), compared with teams that won in the last game (*M* = 0.546; *SD* = 0.498; *t*(2799.8) = −6.789; *p* < 0.001). Additionally, more offensive strategic adjustments are made, if the team did not face a win in the last game (*M* = 0.288; *SD* = 0.453) compared to teams, which lost in the last game (*M* = 0.218; *SD* = 0.413; *t*(3019.3) = 4.766; *p* < 0.001).

To validate whether this distribution changes when the victory in the last game was heavy, the respective *t*-tests are given in Table C.7.

Table C.7: *t-tests for the fraction of strategic initial formation changes concerning a previous heavy win*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past heavy win, more defensive	Past heavy win, more defensive	0.270 ± 0.444	0.213 ± 0.410	greater	2.384	402.72	[0.018.; Inf)	0.009	**
No past heavy win, neutral	Past heavy win, neutral	0.461 ± 0.499	0.593 ± 0.492	less	−4.580	392.3	(−Inf; −0.084]	< 0.001	***
No past heavy win, more offensive	Past heavy win, more offensive	0.269 ± 0.443	0.194 ± 0.396	greater	3.173	408.2	[0.036.; Inf)	< 0.001	***

Source: Own representation

This is not the case; the results are remarkably similar. The same is valid for unexpected wins, whose results in Table C.8 show the same finding.

Table C.8: *t-tests for the fraction of strategic initial formation changes concerning a previous unexpected win*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past unexpected win, more defensive	Past unexpected win, more defensive	0.276 ± 0.447	0.197 ± 0.398	greater	4.029	714.52	[0.047; Inf)	< 0.001	***
No past unexpected win neutral	Past unexpected win, neutral	0.456 ± 0.498	0.579 ± 0.494	less	−5.169	669.87	(−Inf; −0.084]	< 0.001	***
No past unexpected win, more offensive	Past unexpected win, more offensive	0.268 ± 0.443	0.223 ± 0.417	greater	2.196	690.37	[0.011; Inf)	0.014	*

Source: Own representation

Appendix D – *t*-tests regarding Hypothesis 2

Here, the *t*-tests concerning Hypothesis 2 are presented, thus, if being in a loss frame or win frame is related to more strategic substitutions. Table D.1 contains the results for being in a loss frame, using the reference category as playing as expected.

Table D.1: *t-tests for the fraction of strategic substitutions concerning being in a loss frame*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
Loss frame, more defensive	As expected, more defensive	0.238 ± 0.426	0.327 ± 0.469	less	−4.317	1249.4	(−Inf; −0.055]	< 0.001	***
Loss frame, neutral	As expected, neutral	0.268 ± 0.443	0.308 ± 0.462	less	−1.887	1184.8	(−Inf; −0.005]	0.030	*
Loss frame, more offensive	As expected, more offensive	0.494 ± 0.500	0.365 ± 0.481	greater	5.535	1102.9	[0.091; Inf)	< 0.001	***

Source: Own representation

Less defensive substitutions are made if a team is in a loss frame ($M = 0.238$; $SD = 0.426$) compared to teams, which are playing as expected ($M = 0.327$; $SD = 0.469$; $t(1249.4) = -4.317$; $p < 0.001$). Additionally, the coaches in a loss frame substitute more offensively ($M = 0.494$; $SD = 0.500$) than coaches facing an expected result ($M = 0.365$; $SD = 0.481$; $t(1102.9) = 5.535$; $p < 0.001$).

The opposite is true if considering being in a win frame and Table D.2.

Table D.2: *t-tests for the fraction of strategic substitutions concerning being in a win frame*

x	**y**	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	***t*-statistic**	**df**	**95 %-CI**	***p*-value**	**Significance**
Win frame, more defensive	As expected, more defensive	0.421 ± 0.494	0.327 ± 0.469	greater	4.048	1090.7	[0.055; Inf)	< 0.001	***
Win frame, neutral	As expected, neutral	0.311 ± 0.463	0.308 ± 0.462	greater	0.149	1137.7	[−0.033; Inf)	0.441	n.s.
Win frame, more offensive	As expected, more offensive	0.268 ± 0.443	0.365 ± 0.481	less	−4.492	1232.2	(−Inf; −0.061]	< 0.001	***

Source: Own representation

More defensive substitutions are made if a team is in a win frame (*M* = 0.421; *SD* = 0.494) compared to teams, which are playing as expected (*M* = 0.327; *SD* = 0.469; *t*(1090.7) = 4.048; *p* < 0.001). Coaches in a loss frame substitute less offensively (*M* = 0.268; *SD* = 0.443) than coaches facing an expected result (*M* = 0.365; *SD* = 0.481; *t*(1232.2) = −4.492; *p* < 0.001).

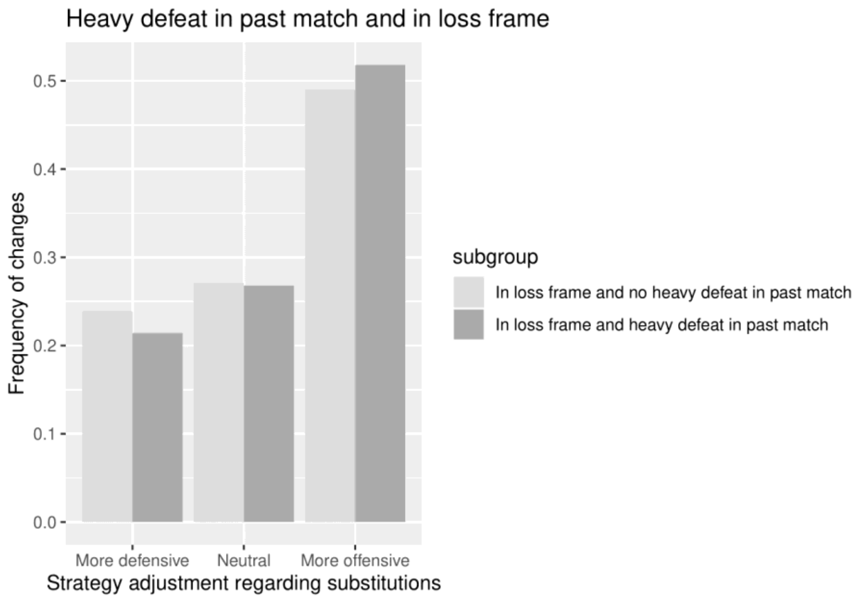
Appendix E – Further Figures and *t*-tests regarding Hypothesis 3

This subsection provides the findings regarding Hypothesis 3.

E.1 Further Figures

First are the results regarding strong and unexpected defeats in terms of being in a loss frame and in a win frame, followed by the same findings for wins and strong wins in the previous game.

Figure E.1: *Fraction of substitutions concerning a previous heavy defeat and being in a loss frame*

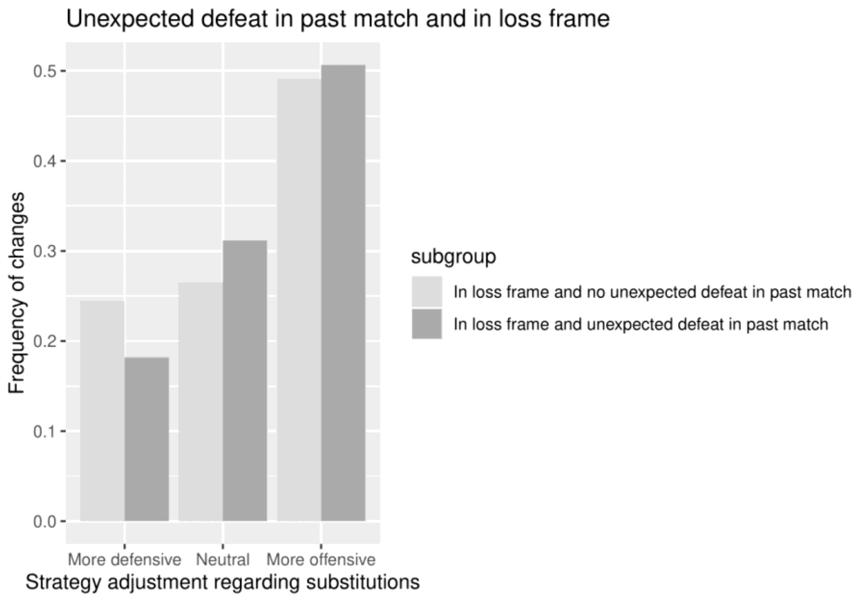


Source: Own representation

One can see in Figure E.1 that coaches are less likely to switch defensively or neutrally when they are below their expectations in the current game and have lost the last game heavily than when they are against their expectations and have not lost the last game heavily. In contrast, the percentage of offensive changeovers is higher in this subgroup.

Compared to the setting earlier regarding general losses in Figure 5.6, in Figure E.1 one can see that teams that are behind their expectations and did not lose in the last game are hardly different from teams that are behind their expectations and did not lose heavily in the last game, these proportions are almost identical.

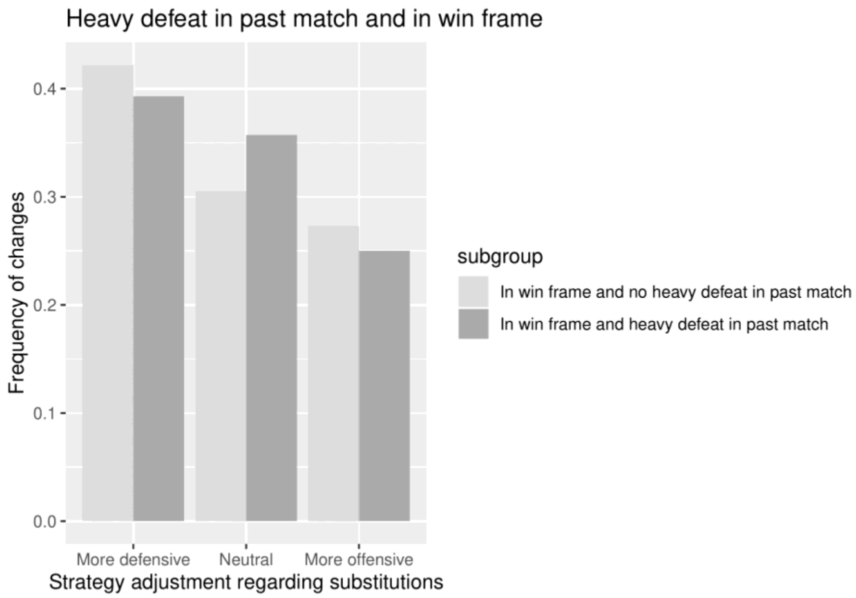
Figure E.2: *Fraction of substitutions concerning a previous unexpected defeat and being in a loss frame*



Source: Own representation

Figure E.2 shows the graphic concerning unexpected defeats and unexpectedly bad half-time results. Again, fewer defensive substitutions are made after experiencing an unexpected defeat. Compared to general and heavy losses, the portions are again similar, but with a tendency to more offensive substitutions compared to general and heavy losses.

Figure E.3: *Fraction of substitutions concerning a previous heavy defeat and being in a win frame*

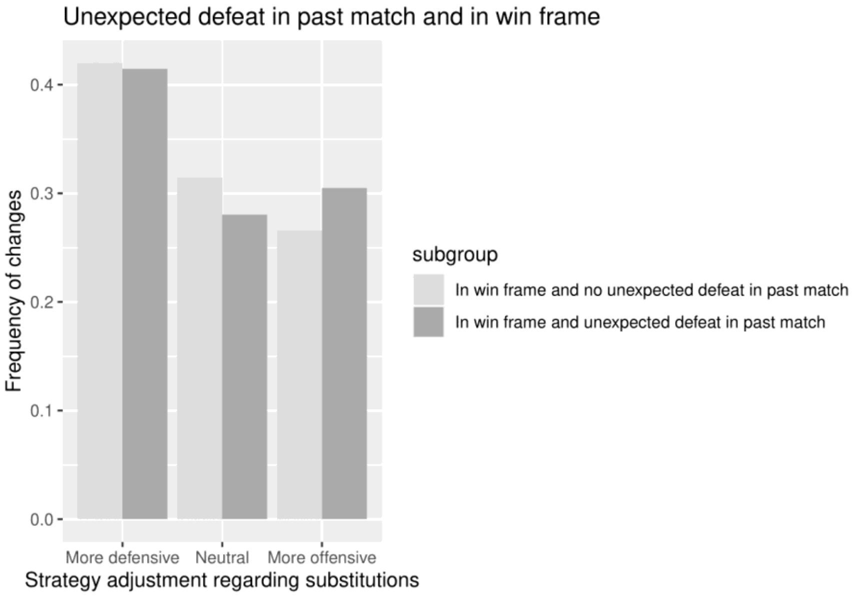


Source: Own representation

Concerning being in a win frame, Figure E.3 expresses the fractions of heavy defeats. It shows that more neutral substitutions are made after experiencing an unexpected defeat and being above expectations in the current game comparing it to the situation without a prior heavy loss. Different from Figure 5.7 related to general defeats is that in Figure E.3 after a high defeat, the substitutions are less offensive and more neutral.

The situation after unexpected defeats and being in a win frame, on the other hand, is comparable to the situation of general defeats, as Figure E.4 shows. Thus, if the loss was an unexpected one more offensive substitutions are made.

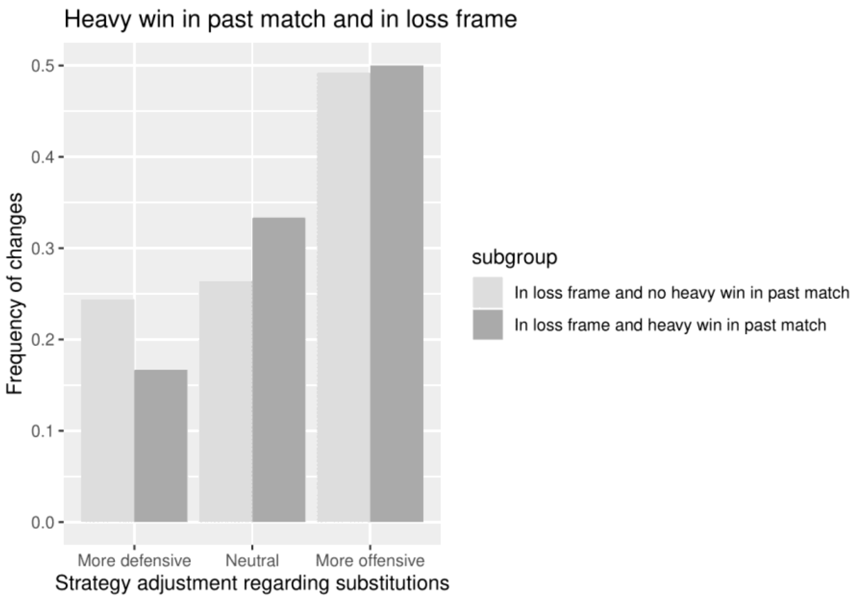
Figure E.4: *Fraction of substitutions concerning a previous unexpected defeat and being in a win frame*



Source: Own representation

The following results are now given in terms of previous good results.

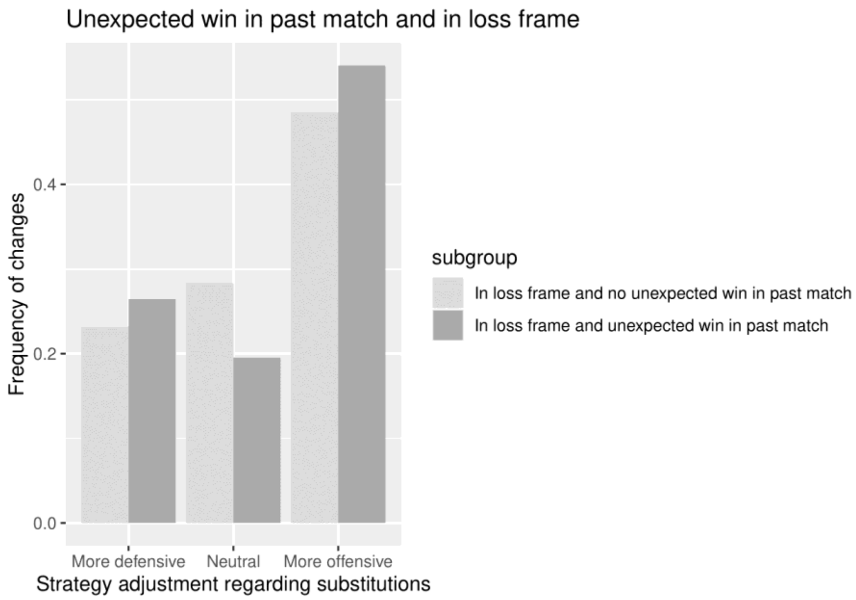
Figure E.5: *Fraction of substitutions concerning a previous heavy win and being in a loss frame*



Source: Own representation

Figure E.5 includes the results concerning heavy wins. The proportions shift compared to Figure 5.8, coaches change less defensively and more neutrally and offensively when the win was a heavy one, and they each lag against their expectations. The defensive substitutions are also less frequent when lagging expectations and winning a heavy victory in the game before compared to lagging expectations and not winning heavily in the game before.

Figure E.6: *Fraction of substitutions concerning a previous unexpected win and being in a loss frame*

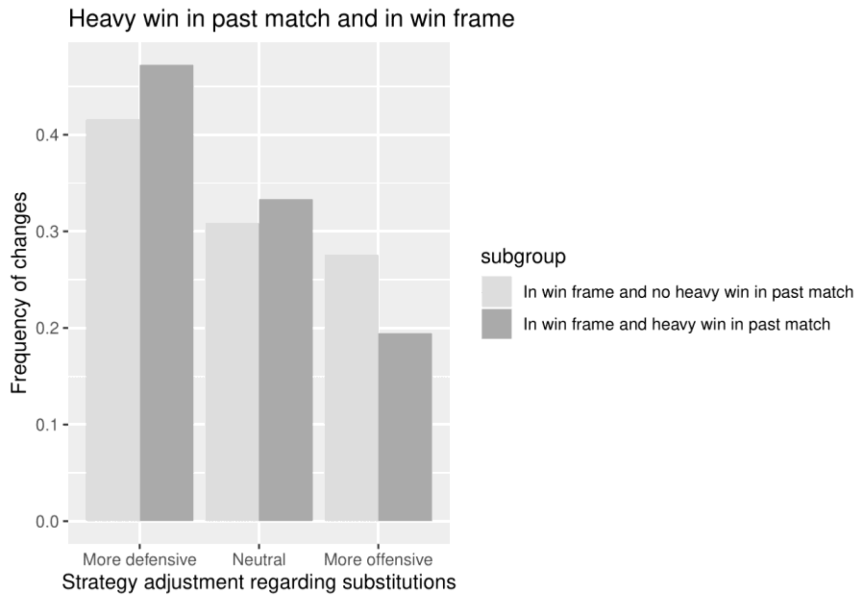


Source: Own representation

If the win was unexpected, much fewer neutral substitutions are conducted and changes are, as in Figure E.6, more defensively and more offensively compared to Figure E.5. About Figure 5.8, more offensive substitutions are made after unexpected losses than after general losses, when being in a loss frame.

This subsection concludes with the analyses in terms of prior good results and unexpectedly good half-time results.

Figure E.7: *Fraction of substitutions concerning a previous heavy win and being in a win frame*

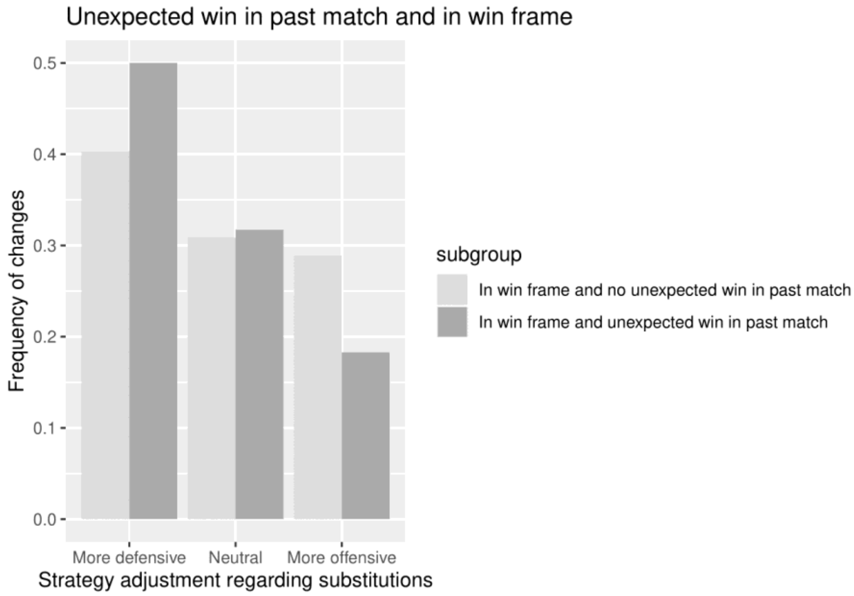


Source: Own representation

The graphical results of Figure E.7 are that more defensive and neutral substitutions and much fewer offensive substitutions are made after winning heavily and being in a win frame compared to only being in a win frame. This is in a similar propensity as in Figure 5.9.

The last is Figure E.8 concerning unexpected wins and being in a win frame.

Figure E.8: *Fraction of substitutions concerning a previous unexpected win and being in a win frame*



Source: Own representation

It shows that after unexpected wins and if the result in the following game is above expectations, much fewer offensive substitutions are made. Also, coaches conduct more defensive substitutions after unexpected wins compared to heavy or general wins, when being in a win frame.

E.2 t-tests

As above, the results of the one-sided *t*-tests are shown.

Table E.1: *t-tests for the fraction of substitutions concerning a previous defeat and being in a loss frame*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past defeat, loss frame, more defensive	Past defeat, loss frame, more defensive	0.247 ± 0.432	0.218 ± 0.414	greater	0.809	469.61	[−0.030; Inf)	0.210	n.s.
No past defeat, loss frame, neutral	Past defeat, loss frame, neutral	0.270 ± 0.444	0.273 ± 0.446	less	−0.080	451.73	(−Inf; 0.059]	0.468	n.s.
No past defeat, loss frame, more offensive	Past defeat, loss frame, more offensive	0.483 ± 0.500	0.509 ± 0.501	less	−0.608	452.91	(−Inf; 0.044]	0.272	n.s.

Source: Own representation

Table E.1 shows no significant differences between the strategic substitutions in the subgroups of being in a loss frame and no previous defeat compared to a previous defeat. The same holds also for previous heavy defeats and Table E.2.

Table E.2: *t-tests for the fraction of substitutions concerning a previous heavy defeat and being in a loss frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past heavy defeat, loss frame, more defensive	Past heavy defeat, loss frame, more defensive	0.239 ± 0.427	0.214 ± 0.414	greater	0.421	67.298	[−0.073; Inf)	0.338	n.s.
No past heavy defeat, loss frame, neutral	Past heavy defeat, loss frame, neutral	0.271 ± 0.445	0.268 ± 0.447	greater	0.052	66.445	[−0.101; Inf)	0.480	n.s.
No past heavy defeat, loss frame, more offensive	Past heavy defeat, loss frame, more offensive	0.490 ± 0.500	0.518 ± 0.504	less	−0.393	66.366	(−Inf; 0.090]	0.348	n.s.

Source: Own representation

Table E.3: *t-tests for the fraction of substitutions concerning a previous unexpected defeat and being in a loss frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past unexpected defeat, loss frame, more defensive	Past unexpected defeat, loss frame, more defensive	0.244 ± 0.430	0.182 ± 0.388	greater	1.304	104.71	[−0.017; Inf)	0.098	+
No past unexpected defeat, loss frame, neutral	Past unexpected defeat, loss frame, neutral	0.265 ± 0.442	0.312 ± 0.466	less	−0.828	96.635	(−Inf; 0.047]	0.205	n.s.
No past unexpected defeat, loss frame, more offensive	Past unexpected defeat, loss frame, more offensive	0.491 ± 0.500	0.506 ± 0.503	less	−0.258	98.839	(−Inf; 0.086]	0.398	n.s.

Source: Own representation

However, a difference can be detected in Table E.3 concerning unexpected previous losses. Coaches who are in a loss frame and not losing the last game unexpectedly substitute more neutrally (*M* = 0.244; *SD* = 0.430) than the coaches who are in a loss frame after experiencing an unexpected defeat (*M* = 0.182; *SD* = 0.388; *t*(104.71) = 1.304; *p* = 0.098).

Further evaluation is done concerning win frames. Table E.4 presents the *t*-test results concerning being in a win frame after experiencing a defeat.

Table E.4: *t-tests for the fraction of substitutions concerning a previous defeat and being in a win frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past defeat, win frame, more defensive	Past defeat, win frame, more defensive	0.425 ± 0.495	0.411 ± 0.493	greater	0.329	531.85	[−0.054; Inf)	0.371	n.s.
No past defeat, win frame, neutral	Past defeat, win frame, neutral	0.318 ± 0.466	0.298 ± 0.458	greater	0.511	536.38	[−0.043; Inf)	0.305	n.s.
No past defeat, win frame, more offensive	Past defeat, win frame, more offensive	0.258 ± 0.438	0.290 ± 0.455	less	−0.889	516.94	(−Inf; 0.028]	0.187	n.s.

Source: Own representation

Again, the results show no significant difference between the subgroups, neither in terms of previous defeats nor in terms of previous heavy defeats, as Table E.5 demonstrates.

Table E.5: *t-tests for the fraction of substitutions concerning a previous heavy defeat and being in a win frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past heavy defeat, win frame, more defensive	Past heavy defeat, win frame, more defensive	0.422 ± 0.494	0.393 ± 0.493	greater	0.420	66.622	[−0.086; Inf)	0.338	n.s.
No past heavy defeat, win frame, neutral	Past heavy defeat, win frame, neutral	0.305 ± 0.461	0.357 ± 0.483	less	−0.769	65.455	(−Inf; 0.061]	0.222	n.s.
No past heavy defeat, win frame, more offensive	Past heavy defeat, win frame, more offensive	0.273 ± 0.446	0.250 ± 0.437	greater	0.373	67.045	[−0.079; Inf)	0.355	n.s.

Source: Own representation

Table E.6: *t-tests for the fraction of substitutions concerning a previous unexpected defeat and being in a win frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past unexpected defeat, win frame, more defensive	Past unexpected defeat, win frame, more defensive	0.420 ± 0.494	0.415 ± 0.496	greater	0.091	107.37	[−0.092; Inf)	0.464	n.s.
No past unexpected defeat, win frame, neutral	Past unexpected defeat, win frame, neutral	0.315 ± 0.465	0.280 ± 0.452	greater	0.632	109.16	[−0.055; Inf)	0.264	n.s.
No past unexpected defeat, win frame, more offensive	Past unexpected defeat, win frame, more offensive	0.266 ± 0.442	0.305 ± 0.463	less	−0.720	105.07	(−Inf; 0.051]	0.237	n.s.

Source: Own representation

This is also the case with unexpected previous defeats and with an unexpectedly good half-time result. This can be seen in Table E.6.

From now on, one can see the results in terms of positive outcomes and being in a loss frame.

Table E.7: *t-tests for the fraction of substitutions concerning a previous win and being in a loss frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past win, loss frame, more defensive	Past win, loss frame, more defensive	0.231 ± 0.422	0.244 ± 0.430	less	−0.368	538.39	(−Inf; 0.045]	0.356	n.s.
No past win, loss frame, loss frame, neutral	Past win, loss frame, neutral	0.276 ± 0.448	0.264 ± 0.442	greater	0.329	549.33	[−0.048; Inf)	0.371	n.s.
No past win, loss frame, loss frame, more offensive	Past win, loss frame, more offensive	0.493 ± 0.501	0.492 ± 0.501	greater	0.022	544.71	[−0.067; Inf)	0.491	n.s.

Source: Own representation

Table E.7 regarding a previous win and being in a loss frame also shows no significant differences.

If considering heavy wins instead, it can be deduced that coaches who are in a loss frame and did not win the last game heavily substitute more defensively (M = 0.244; SD = 0.430) than the coaches who are in a loss frame after winning heavily (M = 0.167; SD = 0.376; $t(76.781)$ = 1.494; p = 0.070). This is given in Table E.8.

Table E.8: *t-tests for the fraction of substitutions concerning a previous heavy win and being in a loss frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past heavy win, loss frame, more defensive	Past heavy win, loss frame, more defensive	0.244 ± 0.430	0.167 ± 0.376	greater	1.494	76.781	[−0.009; Inf)	0.070	+
No past heavy win, loss frame, neutral	Past heavy win, loss frame, neutral	0.264 ± 0.441	0.333 ± 0.475	less	−1.080	70.478	(−Inf; 0.038]	0.142	n.s.
No past heavy win, loss frame, more offensive	Past heavy win, loss frame, more offensive	0.492 ± 0.500	0.500 ± 0.504	less	−0.119	72.195	(−Inf; 0.106]	0.453	n.s.

Source: Own representation

Table E.9: *t-tests for the fraction of substitutions concerning a previous unexpected win and being in a loss frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past unexpected win, loss frame, more defensive	Past unexpected win, loss frame, more defensive	0.232 ± 0.422	0.264 ± 0.444	less	−0.636	113.33	(−Inf; 0.052]	0.263	n.s.
No past unexpected win, loss frame, neutral	Past unexpected win, loss frame, neutral	0.283 ± 0.451	0.195 ± 0.399	greater	1.867	125.31	[0.010; Inf)	0.032	*
No past unexpected win, loss frame, more offensive	Past unexpected win, loss frame, more offensive	0.485 ± 0.500	0.540 ± 0.501	less	−0.956	116.15	(−Inf; 0.041]	0.171	n.s.

Source: Own representation

If the win was, however, unexpected, coaches who are in a loss frame and did not win the last game unexpectedly substitute more defensively (*M* = 0.283; *SD* = 0.451) than the coaches who are in a loss frame after winning unexpectedly (*M* = 0.195; *SD* = 0.399; $t(125.31) = 1.867$; $p = 0.032$). This is shown in Table E.9.

Finally, the results concerning previous good outcomes and unexpectedly good intermediate outcomes are reported.

Table E.10: *t-tests for the fraction of substitutions concerning a previous win and being in a win frame*

x	y	$\bar{x} \pm SD$	$\bar{y} \pm SD$	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past win, win frame, more defensive	Past win, win frame, more defensive	0.393 ± 0.489	0.468 ± 0.500	less	−1.779	433.23	(−Inf; −0.005]	0.038	*
No past win, win frame, neutral	Past win, win frame, neutral	0.305 ± 0.461	0.319 ± 0.467	less	−0.372	436.4	(−Inf; 0.050]	0.355	n.s.
No past win, win frame, more offensive	Past win, win frame, more offensive	0.302 ± 0.460	0.213 ± 0.410	greater	2.465	485.96	[0.030; Inf)	0.007	**

Source: Own representation

Table E.10 reports the *t*-test results concerning a previous win and being in a win frame. If the team did not win the last game and is above expectations, coaches substitute significantly less defensively (*M* = 0.393; *SD* = 0.489) than the coaches who are in a loss frame after winning (*M* = 0.468; *SD* = 0.500; $t(433.23) = -1.779$; $p = 0.038$). Furthermore, more offensive substitutions are conducted after not winning in the last game and being in a win frame (*M* = 0.302; *SD* = 0.460) compared to winning in the last game and being in a win frame (*M* = 0.213; *SD* = 0.410; $t(485.96) = 2.465$; $p = 0.007$).

However, when looking at heavy wins and Table E.11, no significant results can be found.

Table E.11: *t-tests for the fraction of substitutions concerning a previous heavy win and being in a win frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past heavy win, win frame, more defensive	Past heavy win, win frame, more defensive	0.416 ± 0.493	0.472 ± 0.506	less	−0.648	39.26	(−Inf; 0.090]	0.260	n.s.
No past heavy win, win frame, neutral	Past heavy win, win frame, neutral	0.308 ± 0.462	0.333 ± 0.478	less	−0.303	39.194	(−Inf; 0.113]	0.382	n.s.
No past heavy win, win frame, more offensive	Past heavy win, win frame, more offensive	0.276 ± 0.447	0.194 ± 0.401	greater	1.168	40.616	[−0.036; Inf)	0.125	n.s.

Source: Own representation

Table E.12: *t-tests for the fraction of substitutions concerning a previous unexpected win and being in a win frame*

x	y	$\bar{x}$ ± SD	$\bar{y}$ ± SD	H_A	*t*-statistic	df	95 %-CI	*p*-value	Significance
No past unexpected win, win frame, more defensive	Past unexpected win, win frame, more defensive	0.403 ± 0.491	0.500 ± 0.502	less	−1.806	145.98	(−Inf; −0.008]	0.037	*
No past unexpected win, win frame, neutral	Past unexpected win, win frame, neutral	0.308 ± 0.462	0.317 ± 0.468	less	−0.176	147.05	(−Inf; 0.074]	0.430	n.s.
No past unexpected win, win frame, more offensive	Past unexpected win, win frame, more offensive	0.289 ± 0.454	0.183 ± 0.388	greater	2.464	165.85	[0.035; Inf)	0.007	**

Source: Own representation

If the win was unexpected, again the same significances as in Table E.10 are seen. Thus, if the team did not win the last game unexpectedly and is above expectations, coaches substitute significantly less defensively ($M = 0.403$; $SD = 0.491$) than the coaches who are in a loss frame after winning unexpectedly ($M = 0.500$; $SD = 0.502$; $t(145.98) = -1.806$; $p = 0.037$). Additionally, more offensive substitutions are conducted after not winning unexpectedly in the last game and being in a win frame ($M = 0.289$; $SD = 0.454$) compared to winning unexpectedly in the last game and being in a win frame ($M = 0.183$; $SD = 0.388$; $t(165.85) = 2.464$; $p = 0.007$).

Appendix F – Assumptions of the Fixed Effects Regression

For the fixed effects regression results to be validly interpreted, the following assumptions must be valid. The assumptions are a correct specification of the model, that is, linearity between explained and explanatory variables (*FE.1*), random sampling (*FE.2*), no collinearity between explanatory variables (*FE.3*), strict exogeneity, which means that the error term must be uncorrelated with all explanatory variables and over all periods (*FE.4*), homoskedasticity of the error terms (*FE.5*), and serially uncorrelated idiosyncratic errors over time (*FE.6*) (Wooldridge, 2012).

Appendix G – Further Regression Specification Regarding Hypothesis 1

This appendix chapter aims to present the results of Hypothesis 1 when incorporating the specification of Bucciol et al. (2019). Table G.1 presents the results of the regression in the notion of Bucciol et al. (2019).

Table G.1: *Fixed effects regression concerning initial formation changes*

	(1)	(2)	(3)	(4)
	Any change	Formation measure change	More defensive	More offensive
Prior Bad Results				
Defeat in past match	0.064*	0.177*	−0.001	0.068*
	(0.031)	(0.073)	(0.025)	(0.031)
Further defeats	0.132***	0.002	0.058*	0.054+
	(0.034)	(0.070)	(0.025)	(0.031)
Heavy defeat in past match	0.103**	−0.087	0.071*	0.033
	(0.031)	(0.108)	(0.035)	(0.042)
Unexpected defeat in past match	0.005	−0.165*	0.030	−0.047
	(0.032)	(0.074)	(0.031)	(0.029)
Prior Good Results				
Win in past match	−0.033	−0.037	0.001	−0.026
	(0.032)	(0.075)	(0.028)	(0.033)
Further wins	0.045	0.054	0.006	0.045
	(0.039)	(0.062)	(0.028)	(0.029)
Heavy win in past match	−0.058+	0.029	−0.053+	−0.014
	(0.032)	(0.055)	(0.029)	(0.030)
Unexpected win in past match	−0.001	0.130	−0.049+	0.035
	(0.028)	(0.080)	(0.028)	(0.032)
Control Variables				
Table standing after past match	−0.001	−0.009	0.003	−0.003
	(0.005)	(0.005)	(0.003)	(0.003)
Table standing of the opponent after past match	−0.005**	0.013**	−0.006**	0.001
	(0.002)	(0.004)	(0.002)	(0.001)
Home playing	−0.010	0.143*	−0.056**	0.050**
	(0.016)	(0.057)	(0.021)	(0.018)
Chances in past match	−0.013***	−0.023**	0.002	−0.013***
	(0.003)	(0.007)	(0.003)	(0.003)
Fixed Effects				
Fixed Effects: Coach	x	x	x	x
Fixed Effects: Team x Season	x	x	x	x
Fixed Effects: Matchday x Season	x	x	x	x
Characteristics				
Num.Obs.	2880	2880	2880	2880
R2	0.185	0.077	0.102	0.114
Std.Errors	by: Coach	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own representation

The reference category here is a team that drew the last game. As Bucciol et al. (2019) state, the coefficients of further defeats as well as heavy and unexpected defeats must be seen as the marginal effect in addition to the general defeat, meaning that the total effect of, for instance, further defeats is given by the sum of the coefficient of a past defeat and the further defeats.

The dependent variable in regression (1) is a dummy variable, if any initial formation changes, even a strategically neutral one, occurs. The number of observations is 2,880 because further defeats and wins can only occur after the third matchday, thus, the first two matchdays of each season are omitted. It follows that if a defeat occurred in the previous game, *ceteris paribus*, coaches adapt the initial formation in the next game significantly more often compared to the reference category draw in the previous game (ß = 0.064, SE = 0.031, $p < 0.05$). The exact interpretation would be that a defeat in the past match corresponds to a 6.4-percentage point increase in the probability of observing initial formation changes compared to a draw in the previous game. Moreover, further defeats are highly significant in a positive sense, meaning that further defeats correspond to an additional increase in initial formation changes compared to general defeats (ß = 0.132, SE = 0.034, $p < 0.001$) and so do heavy defeats (ß = 0.103, SE = 0.031, $p < 0.01$). On the contrary and assessing previous good results, heavy previous wins are related to fewer initial formation changes than wins in general (ß = −0.058, SE = 0.032, $p < 0.10$). One should also interpret the significant control variables. The worse the table standing of the opponent after the past match, the fewer initial changes happen (ß = −0.005, SE = 0.002, $p < 0.01$). Additionally, chances in the past match are highly significant and negatively related to initial changes (ß = −0.013, SE = 0.003, $p < 0.001$), meaning that more chances in the past match are also related to fewer initial changes.

When looking at the overall initial formation measure of the change in specification (2), a defeat corresponds to a significantly higher offensive formation change (ß = 0.177, SE = 0.073, $p < 0.05$). An unexpected defeat in the last game to a significantly higher defensive one compared to a general loss (ß = −0.165, SE = 0.074, $p < 0.05$), which means that the formation measure change does not substantially differ from the situation of a draw in the last game. This provides evidence that further differentiation between unexpected and general defeats is not necessary in this study. Considering the control variables, the higher, thus the worse, the table standing of the opponent after the past match, the more offensive the formation measure change (ß = 0.013, SE = 0.004, $p < 0.01$). Playing at the home stadium is also related to a more offensive formation adaption (ß = 0.143, SE = 0.057, $p < 0.05$). More chances in the past match correspond to a more defensive adaption (ß = −0.023, SE = 0.007, $p < 0.01$).

Specifications (3) and (4) consider the dummy variables of overall defensive and offensive initial changes, respectively. Hence, specification (3) aims to answer the question, of whether the variables are in general linked to more defensive changes. The same holds for specification (4) concerning only offensive changes.

In regression (3), further defeats (ß = 0.058, SE = 0.025, $p < 0.05$) and heavy defeats in the previous game (ß = 0.071, SE = 0.035, $p < 0.05$) are related to more defensive initial changes, heavy (ß = −0.053, SE = 0.029, $p < 0.10$) and unexpected wins (ß = −0.049, SE = 0.028, $p < 0.10$) to less defensive behavior. The higher the table standing of the opponent after the past match, the lower the fraction of defensive changes (ß = −0.006, SE = 0.002, $p < 0.01$). The same holds for home matches (ß = −0.056, SE = 0.021, $p < 0.01$).

From specification (4) one obtains that if a defeat occurred in the last game, coaches adapt the initial formation in the current game more often offensively (ß = 0.068, SE = 0.031, $p < 0.05$). This additionally increases after further consecutive losses (ß = 0.054, SE = 0.031, $p < 0.10$). Again, if the match is played at the home stadium, the higher the frequency of offensive initial changes (ß = 0.050, SE = 0.018, $p < 0.01$). Again, chances in the past match are highly significant and negatively related to the frequency of offensive initial changes (ß = −0.013, SE = 0.003, $p < 0.001$).

Overall, prior bad outcomes are related to more changes in initial strategic formation changes. Defeats correspond in general to more offensive, but unexpected defeats to more neutral initial adaptions. Wins in general do not influence risk-taking behavior before the next match.

Appendix H – Further Regression Specification Regarding Hypothesis 3

Table H.1 presents a different interaction specification based on Appendix G.

Table H.1: *Fixed effects regression concerning substitutions*

	(8)	(9)	(10)
	Substitution measure	More defensive	More offensive
Prior bad results			
Defeat in past match	−0.303**	−0.023	0.075*
	(0.101)	(0.029)	(0.037)
Further defeats	−0.055	0.084*	0.046
	(0.117)	(0.036)	(0.040)
Heavy defeat in past match	0.261*	0.095**	0.036
	(0.122)	(0.034)	(0.044)
Unexpected defeat in past match	0.248**	0.048	−0.061+
	(0.093)	(0.034)	(0.034)
Prior good results			
Win in past match	0.198+	−0.003	−0.043
	(0.110)	(0.038)	(0.031)
Further wins	0.141+	0.001	0.038
	(0.082)	(0.035)	(0.033)
Heavy win in past match	−0.147	−0.062	0.022
	(0.126)	(0.038)	(0.037)
Unexpected win in past match	−0.227	−0.064+	0.046
	(0.143)	(0.038)	(0.040)
Unexpected results			
Being in a loss frame at half-time	0.058	−0.016	−0.028
	(0.119)	(0.052)	(0.054)
Being in a win frame at half-time	−0.127	0.016	−0.035
	(0.103)	(0.039)	(0.038)
Loss frame x prior bad result			
Defeat in past match × Loss frame	0.532*	0.044	0.056
	(0.203)	(0.069)	(0.056)
Further defeats × Loss frame	0.001	−0.055	−0.048
	(0.198)	(0.089)	(0.073)
Heavy defeat in past match × Loss frame	−0.366	−0.217**	0.011
	(0.298)	(0.079)	(0.091)
Unexpected defeat in past match × Loss frame	−0.212	0.033	0.007
	(0.206)	(0.088)	(0.088)
Loss frame x prior good result			
Win in past match × Loss frame	0.168	0.039	0.016
	(0.185)	(0.077)	(0.082)
Further wins × Loss frame	−0.215	0.042	0.073
	(0.166)	(0.070)	(0.082)
Heavy win in past match × Loss frame	0.514*	−0.004	−0.082
	(0.235)	(0.083)	(0.067)
Unexpected win in past match × Loss frame	−0.177	−0.025	0.008
	(0.239)	(0.084)	(0.085)
Win frame x prior bad result			
Defeat in past match × Win frame	0.189	0.077	−0.082
	(0.193)	(0.069)	(0.070)
Further defeats × Win frame	−0.089	−0.122	0.092
	(0.162)	(0.074)	(0.087)
Heavy defeat in past match × Win frame	0.024	0.065	−0.031
	(0.271)	(0.090)	(0.097)
Unexpected defeat in past match × Win frame	−0.307	−0.142+	0.070
	(0.206)	(0.073)	(0.074)
Win frame x prior good result			
Win in past match × Win frame	−0.027	−0.019	0.079
	(0.178)	(0.083)	(0.065)
Further wins × Win frame	−0.393+	−0.021	−0.048
	(0.216)	(0.084)	(0.097)
Heavy win in past match × Win frame	0.318	0.105	−0.176*
	(0.269)	(0.091)	(0.068)
Unexpected win in past match × Win frame	−0.162	0.093	−0.058
	(0.212)	(0.096)	(0.068)
Control Variables			
Table standing after past match	0.043***	0.005	−0.004
	(0.012)	(0.003)	(0.004)
Table standing of the opponent after past match	0.001	−0.005**	0.001
	(0.004)	(0.002)	(0.002)
Home playing	−0.068	−0.053*	0.045*
	(0.046)	(0.020)	(0.020)
Chances in past match	−0.032**	0.002	−0.013***
	(0.012)	(0.003)	(0.003)
Goal difference at half-time	−0.187***	0.007	0.000
	(0.027)	(0.010)	(0.010)
Fixed Effects			
Fixed Effects: Coach	x	x	x
Fixed Effects: Team x Season	x	x	x
Fixed Effects: Matchday x Season	x	x	x
Characteristics			
Num.Obs.	2880	2880	2880
R2	0.206	0.110	0.118
Std.Errors	by: Coach	by: Coach	by: Coach

Note:
Standard errors clustered at the coach level in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: Own representation

The interpretation of the findings in this context is complex and may require further investigation. It is not straightforward to interpret the observed effects and interactions in a specific way. As such, the interpretation of these results presents a convincing opportunity for future research and exploration. Additional studies and analyses could help shed more light on the underlying mechanisms and provide a more comprehensive understanding of the dynamics between a previous defeat, being in a loss frame, and their combined influence on substitutions.

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I am incredibly happy to have now closed my *mental account* concerning my thesis and completed my master's degree. I am already looking forward to my time as a doctoral student back in my hometown at the Institute of Economics at my alma mater Ulm University, where I will be able to continue my research in this exciting subject area.

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Statutory Declaration

I hereby declare that I have composed the present thesis myself and without the use of any other than the cited sources and aids. Sentences or parts of sentences quoted are marked as such; other references about the statement and scope are indicated by full details of the publications concerned. The thesis in the same or similar form has not been submitted to any examination body and has not been published. This thesis was not yet, even in part, used in another examination or as a course performance.

Pavia, Sunday, June 25, 2023

place, date (signature)