# Loss Aversion and Decision-Making under Increased Choice: Evidence from a Natural Experiment in Football

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**Abstract**

This paper provides causal evidence that an increased strategic choice set can impair decision quality under pressure. I exploit a natural experiment in professional football, where a COVID-19-induced policy change increased the allowed number of substitutions from three to five. Using minute-level data from four major European leagues and an instrumental variable strategy, I show that the policy led to more substitutions when teams underperformed expectations. However, these additional choices were causally linked to significantly worse outcomes. The negative effect is most pronounced among strong favorites—teams facing the highest expectation pressure. These findings suggest that behavioral mechanisms such as action bias and choice overload undermine performance when decision-makers face an increased choice set under psychological pressure. The results challenge the classical assumption that more choice improves outcomes and have broader implications for organizational design under pressure.

**Keywords:** Loss Aversion, Reference Dependence, Decision Making, Natural Experiment, Football

**JEL Codes:** C26, D81, D91, Z20

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# 1 Introduction

Does increasing the set of available choices always improve outcomes? While canonical economic theory posits that an increased choice set cannot make a rational agent worse off, a growing body of research in behavioral economics suggests this may not hold true when decision-makers face cognitive constraints and psychological pressure (Iyengar & Lepper, 2000; Schwartz, 2004; Simon, 1955). Core aspects in this context are reference-dependent preferences, which create moments of intense pressure when performance falls short of a reasonable expected benchmark (Kahneman & Tversky, 1979), placing decision-makers in what is known as a *"loss frame"*. This paper examines an empirical puzzle: does an increased choice set improve or impair decisions within such high-pressure moments? I study this question in a high-stakes strategic environment—professional football—that encompasses such moments of pressure.

I provide causal evidence that when decision-makers underperform expectations, they utilize their increased choice set more frequently, but these additional choices lead to significantly worse outcomes. This performance decline reflects reactive interventions in situations where decision-makers lack optimal strategies and make desperate decisions under pressure. Notably, the opposite is true when decision-makers outperform expectations: in gain frames, the same additional flexibility leads to substantially better outcomes. This asymmetry cannot be explained by choice quality or resource constraints. Instead, it reveals that psychological pressure and reference dependence fundamentally shape decision quality. My findings thereby qualify recent insights suggesting that loss frames can serve as a beneficial "de-biasing" mechanism. For instance, in the context of simple delegation decisions, loss frames have been shown to reduce cognitive biases like algorithm aversion (Bockstedt & Buckman, 2025). I argue that this positive effect reverses when the decision-maker is not only under pressure but also faces an increased strategic choice set. Under these conditions, I find that an increased choice set appears to amplify behavioral biases such as action bias and choice overload rather than enabling rational optimization.

I leverage a natural experiment in professional football where a COVID-19-induced policy change exogenously increased the set of allowed substitutions from three to five. The setting of professional football offers an ideal laboratory for observing how leaders and teams respond to pressure, how increased flexibility can backfire, and how cognitive biases shape strategic choices in complex, high-stakes environments. It combines clean identification—the policy was externally imposed, not chosen by teams—with expert decision-makers—coaches with years of strategic experience—and high stakes (Palacios-Huerta, nd). Using detailed minute-by-minute data from all 1,446 matches played in the

2019/20 season in four major European leagues, I document how substitution patterns shifted, especially in loss frames, defined as situations where a team is performing worse than expected based on pre-game betting odds. To address endogeneity concerns, I employ an instrumental variable (IV) approach. My IV estimates reveal that these policy-induced substitutions in loss frames are associated with a substantial negative performance effect. My analysis of the underlying mechanisms suggests that this effect is driven by several behavioral factors: it is concentrated among strong favorites facing high expectation pressure, is associated with an increase in strategically neutral substitutions, and is moderated by managerial experience.

This study contributes to several strands of literature. First, I provide new causal field evidence on reference-dependent preferences and loss aversion in a managerial context. A cornerstone of behavioral economics is loss aversion—that losses weigh more heavily than equivalent gains (Kahneman & Tversky, 1979). This bias is confirmed across various contexts, from insurance choices (Sydnor, 2010) to labor supply (Crawford & Meng, 2011), with reference points being highly context-specific (Baillon et al., 2020). While prospect theory is well-established, prior work has not examined how loss aversion interacts with increased choice sets to affect decision quality in the field. My contribution is to provide—to my knowledge—the first causal evidence of this interaction in a high-stakes managerial environment. Second, my work offers novel insights for the literature on behavioral economics in the context of sports. This literature has documented loss aversion in golf (Pope & Schweitzer, 2011), motivational rebounds in basketball (Berger & Pope, 2011), and the role of unmet expectations in triggering behavioral spillovers and a perceived "loss of control" (Card & Dahl, 2011).[1] My analysis directly builds on Bartling et al. (2015), who first showed that coaches substitute more in loss frames, and connects to the broader question of maximization behavior in professional sports (Romer, 2006). By exploiting an exogenous policy shock and employing an instrumental variable strategy, I take the next step: estimating how these behavioral shifts causally translate into performance consequences—a gap the prior work left unaddressed. While Dilger & Vischer (2024) also examine the five-substitution policy, they do not distinguish loss frame decisions nor assess causal impacts on outcomes. Furthermore, I advance the literature on decision-making under pressure by demonstrating that individual managerial characteristics—particularly experience and strategic decision-making style—significantly moderate vulnerability to pressure-induced errors. This heterogeneity reveals that the same choice expansion can have vastly different consequences depending on who is making the decisions, highlighting the importance of matching decision-makers to high-stakes

[1] Bartling et al. (2015) discuss the relevance of the "loss of control" framework from Card and Dahl (2011) in this context.

environments based on their behavioral profiles. Third, I contribute to the literature on the paradox of choice and related decision-making biases. This literature suggests that an overabundance of options can impair decision quality, a phenomenon termed choice overload (Iyengar & Lepper, 2000; Schwartz, 2004).[2] While much experimental research on this bias exists, causal field evidence is scarce and typically focuses on different contexts like consumer or voting decisions (e.g., Cunow et al., 2021; Jilke et al., 2015; Malone & Lusk, 2019). My study contributes by providing—to my knowledge—the first causal field evidence for this phenomenon in a high-stakes, real-time, managerial setting and by identifying psychological pressure[3] as a key moderator. My findings provide rare causal field evidence that this effect is amplified by action bias—the impulse to act even if inaction is optimal (Bar-Eli et al., 2007; Patt & Zeckhauser, 2000) and exists even when decision-makers are expert professionals under time pressure. Finally, it connects to recent work on decision-making under complexity and cognitive uncertainty. While this literature often focuses on information acquisition (e.g., Oprea, 2020; Enke & Graeber, 2023), my findings demonstrate that an increased choice set can similarly impair performance when cognitive resources are strained by psychological pressure.[4]

My findings challenge the conventional wisdom in organizational design that expanding decision-maker autonomy is uniformly beneficial. I provide direct causal evidence that such flexibility can backfire when agents are under psychological pressure, leading to systematically worse outcomes. For practitioners, this implies that managerial experience and decision-making style play a critical role in navigating high-stakes environments. For policy-makers, it suggests that "smart" flexibility—linked to specific decision contexts or gatekeeping mechanisms—may be more effective than blanket expansions of choice sets. These insights extend beyond sports to other domains such as emergency medicine, crisis management, and financial regulation, where leaders face similar structural features: time pressure, high uncertainty, and the potential for increased choice sets to impair expert decision-making.

The remainder of this paper is structured as follows. Section 2 describes the experimental setting and the data. Section 3 outlines the identification strategy. Section 4 presents the main results.

[2]Empirical work on choice overload also highlights that an abundance of alternatives can reduce satisfaction and increase regret (e.g., Botti & Iyengar, 2006; Kamenica, 2012). Furthermore, Rational Inattention Theory suggests limited attention leads agents to ignore valuable information under overload (Sims, 2003).

[3]See, e.g., Apesteguia & Palacios-Huerta (2010) and Kocher et al. (2012) for studies on performance under pressure in sports.

[4]While I test several potential mechanisms, my analysis provides the strongest evidence for action bias as the primary behavioral driver. I distinguish this from anticipated regret—the desire to avoid future feelings of having done too little (Bell, 1982; Bleichrodt et al., 2010; Loomes & Sugden, 1982; Zeelenberg et al., 2002) by showing that coaches are in fact less likely to exhaust all available substitutions when in a loss frame (Appendix B.4). This pattern contradicts a simple regret-of-omission story and aligns instead with action bias: the impulse to act, but not necessarily to act maximally.

Section 5 analyzes the underlying mechanisms. Section 6 discusses the broader implications and section 7 concludes.

## 2 Data and Experimental Setting

This study relies on a comprehensive minute-by-minute panel covering all 1,446 matches[5] from the 2019/20 season across four major European leagues— the English Premier League, Spanish La Liga, German Bundesliga, and Italian Serie A.[6] The dataset contains goals, cards, and the exact timing of substitutions, following Bartling et al. (2015). These data were web-scraped from a leading German sports magazine (kicker, 2020). Leveraging a fine-grained dataset that tracks game dynamics and specific events at the minute-level for each team enables the analysis of behavioral adaptation and strategic updating under pressure.

### 2.1 The Natural Experiment: An Exogenous Expansion of the Choice Set

My identification strategy leverages an exogenous regulatory shock that increased the choice set for team managers. In May 2020, in response to fixture congestion caused by the COVID-19 pandemic, the International Football Association Board (IFAB) decided to temporarily lift the allowed number of substitutions from three to five per team (International Football Association Board, 2020). While the pandemic created a unique context, my analysis uses the policy change itself as the source of exogenous variation. My analysis deliberately focuses on the 2019/20 season to isolate the immediate, pre-learning responses to the increased choice set. Analyzing potential long-term adaptation and learning effects is an important avenue for future research but is beyond the scope of this paper.

The substitution policy change also introduced timing-related constraints. To prevent match delays, the five substitutions had to be made in a maximum of four distinct substitution slots per team: three during regular play and one during the halftime break. This additional constraint ensures that strategic substitutions—particularly in the second half—are still bound by coordination costs and timing pressure, reinforcing the paper's focus on in-game high-stakes decision-making.

Table 1 summarizes the timeline of the substitution policy implementation across the four leagues analyzed. While the decision to allow five substitutions was announced centrally by the IFAB in May 2020, the timing of adoption and implementation varied slightly across leagues, reflecting differences in national scheduling and restart plans. The table reports the date of the first matchday on which the policy took effect as well as catch-up matches from earlier matchdays played after the policy change.

[5] All analyses include all matches and thus all coaches, regardless of how many games a coach managed (including interim coaches and those active only before or only after the policy change).

[6] French Ligue 1 data is not included as the season was suspended due to COVID-19.

Table 1: Timing of Policy Change by League

| League | First Affected Matchday | Date of First Affected Matchday | Catch-Up Matches |
|---|---|---|---|
| Bundesliga | 26th Matchday | 16 May 2020 | One from Matchday 24 |
| Premier League | 30th Matchday | 17 June 2020 | Two from Matchday 28 |
| Serie A | 27th Matchday | 20 June 2020 | Four from Matchday 25 |
| La Liga | 28th Matchday | 11 June 2020 | None |

*Note:* "Catch-up matches" refer to games from an earlier matchday that were rescheduled and played after the new substitution policy had already been implemented for the regularly scheduled matches.

### 2.2 The Loss Frame

In line with Bartling et al. (2015), I define a "loss frame" as a situation where a team's performance is below its ex-ante expectations. This reference point is determined by pre-match betting odds, which suggest the most likely outcome. Specifically, the most likely outcome is identified as the result with the highest implied probability among a win, draw, or loss based on the betting odds. The pre-match betting odds were accessed from football-data.co.uk (2020), an open-source database. For this study, I used data from Bet365, one of the world's largest online bookmakers. I follow the main loss frame definition of Bartling et al. (2015), stating that a team is in a loss frame if it is trailing relative to its expectation and if at least one goal has been scored. This condition ensures that a 0:0 score at the start of a match does not prematurely classify a team as being in a loss frame. Specifically, a team is considered to be in a loss frame when it is expected to win but is either losing or drawing (with at least one goal scored, e.g., 1:1, 2:2, etc.), or when it is expected to draw but is losing.

Comparable to Bartling et al. (2015), teams are, on average, in a loss frame in approximately 14.1% of the minutes before and 13.4% after the policy change.

### 2.3 Data Description

To provide an overview of the data, summary statistics for key match events are presented at both the match level (Table 2) and the minute-team level (Table 3).[7]

Across all matches in the sample, a total of 4,091 goals were scored, 6,637 cards were issued, and 9,458 substitutions were made. Examining the pre- and post-policy periods, 1,038 matches occurred before the policy change and 408 after. In the pre-policy period, these matches saw 2,928 goals, 4,894 cards, and 5,958 substitutions. Following the policy change, the corresponding figures were

[7]The minute-team level data forms the basis for the main regression analyses.

1,163 goals, 1,743 cards, and 3,500 substitutions. Substitutions are categorized as offensive, neutral, or defensive based on the positions of the players involved, following the classification provided by kicker (2020). An offensive substitution, for example, involves a striker replacing a midfielder or defender.

Table 2: Summary Statistics (Per Match)

| | Pre-Policy Change | | | | | Post-Policy Change | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Median | Min | Max | Mean | SD | Median | Min | Max |
| **Goals** | | | | | | | | | | |
| Goals | 2.821 | 1.620 | 3.000 | 0.000 | 9.000 | 2.850 | 1.586 | 3.000 | 0.000 | 8.000 |
| **Cards** | | | | | | | | | | |
| Total | 4.715 | 2.323 | 5.000 | 0.000 | 12.000 | 4.272 | 2.307 | 4.000 | 0.000 | 13.000 |
| Yellow | 4.504 | 2.194 | 4.000 | 0.000 | 12.000 | 4.054 | 2.144 | 4.000 | 0.000 | 11.000 |
| Red | 0.211 | 0.480 | 0.000 | 0.000 | 4.000 | 0.218 | 0.547 | 0.000 | 0.000 | 4.000 |
| **Substitutions** | | | | | | | | | | |
| Total | 5.740 | 0.577 | 6.000 | 1.000 | 6.000 | 8.578 | 1.477 | 9.000 | 3.000 | 10.000 |
| Offensive | 1.326 | 0.975 | 1.000 | 0.000 | 5.000 | 1.598 | 1.190 | 2.000 | 0.000 | 6.000 |
| Neutral | 3.343 | 1.297 | 3.000 | 0.000 | 6.000 | 5.441 | 1.884 | 5.000 | 0.000 | 10.000 |
| Defensive | 1.071 | 0.892 | 1.000 | 0.000 | 4.000 | 1.539 | 1.092 | 1.000 | 0.000 | 6.000 |
| Strategy Adjustment Measure | 1.329 | 1.169 | 1.000 | 0.000 | 7.000 | 1.400 | 1.363 | 1.000 | 0.000 | 7.000 |

*Note:*
N = 1,446

Table 2 shows that the average number of goals per match remained relatively stable, with 2.821 goals pre-policy change and 2.850 post-policy change. Similarly, the incidence of red cards per match was low and consistent across both periods (0.211 pre-policy, 0.218 post-policy). There was a slight decrease in the average number of total cards per match, from 4.715 to 4.272, primarily driven by a reduction in yellow cards. The most significant change observed at the match level (Table 2) concerns substitutions. The mean number of total substitutions per match increased markedly from 5.740 pre-policy to 8.578 post-policy. This increase was evident across all types of substitutions—offensive (1.326 to 1.598), neutral (3.343 to 5.441), and defensive (1.071 to 1.539)—suggesting active use of the additional allowance. The maximum number of total, offensive, and defensive substitutions per match also increased, further indicating that coaches utilized the increased substitution allowance. The *Strategy Adjustment Measure*, a proxy for the strategic riskiness of substitutions based on Bartling et al. (2015), shows a slight increase at the match level from 1.329 to 1.400 post-policy change.[8]

[8]Following Bartling et al. (2015), the *Strategy Adjustment Measure* is calculated by assigning numerical values to player positions—strikers 4, midfielders 3, defenders 2, and goalkeepers 1. For each substitution, the measure equals the positional value of the incoming player minus the positional value of the outgoing player. A substitution of a striker for a defender, for example, would score +2, indicating an offensive adjustment, whereas a substitution of a defender for a striker would score –2, indicating a defensive adjustment.

Table 3 provides further granularity at the minute-team level. Consistent with the match-level data, the average substitution rate per minute per team increased from 0.031 to 0.047 post-policy. The *Strategy Adjustment Measure* at the minute-team level remained relatively stable around 0.001 in both periods.

Table 3: Summary Statistics (Per Minute and Team)

| | Pre-Policy Change | | | | | Post-Policy Change | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Median | Min | Max | Mean | SD | Median | Min | Max |
| **Goals** | | | | | | | | | | |
| Goals | 0.015 | 0.123 | 0.000 | 0.000 | 1.000 | 0.016 | 0.124 | 0.000 | 0.000 | 1.000 |
| **Cards** | | | | | | | | | | |
| Total | 0.026 | 0.160 | 0.000 | 0.000 | 3.000 | 0.023 | 0.153 | 0.000 | 0.000 | 3.000 |
| Yellow | 0.025 | 0.156 | 0.000 | 0.000 | 2.000 | 0.022 | 0.148 | 0.000 | 0.000 | 2.000 |
| Red | 0.001 | 0.034 | 0.000 | 0.000 | 1.000 | 0.001 | 0.036 | 0.000 | 0.000 | 3.000 |
| **Substitutions** | | | | | | | | | | |
| Total | 0.031 | 0.184 | 0.000 | 0.000 | 3.000 | 0.047 | 0.269 | 0.000 | 0.000 | 4.000 |
| Offensive | 0.007 | 0.086 | 0.000 | 0.000 | 2.000 | 0.009 | 0.098 | 0.000 | 0.000 | 3.000 |
| Neutral | 0.018 | 0.139 | 0.000 | 0.000 | 2.000 | 0.030 | 0.202 | 0.000 | 0.000 | 3.000 |
| Defensive | 0.006 | 0.077 | 0.000 | 0.000 | 2.000 | 0.008 | 0.096 | 0.000 | 0.000 | 2.000 |
| Strategy Adjustment Measure | 0.001 | 0.140 | 0.000 | -3.000 | 3.000 | 0.001 | 0.155 | 0.000 | -3.000 | 3.000 |

*Note:*
N = 264,214

# 3 Identification Strategy

My approach to analyzing the productivity of substitutions advances the literature by directly addressing the endogeneity concerns inherent in previous OLS-based match-level analyses of this question (Bartling et al., 2015). Estimating the performance effect of substitutions is challenging because the decision to substitute is endogenous to the game's state and unobserved team quality. While OLS can show correlations, it cannot identify a causal effect. My 2SLS approach is designed to overcome this challenge. By conducting the analysis at the minute-by-minute level, I can employ a powerful instrumental variable strategy. My instruments are constructed by interacting the exogenous policy shock with the (endogenous) time-varying game state. The exogeneity required for identification comes from the policy shock component of this interaction. This strategy enables me to isolate plausibly exogenous variation in substitution events that is driven by the policy change but varies depending on the specific pressure situation within a match. Furthermore, by including all matches rather than restricting the sample to only those where a team experienced a loss frame, I can directly compare the causal effects across different psychological contexts (loss vs. gain frames). Together, this methodological framework allows me to move beyond correlation and provide—to my knowledge—the first causal field evidence on the productivity of an increased choice set under pressure.

My identification strategy combines two sources of variation to estimate the causal effect of the increased choice set. Following Bartling et al. (2015), I use the within-match variation between being in and out of a loss frame to identify behavioral responses to pressure. Crucially, I add a second layer of identification by exploiting the exogenous, cross-match variation in the size of the choice set induced by the 2020 substitution policy change. This combination allows me to employ an IV strategy to estimate causal performance effects, which I detail in the following sections.

A key challenge for my identification strategy is that the policy change coincided with most post-policy matches being played without spectators ("ghost games"). The absence of fans is known to have affected various aspects of the game, such as the home advantage and match intensity (e.g., Dilger & Vischer, 2022; Ferraresi & Gucciardi, 2023; Fischer & Haucap, 2021; Scoppa, 2021; Wang & Qin, 2023; Wunderlich et al., 2021). While this raises potential concerns for my analysis, I argue that this unique context is unlikely to invalidate my causal estimates. Theoretically, the absence of crowd pressure should reduce emotional arousal and foster more deliberate, rational decision-making.[9] This

[9]This aligns with anecdotal evidence from players who described these matches as feeling less intense. For instance, Borussia Mönchengladbach midfielder Tobias Strobl stated, "Of course, it feels like a friendly match", and Borussia Dortmund goalkeeper Roman Bürki noted, "This was no different from the games we used to play when we were

implies that the "ghost game" context likely provides a setting where behavioral biases are mitigated rather than amplified. If behavioral biases are indeed the channel through which increased choice affects performance, this context would therefore lead to a conservative, lower-bound estimate of such effects. It makes it less likely, not more, to find evidence for pressure-induced decision-making errors. Furthermore, while any general effect of the empty stadiums on substitution levels is absorbed by the policy's main effect in my difference-in-differences (DID) design, my robustness checks in Appendix A.5 provide additional, direct evidence. By analyzing the few exceptions of "catch-up" and pre-pandemic "ghost matches", I show that the substitution rule, not the absence of fans, is the primary driver of the observed behavioral shifts. To further address concerns that the characteristics of teams might have systematically differed across the policy change, I conduct a formal balancing test. As shown in Appendix Table 11, I find no significant differences in key covariates such as prior league position or pre-match betting odds between the pre- and post-policy periods.

Building on the framework of Bartling et al. (2015) and theories of behavior under pressure, I expect that the increased substitution allowance would lead coaches to make more substitutions when their team is in a loss frame. This anticipated behavioral shift could be driven by an heightened action bias, or increased regret aversion, as coaches seek to influence the match outcome with more available substitutions. Crucially, prospect theory (Kahneman & Tversky, 1979) predicts a strong asymmetry in the consequences of these choices. I therefore hypothesize that the causal effect of these policy-induced substitutions on performance is negative in loss frames, where psychological pressure impairs decision quality. In contrast, I expect the effect to be non-negative (null or positive) in gain frames, where such pressure is absent and coaches can leverage their increased choice set rationally.

### 3.1 Policy Impact on Substitution Behavior

Before causally assessing the impact of additional substitutions on match outcomes, I first establish that the policy change–the expansion of allowed substitutions–indeed altered coaching behavior, particularly in loss frames. This initial analysis serves to demonstrate that the policy had a tangible effect on substitution patterns, a necessary precondition for it to subsequently influence productivity. Understanding this behavioral response also provides context for interpreting the main productivity results.

To assess the impact of the policy change and loss frames on substitution frequency, I specify the

children; without spectators, just having fun" (ESPN, 2020).

following OLS model:

$$Substitution_{itm} = \beta_1 \cdot LossFrame_{itm} + \beta_2 \cdot LossFrame_{itm} \times PolicyChange_i + \boldsymbol{\beta_3} \cdot \mathbf{X}'_{itm} + \alpha_{it} + u_{itm} \quad (1)$$

Here[10], the primary variables for this analysis are $Substitutions_{itm}$, representing the number of substitutions made by team $t$ in minute $m$ of match $i$; $LossFrame_{itm}$, as defined in Section 2.2; and $PolicyChange_i$, a binary indicator for matches played under the five-substitution rule, based on the exact league-specific implementation date, including any rescheduled matches.

$\mathbf{X}'_{itm}$ defines the set of control variables, including the exact goal difference for team $t$ in match $i$ in minute $m$ and optional minute fixed effects. The term $\alpha_{it}$ represents team-match fixed effects, which account for unobserved time-invariant heterogeneity at the team-match level, controlling for factors such as baseline home advantage, referee characteristics, or pre-existing team dynamics. The idiosyncratic error term is $u_{itm}$.

Standard errors are clustered at the match level to account for potential intra-match correlation. The coefficient of interest, $\beta_2$, quantifies how the policy change differentially affected substitution frequency within loss frames. This analysis of behavioral adaptation sets the stage for evaluating the productivity of these policy-induced substitutions.

### 3.2 Productivity Analysis

The central empirical objective is to determine the causal impact of policy-induced substitutions, particularly those made in loss frames, on final match outcomes, measured by the final goal difference.

To assess this relationship, I first consider an OLS model that regresses final goal difference on substitution behavior, controlling for various match and team characteristics. However, OLS estimates of the effect of substitutions on match outcomes are likely to be biased due to endogeneity. For instance, unobserved factors such as squad depth, team form or superior coaching ability might be positively correlated with both the propensity to make tactical substitutions (even in loss frames, perhaps reflecting better bench utilization) and with achieving better (or less negative) final goal differences. If such a positive correlation exists, OLS would attribute some of the positive impact of this unobserved quality to the substitutions themselves, leading to an upward bias in the estimated effect of substitutions. This means OLS could understate a true negative effect or overstate a positive one.

[10]While Bartling et al. (2015) use the *Strategy Adjustment Measure* to quantify the offensive nature of substitutions based on position changes, I instead focus on the frequency of substitutions as the main behavioral outcome. This reflects my emphasis on the overall intensity of coaching interventions rather than their directional nature. Results using the measure for substitution riskiness are presented in Appendix A.7

To address these endogeneity concerns and identify a causal impact, I employ a two-stage least squares (2SLS) instrumental variable strategy. The policy change that increased the substitution allowance from three to five—and thus the choice set—serves as the basis for my instruments. This policy change is exogenous to any specific team's minute-by-minute performance and directly impacts substitution behavior, creating variation in substitution frequency not driven by underlying match conditions or team characteristics.

My IV strategy focuses on substitutions made primarily in the second half of matches. This focus is motivated by the established understanding that substitutions in the first half are predominantly forced by injuries, whereas those in the second half are more likely to reflect strategic coaching decisions aimed at influencing the match outcome (e.g., Bartling et al., 2015). Bartling et al. (2015), for instance, document that strategic adjustments and most substitutions typically occur after halftime and throughout the second half, with early-match substitutions being rare. By concentrating on this period of heightened strategic activity, my instruments—specifically the policy change interacted with loss frame status and indicators for second-half play—are designed to capture variation in discretionary substitution choices under pressure. This approach aims to isolate strategic responses from changes forced by unforeseen circumstances like injuries, thereby enhancing the plausibility of the exclusion restriction.

My identification strategy thus leverages a plausibly exogenous policy shock that primarily affects second-half, discretionary substitutions, isolating variation in strategic choices that is orthogonal to unobserved team or match quality.

The second-stage equation estimates the effect of substitutions on the final goal difference:

$$FinalGoalDiff_{itm} = \gamma_0 + \gamma_1 \cdot \widehat{Substitution}_{itm} + \gamma_2 \cdot \widehat{Substitution_{itm} \times LossFrame_{itm}} + \boldsymbol{\gamma_3} \cdot \mathbf{X}'_{itm} + \epsilon_{itm} \quad (2)$$

Here, $FinalGoalDiff_{itm}$ is the final goal difference for team $t$ in match $i$, which is constant across all minutes $m$ within that match. $\widehat{Substitution}_{itm}$ and $\widehat{Substitution_{itm} \times LossFrame_{itm}}$ are the predicted values for the endogenous variables from the first-stage regressions. The vector $\mathbf{X}'_{itm}$ includes control variables such as the exact goal difference, a dummy for home matches, and its interaction with the policy change and optional fixed effects. Team-match fixed effects are not included in this 2SLS setup due to the nature of the estimation.

The first-stage regressions (detailed in Appendix A.1, Equations 3 and 4) predict the endogenous substitution variables using the policy change and its interactions with the loss frame dummy and an indicator for the first half as instruments.

The validity of this IV approach hinges on the exclusion restriction: the assumption that the instruments affect the final goal difference only through their impact on substitution behavior, conditional on controls. While this assumption cannot be directly tested, I acknowledge two potential alternative channels. First, player pacing could change. The knowledge of having five available substitutes might lead starting players to exert effort more intensely, knowing they are more likely to be replaced. Second, the policy change could alter the game's overall strategy dynamics, as teams anticipate more substitutions from their opponents.

However, I argue these channels are unlikely to invalidate the results. The identification strategy relies on the interaction between the policy change and a team being in a loss frame during the second half. A general change in player pacing or strategy dynamics would apply systematically to the post-policy period, but it is not theoretically obvious why it would specifically correlate with the interaction term, which isolates the effect of discretionary, pressure-induced substitutions. Therefore, while these effects form part of the new context, my instrument plausibly isolates the causal effect of a team's own marginal substitution choices. This interpretation is supported by two pieces of evidence: first, my main 2SLS estimates are robust to controlling for the opponent's lagged substitution patterns (see Appendix A.4.1, Table 12). Second, placebo tests show that my instrument has no effect on other strategic margins, such as the number of yellow cards (see Appendix A.4.3).

This 2SLS estimation identifies a Local Average Treatment Effect (LATE), representing the causal impact for the compliers—the subset of matches and teams whose substitution behavior was affected by the policy change (Imbens & Angrist, 1994; Heckman, 1997).

# 4 Results

This section presents the descriptive evidence on substitution patterns, focusing on how they vary by policy period and game context, and regression results regarding the policy impact on substitution behavior and the productivity analysis.

## 4.1 Descriptive Evidence

Figure 1 provides an aggregated perspective on the substitution patterns by comparing average substitution rates per minute across different game contexts and policy periods.

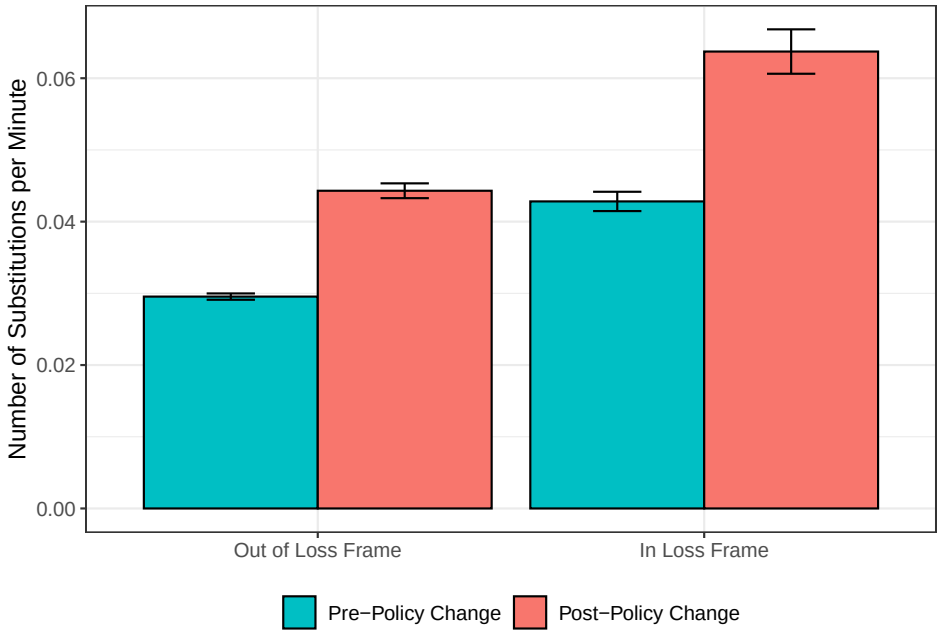


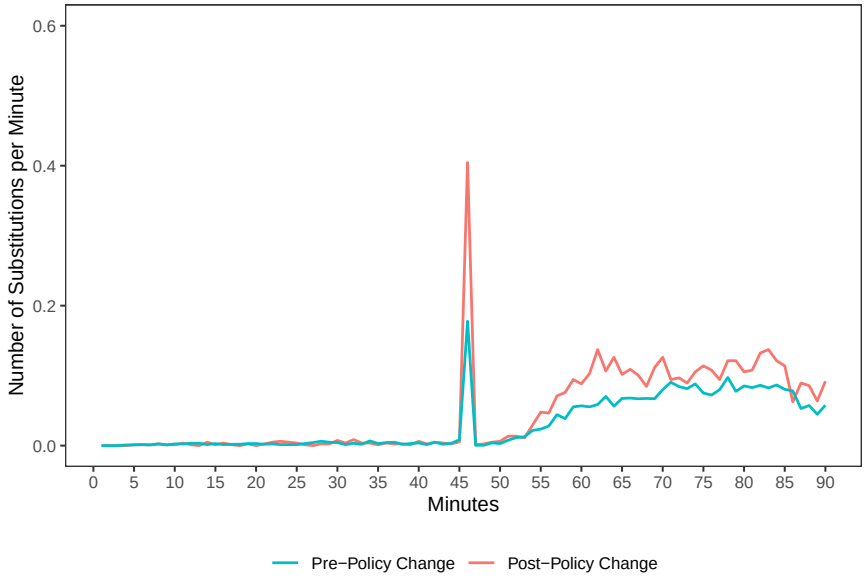

Figure 1: Substitutions per Minute

*Note: Error bars represent the 95% confidence intervals.*

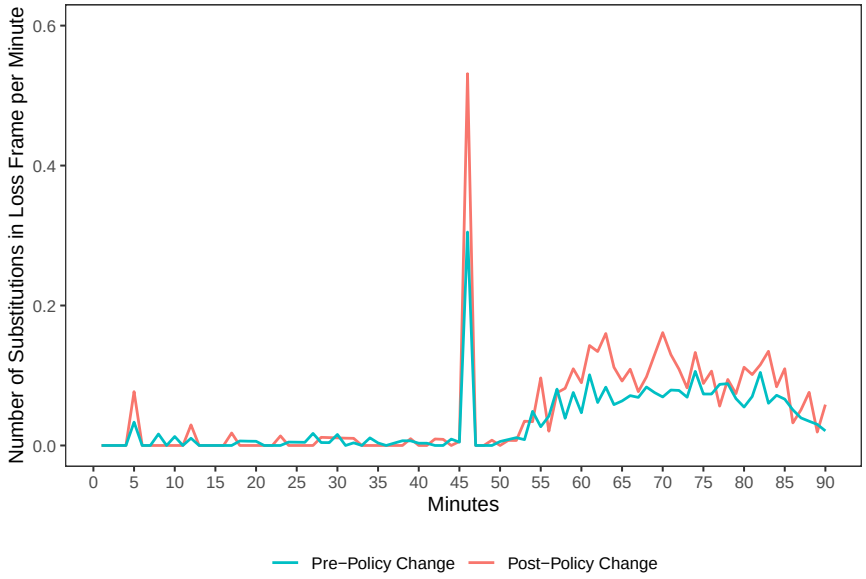
This bar chart highlights two key findings. First, consistent with reference-dependent preferences and the framework of Bartling et al. (2015), teams consistently substitute more frequently when in a loss frame, both before and after the policy change. Second, the absolute increase in substitution rates following the policy change was more pronounced within loss frames (an increase of approximately 0.02 substitutions per minute) compared to non-loss frames (an increase of approximately 0.015). Consequently, the differential substitution rate between being in and out of a loss frame widened after the policy change (from 0.01 to 0.015). This provides initial evidence that the increased allowance disproportionately amplified substitution activity when teams were underperforming expectations,

suggesting a heightened behavioral response to the loss frame when the choice set is increased.

While Figure 1 provides an aggregated, quantitative perspective on the substitution frequency, Figure 2 illustrates the dynamics of substitution frequency over the course of a match.




**(a)** Overall




**(b)** In Loss Frames

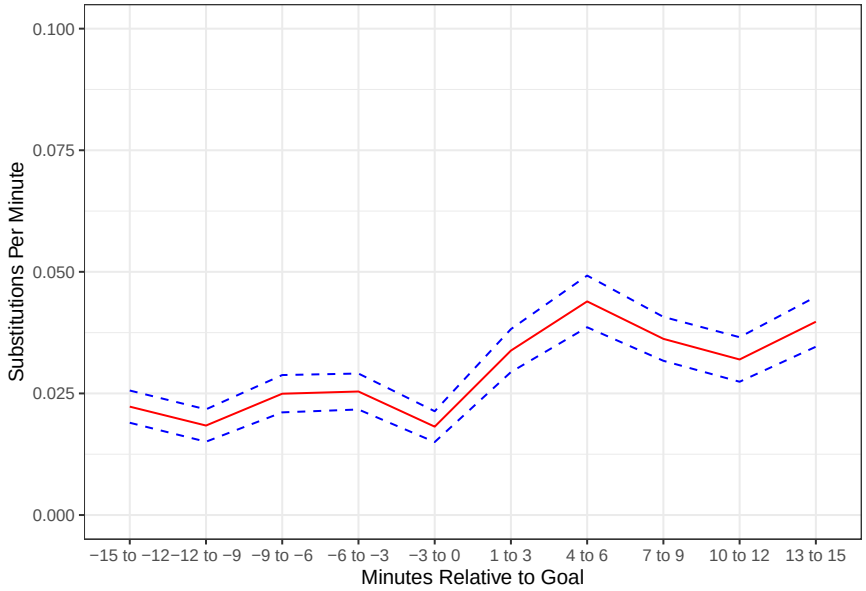
Figure 2: Dynamics of Substitutions during the Match

Panel (a) displays the overall substitution patterns. In both periods, substitution rates are

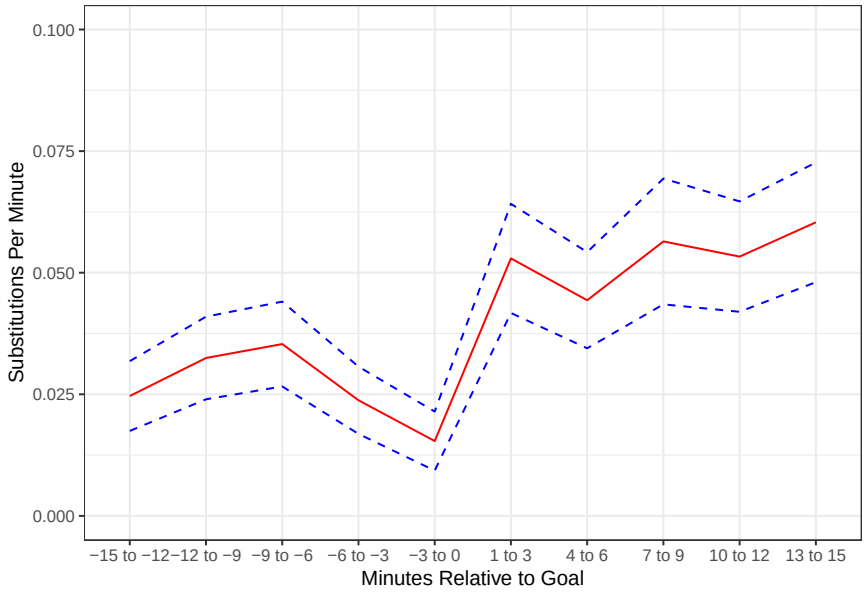
minimal during the first half, consistent with changes primarily due to injuries. A clear peak in activity occurs at halftime (45-minute mark), a common breakpoint for tactical adjustments. This halftime peak is larger post-policy (over 0.4 substitutions per minute) compared to pre-policy (approximately 0.18). Throughout the second half, the post-policy substitution frequency consistently exceeds pre-policy levels, indicating an overall increase in substitution activity. For instance, the average substitution rate in the second half rose from approximately 0.06 per minute pre-policy to 0.09 post-policy, with this difference becoming particularly pronounced from the 60th minute onwards.

Panel (b) specifically explores these dynamics when teams are in a loss frame. The general patterns mirror those observed overall: substitution activity in loss frames is also minimal in the first half, spikes at halftime, and then trends upwards in the second half. A direct comparison with Panel (a) and within Panel (b) reveals that the post-policy increase in substitution rates during the second half is even more pronounced when teams are in a loss frame. The post-policy substitution rate in loss frames is consistently and substantially higher than both the pre-policy rate in loss frames and often exceeds the general post-policy rate observed in Panel (a), especially from the 60th minute onwards. This suggests that the increased substitution allowance was particularly leveraged for adjustments when teams were underperforming during the critical latter stages of matches.

Beyond the substitution patterns shown in Figure 2, it is also insightful to examine the more immediate, reactive substitution behavior following a specific in-match event that triggers a loss frame. Figure 3 examines the immediate substitution response to conceding a goal that places a team into a loss frame. Consistent with loss aversion, both pre- and post-policy periods show a spike in substitutions in the minutes immediately following such a goal. However, this reactive response is markedly amplified after the policy change. Pre-policy, substitutions increase by approximately 67% in the 1-3 minutes after conceding into a loss frame. Post-policy, this increase is roughly 100%. This contrast indicates that the increased substitution allowance made coaches significantly more reactive to the negative shock of entering a loss frame, using the increased choice set to make more immediate changes in an attempt to recover.




**(a)** Pre-Policy Change




**(b)** Post-Policy Change

Figure 3: Substitution Response to Loss-Inducing Goals

*Note: Dotted lines indicate 95% confidence bands.*

### 4.2 Policy Impact on Substitution Behavior

To empirically assess how the increased substitution allowance influenced coaching behavior, I first estimate the impact of the policy change on the frequency of substitutions per minute using OLS. Table 4 presents these results, where the dependent variable is the number of substitutions made by a team in a given minute within a match. The key coefficient of interest is the interaction term, "Loss Frame x Policy Change", which captures the differential effect of the policy change on substitution frequency when a team is in a loss frame.

Specification (OLS-1), the most basic model with team-match fixed effects and control for the exact goal difference, shows that being in a loss frame is associated with approximately 0.037 additional substitutions per minute ($SE = 0.002, p < 0.001$). The interaction term, "Loss Frame x Policy Change", is positive and significant at 0.020 ($SE = 0.005, p < 0.001$). This indicates that the policy change led to an additional 0.020 substitutions per minute for teams in a loss frame, an increase of over 50% relative to the baseline loss frame effect. This effect remains stable when controlling for previous red cards in specification (OLS-2).

Specifications (OLS-3) and (OLS-4) introduce minute fixed effects to account for common time trends in substitution patterns, such as an increased propensity to substitute later in the match. With minute fixed effects, the coefficient on Loss Frame becomes negative ($\beta = -0.003, SE = 0.001, p < 0.05$), suggesting that, conditional on the overall time trend, teams might make slightly fewer substitutions in loss frames. This could be because loss frames often occur later in matches when substitution rates are generally higher.

However, the interaction term "Loss Frame x Policy Change" remains positive and statistically significant across all specifications. In the most comprehensive model (4), the coefficient is 0.017 ($SE = 0.004, p < 0.001$), implying that after the policy change, teams in a loss frame made an additional 0.017 substitutions per minute beyond any baseline effect of being in a loss frame or general time trends.

Table 4: Number of Substitutions per Minute

| | Number of Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.037*** | 0.035*** | -0.003* | -0.003* |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| Loss Frame x Policy Change | 0.020*** | 0.020*** | 0.017*** | 0.017*** |
| | (0.005) | (0.005) | (0.004) | (0.004) |
| **Control Variables** | | | | |
| Exact goal difference | 0.004*** | 0.004*** | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.049*** | | 0.001 |
| | | (0.003) | | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.004 | 0.005 | 0.046 | 0.046 |
| R2 Adj. | -0.007 | -0.006 | 0.035 | 0.035 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

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

These OLS results provide statistical evidence that the increased substitution allowance led to a significant and disproportionate increase in substitution activity specifically when teams were underperforming relative to pre-game expectations. This observed behavioral adaptation aligns with theories of reference-dependent preferences, where deviations below a reference point, loss frames, trigger a more pronounced response, a response that appears to be further amplified by the increased choice set afforded by the policy change.

### 4.3 Productivity Analysis

Having established a behavioral response to the increased choice set, I now turn to the core question of whether these additional substitutions actually improved team outcomes. Therefore, this subsection analyzes the impact of substitutions, particularly those made in loss frames, on the final match outcome, measured by the final goal difference.

I first examine this relationship using OLS. Table 5 presents OLS estimates regressing the final goal difference on substitution indicators and control variables. Across all specifications, the coefficient on the interaction term "Substitution x Loss Frame" is negative and statistically significant.

Table 5: OLS Productivity Analysis of Substitutions

| | Final goal difference | | | |
|---|---|---|---|---|
| | (OLS-5) | (OLS-6) | (OLS-7) | (OLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.175*** | | | |
| | (0.029) | | | |
| **Substitutions** | | | | |
| Substitution | 0.013+ | 0.019** | 0.011 | 0.041*** |
| | (0.007) | (0.007) | (0.007) | (0.006) |
| Substitution x Loss Frame | -0.134*** | -0.122*** | -0.135*** | -0.126*** |
| | (0.025) | (0.023) | (0.025) | (0.022) |
| **Control Variables** | | | | |
| Exact goal difference | 1.088*** | 0.991*** | 1.089*** | 0.862*** |
| | (0.017) | (0.017) | (0.017) | (0.021) |
| Exact goal difference x Loss Frame | -0.112** | -0.057 | -0.118** | 0.056 |
| | (0.042) | (0.041) | (0.042) | (0.043) |
| Loss Frame | 0.287*** | 0.100* | 0.292*** | -0.154** |
| | (0.053) | (0.050) | (0.054) | (0.051) |
| Home | 0.268*** | 0.309*** | 0.288*** | 0.382*** |
| | (0.062) | (0.060) | (0.069) | (0.067) |
| Home x Policy Change | -0.075 | -0.073 | -0.150 | -0.126 |
| | (0.067) | (0.065) | (0.131) | (0.124) |
| Previous match events (red cards) | | | | -0.369*** |
| | | | | (0.080) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.488 | 0.526 | 0.489 | 0.569 |
| R2 Adj. | 0.488 | 0.526 | 0.488 | 0.569 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*
Standard errors in parentheses.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

For instance, in specification (OLS-8) which includes a comprehensive set of team, matchday-league, and opponent fixed effects, as well as controls for the current goal difference and previous red cards, an additional substitution made in a loss frame is associated with a decrease of approximately 0.126 goals in the final goal difference ($SE = 0.022, p < 0.001$). While substitutions outside of loss frames (*Substitution*) show a generally positive, though not always significant, association with out-

comes, those made within a loss frame are consistently linked to worse results. However, as discussed in Section 3.2, these OLS estimates are likely biased due to endogeneity, potentially understating a true negative effect if, for example, unobserved superior coaching quality is correlated with both a higher propensity for strategic substitutions and better overall outcomes.

To address these endogeneity concerns and obtain causal estimates, I employ the 2SLS instrumental variable strategy detailed in Section 3.2. The first-stage regressions (presented in Tables 7 and 8 in Appendix A.1) demonstrate that the instruments are strong predictors of the endogenous substitution variables. Furthermore, the first-stage robust Wald F-Statistics, reported in Table 6 for each endogenous variable, exceed 500 in all specifications (well above the threshold of 100), supporting the strength of the instruments under the applied clustering structure.

Table 6 presents the second-stage 2SLS results. The coefficient on "Substitution" (substitutions made outside a loss frame or in the first half) is generally positive, ranging from 0.100 to 0.889 across specifications, though its statistical significance varies with the inclusion of different fixed effects.

The key coefficient, "Substitution x Loss Frame", is negative, statistically significant, and considerably larger in magnitude than the OLS estimates across all specifications. In my most comprehensive model (2SLS-8), the coefficient is -3.398 ($SE = 1.110, p < 0.01$).

It is crucial to interpret this coefficient carefully. Although the regression is estimated at the team-minute level, it captures the causal impact of a single substitution event. This estimate represents a Local Average Treatment Effect (LATE) for the "compliers"—the specific group of coaches whose decision to make a marginal second-half substitution in a loss frame was induced by the new policy. The large magnitude of the LATE, combined with its relatively wide confidence interval, is consistent with the effect being driven by a small and specific subgroup of "compliers" for whom the policy change was particularly impactful.

To translate this event-level LATE into a more intuitive match-level magnitude, I perform a back-of-the-envelope calculation. I estimate the policy-induced increase in second-half, loss-frame substitutions per match. A series of OLS regressions, detailed in Appendix A.2, shows that this effect is robust across various specifications. The estimates range from 0.348 to 0.426, all highly significant. Using the most conservative estimate from specification (OLS-D) in Table 9, which includes team fixed effects and controls for the final goal difference, the policy change led to approximately 0.348 additional substitutions per match ($SE = 0.087, p < 0.001$).

Multiplying this conservative estimate by the LATE coefficient yields an implied match-level performance consequence of approximately -1.18 goals per complier match, with a 95% confidence interval of [-2.14, -0.23], equivalent to 0.62 standard deviations of the final goal difference distribution (SD

= 1.92). This magnitude reflects the concentrated effect among the complier population—coaches making marginal, discretionary substitutions when their team is in a loss frame. For this group in these specific circumstances, additional interventions proved counterproductive.

The large magnitude of the LATE is consistent with an interpretation of reactive interventions in desperate situations where the baseline probability of a positive turnaround is already low. The increased choice set appears to prompt actions that, for the complier group, are on average counterproductive. The large discrepancy between the IV estimate and the smaller OLS estimate is consistent with an upward bias in OLS, likely driven by unobserved factors such as superior coaching quality.

Table 6: 2SLS Productivity Analysis of Substitutions

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.185*** | | | |
| | (0.031) | | | |
| **Substitutions** | | | | |
| Substitution | 0.322 | 0.477* | 0.100 | 0.889*** |
| | (0.223) | (0.220) | (0.158) | (0.172) |
| Substitution x Loss Frame | -3.810** | -3.256** | -3.988*** | -3.398** |
| | (1.195) | (1.134) | (1.200) | (1.110) |
| **Control Variables** | | | | |
| Loss Frame | 0.458*** | 0.242** | 0.474*** | -0.012 |
| | (0.085) | (0.078) | (0.086) | (0.077) |
| Exact goal difference | 1.088*** | 0.991*** | 1.089*** | 0.861*** |
| | (0.017) | (0.017) | (0.017) | (0.021) |
| Exact goal difference x Loss Frame | -0.116** | -0.060 | -0.124** | 0.053 |
| | (0.042) | (0.042) | (0.043) | (0.044) |
| Home | 0.265*** | 0.308*** | 0.286*** | 0.382*** |
| | (0.063) | (0.060) | (0.069) | (0.067) |
| Home x Policy Change | -0.067 | -0.070 | -0.147 | -0.125 |
| | (0.070) | (0.067) | (0.130) | (0.124) |
| Previous match events (red cards) | | | | -0.382*** |
| | | | | (0.081) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **First-Stage Robust Wald F-Statistics** | | | | |
| F-Statistic: Substitution | 830.79 | 828.51 | 796.17 | 771.86 |
| F-Statistic: Substitution x Loss Frame | 537.85 | 534.56 | 528.56 | 522.00 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.461 | 0.507 | 0.455 | 0.548 |
| R2 Adj. | 0.461 | 0.507 | 0.455 | 0.548 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

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

To test whether this negative performance effect is specific to the psychological pressure of a loss frame, I conduct a symmetric 2SLS analysis for "gain frames"—situations where a team is performing better than expected. The results, presented in Table 35 in Appendix A.6, reveal a asymmetry. In contrast to the loss-frame findings, the instrumented "Substitution x Gain Frame" interaction term is positive and highly significant across all specifications, e.g. $\beta = 3.413$ ($SE = 1.167, p < 0.01$) in the preferred specification (2SLS-8). This indicates that the same additional flexibility that is detrimental in loss frames leads to causally and significantly better outcomes in gain frames. This finding has

two crucial implications. First, it provides strong support for a behavioral channel rooted in prospect theory, as the quality of decisions fundamentally differs between the domains of losses and gains. Second, it allows me to rule out alternative explanations based on declining marginal player quality. If the fourth and fifth substitutes were inherently weaker, their use should be detrimental regardless of the game context. The fact that their deployment is highly productive in gain frames suggests that the quality of the decision-making, not the quality of the players, is the decisive factor. This conclusion is further strengthened by the finding that this positive gain-frame effect is driven entirely by "Clear Favourites" (see Appendix Table 9). Even for the top teams, whose squads might have been affected by fixture congestion or infections, the additional substitutes proved highly productive when the team was not under the psychological pressure of a loss frame. This provides the strongest possible evidence against an explanation based on weakened squad quality.

To further validate my identification strategy and rule out potential confounds, I conduct several robustness and placebo analyses. As discussed in Section 4, a primary concern is the coincidence of the policy change with matches played without spectators. My exploratory DID analyses, which use "catch-up" matches with fans and pre-pandemic "ghost games", suggest that the substitution rule itself, rather than the absence of a crowd, is the main driver of my results (see Appendix A.5 for details). Furthermore, my main results are robust to controlling for fixture congestion, proxied by the number of days since a team's last match (see Appendix Table 13). Moreover, I conduct placebo analyses. First, using a placebo policy change date either in the pre-policy or in the post-policy period (Appendix A.4.2) shows no significant effects, suggesting the main results are not driven by time trends. Second, a placebo analysis using the number of yellow cards as the outcome variable (Appendix A.4.3) further supports my identification strategy. Crucially, the instrumented "Substitution x Loss Frame" interaction term is statistically insignificant across all specifications. While the main "Substitution" term is significant in some models, it becomes insignificant in my preferred, fully-specified model (2SLS-8), indicating that the policy change did not systematically influence this unrelated strategic margin once all fixed effects are accounted for. Finally, as an additional robustness check, an alternative specification using final shots on target as the outcome variable (Appendix A.4.4) yields an effect that points in the same negative direction as for the final goal difference, further supporting the robustness of my main findings.

This gap between OLS and IV suggests that unobserved confounding—such as coaching quality or bench depth—likely biases naive estimates upwards, masking the true adverse effect of these reactive substitutions. Therefore, potential behavioral mechanisms driving this counterintuitive result will be explored in Section 5.

# 5 Mechanism Analysis: The Role of Psychological Pressure

My central finding presents a paradox: an exogenously increased strategic choice set led to causally worse outcomes for the complier population. This result challenges the canonical assumption that an increased choice set cannot harm a rational decision-maker. In this section, I argue that this paradox is driven by behavioral mechanisms amplified under psychological pressure.

Specifically, I posit that the pressure to avert a looming loss—a "loss frame"—exacerbates cognitive biases. High-stakes environments are known to impair cognitive processing and favor heuristic-based, often suboptimal, decision-making (Ariely et al., 2009; Baumeister, 1984). I argue that two such biases are particularly relevant here: action bias—the compulsion to act even when inaction is optimal (Bar-Eli et al., 2007)—and choice overload, where an abundance of options impairs decision quality (Iyengar & Lepper, 2000). My central hypothesis is therefore that the negative performance effect of increased strategic options is strongest when psychological pressure on the decision-maker is highest. I test this hypothesis along three distinct dimensions: the role of expectation pressure, the nature of the decisions taken, and the individual characteristics of the decision-maker.

## 5.1 Expectation Pressure: The Paradox of Strong Favorites

I first test my pressure hypothesis in the setting where ex-ante expectation pressure is arguably highest: matches involving clear favorites. This scenario was at the heart of managerial debates when the new rule was introduced. Prominent coaches such as Pep Guardiola and Frank Lampard and media commentary suggested a resource-based view, arguing that the increased flexibility would primarily benefit elite teams with deeper, higher-quality squads (Telegraph, 2020). From a behavioral perspective, however, this prediction is not self-evident. Instead, high pre-game expectations can intensify the psychological costs of underperformance. The intense pressure to meet a salient reference point—the expectation of winning—may trigger heightened loss aversion when a team finds itself in a loss frame (Kahneman & Tversky, 1979; Pope & Schweitzer, 2011). Rather than calmly capitalizing on their superior resources, coaches of clear favourites might therefore be particularly prone to overreacting. This pressure could lead them to substitute more aggressively in a bid to "fix" the situation, even if such moves ultimately impair team performance. To test these competing narratives—the resource-based managerial hypothesis versus a behavioral response to high-pressure framing—I re-estimate the main 2SLS specification for two distinct subgroups defined by pre-game betting odds. I define "Clear Favourites" as teams in matches where their implied win probability exceeds 50%, representing the highest-pressure context. As a contrast, I define "Close Favorites" as

those where the difference between win and loss probability is narrow (i.e., an absolute difference below 10%), representing a lower-pressure environment where a negative outcome is less of a deviation from expectations.

Figure 4 presents the resulting LATE estimates for each subgroup, while the full regression results are reported in Appendix B.1 (Tables 40 to 45).

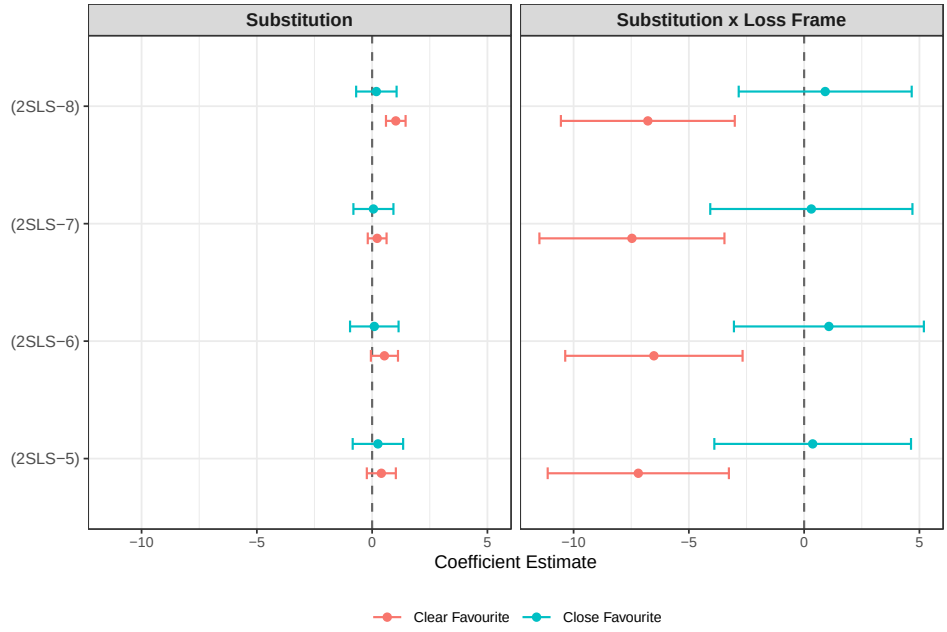



Figure 4: Mechanism Analysis by Favourite Status

*Note: Coefficient estimates with 95% confidence intervals for substitution effects.*

For "Clear Favourites", the negative LATE is large, statistically significant, and robust across all specifications. The point estimate in specification (2SLS-6) implies that for this high-pressure group, the marginal, policy-induced substitution event is associated with a final goal difference that is approximately 7 goals worse. While this magnitude is substantial, it must be interpreted in the context of a highly consequential, reactive decision made under the intense pressure of failing to meet high expectations. In contrast, for "close" matches, where such pressure is lower, the effect is statistically indistinguishable from zero (e.g., +1.1 goals, n.s., in the same specification).

This heterogeneity suggests that the negative consequences of increased choice are concentrated in situations where the psychological pressure from underperformance is highest. It provides strong evidence that loss aversion, fueled by the failure to meet a salient reference point, is a key driver of the observed decision-making errors. This aligns with theories of "choking under pressure", where heightened stakes can overwhelm cognitive processing and lead to suboptimal performance (Ariely

et al., 2009; Baumeister, 1984).

The gain frame analysis (Table 35 in Appendix A.6) provides corroborating evidence for the behavioral interpretation. The near-symmetric magnitude of the effects is difficult to reconcile with alternative explanations based on player quality or bench depth. If additional substitutes were simply lower-quality players, we would expect impaired performance in both contexts. Instead, the asymmetry reveals that the decision-making process itself, not the available talent, drives the outcomes. When psychological pressure is relieved—as it is in gain frames—the expanded choice set enables better outcomes. When pressure is intense, it triggers counterproductive interventions. This pattern lends strong causal support to a behavioral mechanism rooted in prospect theory and psychological pressure, rather than resource constraints.

### 5.2 Behavioral Response: Evidence for Action Bias

Having established that performance declines most sharply under high expectation pressure, I now investigate the specific behavioral channel. I test whether the policy change led to calculated, strategic adjustments or rather to a simpler, reactive heuristic like action bias (Bar-Eli et al., 2007).

The evidence for a behavioral response is strong. As shown in Figure 5 (and detailed in Appendix B.2), the policy-induced increase in loss-frame substitutions is driven primarily by neutral substitutions—an increase of 0.013 substitutions per minute in my most comprehensive model (OLS-4)—, not by offensive ones. This pattern suggests that, under pressure, coaches resorted to simpler, like-for-like replacements (a behavior also documented descriptively by Wittkugel et al. (2022)) rather than decisive, game-altering tactical shifts.

One could argue, however, that such behavior may not reflect a behavioral bias per se but rather a rational response to a deteriorating situation. From this perspective, coaches may simply be engaging in desperation optimization—taking action not because it is optimal in expectation, but because the status quo is already failing, and the marginal benefit of any intervention, however small, outweighs inaction. The substitution may thus appear ineffective ex post without being irrational ex ante. Distinguishing between these two interpretations—bias versus constrained rationality—is inherently difficult in observational settings. Nonetheless, several features of the data suggest that behavioral mechanisms offer a more compelling explanation. First, as noted, the additional substitutions are primarily neutral rather than offensive, which undermines the notion of calculated, goal-oriented optimization. Second, substitutions tend to spike immediately after conceding goals (see Figure 3), a timing pattern more consistent with reactive impulses than deliberate strategy. Third, the strongest negative effects are observed among clear favorites (Section 5.1)—the very teams that

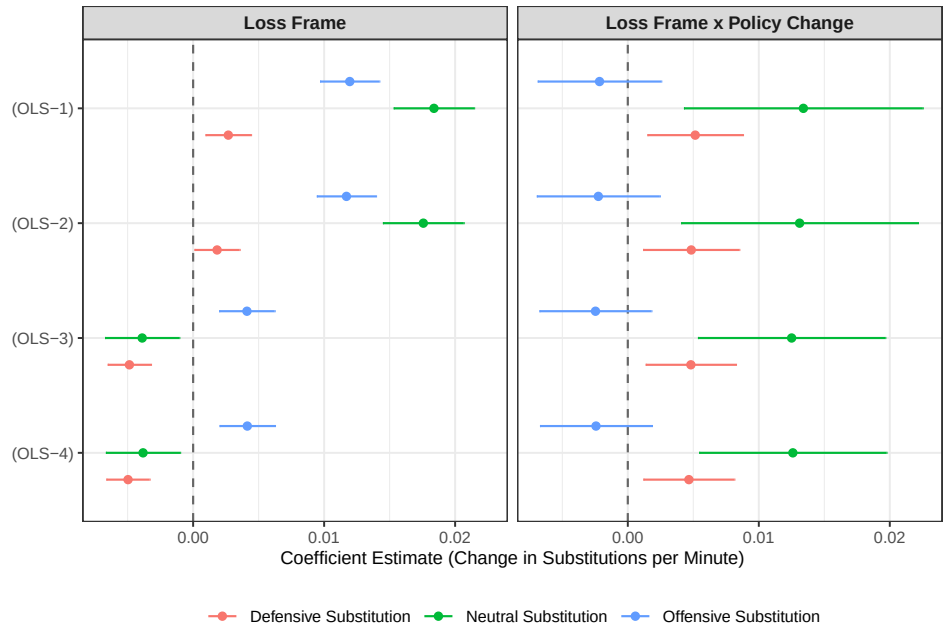



Figure 5: Mechanism Analysis of Substitution Types

*Note: Coefficient estimates with 95% confidence intervals for substitution effects.*

are best equipped to benefit from increased options. This is difficult to reconcile with a purely rational account, as these teams possess the resources and player quality that should allow them to capitalize on added flexibility. This evidence suggests that while action bias is a general response to a loss frame, its negative consequences are most severe for teams under high expectation pressure, not because they necessarily exhibit more bias, but because their pressured, reactive decisions are disproportionately costly.

### 5.3 Coping with Pressure: The Role of Managerial Experience and Style

If psychological pressure is a key driver of the observed performance decline, then a manager's ability to cope should be a crucial moderating factor for these outcomes. In this final part of my analysis, I investigate how a manager's inherent characteristics moderate performance outcomes in high-stakes situations.

First, I explore the role of managerial experience, proxied by coach age. This is motivated by recent findings suggesting that performance under pressure is particularly impaired for less experienced individuals (Englmaier et al., 2024; Klimm et al., 2023). I therefore hypothesize that experienced decision-makers, possessing more refined heuristics and greater emotional regulation, are less susceptible to the cognitive biases induced by a loss frame.

This hypothesis, however, is not trivial, as recent field evidence suggests that market experience may not reduce the underlying bias itself, and can even intensify loss aversion (Emami Namini & Kapoor, 2025). This raises the question: Does experience improve outcomes by reducing the psychological bias, or by providing superior coping mechanisms to manage the consequences of a persistent bias? My results allow to shed light on this question.

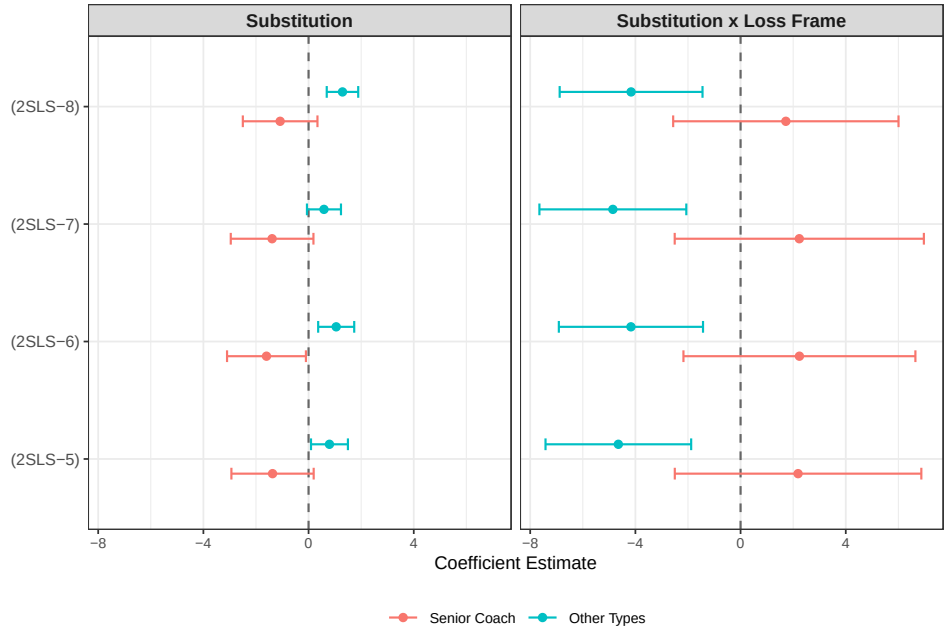



Figure 6: Mechanism Analysis for Senior Coaches

*Note: Coefficient estimates with 95% confidence intervals for substitution effects.*

I test this by comparing "Senior Coaches" (those in the top quintile of the age distribution) to their younger colleagues (see Appendix B.3.1). The results, presented in Figure 6, reveal a trade-off in performance outcomes. In routine, non-loss-frame situations (left panel), the substitutions of senior coaches appear significantly less effective than those of their peers, suggesting their established heuristics may be less adapted to baseline game dynamics. However, this performance deficit is dramatically reversed under the pressure of a loss frame (right panel). While the substitutions of younger coaches in a loss frame are associated with a large and significant negative performance effect, the effect for "Senior Coaches" is statistically indistinguishable from zero. Although the difference between the two groups is not statistically significant at conventional levels, the point estimates suggest that experienced managers are resilient to the pressure-induced errors that affect their peers. They appear to avoid the counterproductive interventions, resulting in decisions that are, at worst, neutral. This indicates that experience provides a powerful buffer against making costly mistakes in

high-stakes moments.

Second, I investigate a different managerial trait: a proactive, risk-loving decision-making style, proxied by coaches who consistently made a high number of offensive substitutions prior to the policy change, thus those in the top quartile of using offensive substitutions, "Offensive Coaches".

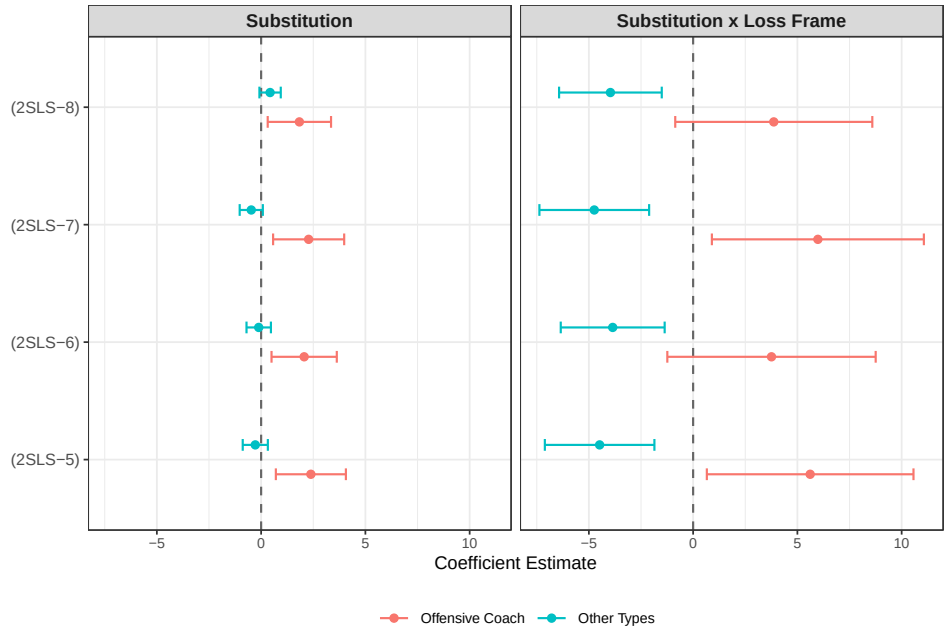



Figure 7: Mechanism Analysis for Offensive Coaches

*Note: Coefficient estimates with 95% confidence intervals for substitution effects.*

The analysis for this group, shown in Figure 7, highlights a different path to resilience (see Appendix B.3.2 for the full regression results). While other coaches make demonstrably counterproductive substitutions in a loss frame (a strongly negative and significant effect), "Offensive Coaches" appear immune to this performance decline. Their intensified actions under pressure are, at worst, neutral rather than harmful. This suggests that a manager's pre-existing strategic disposition can also moderate the negative effects of increased choice under pressure.

Taken together, these findings underscore that the performance consequences of increased discretion are fundamentally heterogeneous. They depend not only on the decision environment but also on the behavioral profile of the decision-maker. While the average manager appears to succumb to pressure, both experience and a proactive style can serve as powerful buffers, fostering resilience in high-stakes environments.

# 6 Discussion

## 6.1 Interpreting the Causal Effect and Behavioral Mechanisms

My instrumental variable approach identifies a LATE of approximately -3.4 goals for the marginal, policy-induced substitution made by "compliers". This large negative effect is concentrated in high-pressure scenarios, such as those faced by strong favorites, and suggests that OLS estimates likely understate the true negative impact due to positive selection bias.

My analysis points to a confluence of behavioral biases, amplified by psychological pressure, as the primary driver. While these mechanisms are likely intertwined, my findings allow me to disentangle their relative importance. The evidence points most strongly to action bias as the core behavioral response. Entering a loss frame triggers heightened loss aversion and a perceived "loss of control" (Card & Dahl, 2011), creating an urgent psychological need to intervene. The key finding from Section 5.2—that the policy-induced increase in substitutions was driven by strategically neutral, like-for-like changes—is direct evidence of this tendency to "do something" rather than to optimize tactically. This aligns perfectly with the definition of action bias Bar-Eli et al. (2007).

However, action bias alone does not fully explain why the negative performance effect is concentrated among strong favorites. This is where choice overload likely acts as a powerful amplifier. The finding that the negative consequences are most severe for teams with the deepest and highest-quality squads—which I proxy using their status as strong favorites—presents a paradox for a purely rational explanation. This paradox is sharpened by my finding that the same flexibility is productive in gain frames, which strongly suggests that the decision-making process itself, rather than player quality, is the key channel. It strongly suggests that the increased choice set, combined with the pressure of high expectations, impaired the cognitive ability of managers to make the optimal decision (Iyengar & Lepper, 2000). Thus, action bias helps explain what coaches did—neutral substitutions—, while choice overload helps explain who was most negatively affected—strong favorites.

Finally, my analysis allows me to distinguish action bias from at least one form of anticipated regret. A manager motivated by the fear of omission—regretting not having done enough—might be expected to exhaust all available options to avoid later self-blame. However, my data suggest this is not the primary driver. As detailed in Appendix B.4, I analyze the likelihood of a team using all five of its substitutions. In the post-policy period, the marginal effect of being in a loss frame on the probability of using all substitutions is negative and statistically significant. This overall effect, derived from the sum of the main "Loss Frame" and the "Loss Frame x Policy Change" coefficients,

indicates that coaches under pressure were in fact less likely to exhaust their full contingent of choices. While the pre-policy coefficient for late-match situations is positive, this reflects behavior under the old three-substitution rule and is not directly relevant for distinguishing mechanisms in the five-substitution regime. Acknowledging that regret theory is complex and that even partial action can mitigate anticipated regret, this finding is nevertheless more consistent with an action bias account—where the primary impulse is simply to act, but not necessarily to exhaust all actions—than with a simple regret-of-omission story.

In summary, my findings reflect a "perfect storm" of biases. The pressure of a loss frame creates a powerful impulse to act—action bias—, which is exacerbated among top teams by the cognitive burden of evaluating an increased set of choices—choice overload.

### 6.2 Further Considerations and Limitations

While behavioral mechanisms offer a strong explanation, alternative views and limitations warrant acknowledgment. Although increased substitutions could be seen as rational responses to factors like fatigue, the persistent negative association after extensive controls points to the critical role of behavioral biases. Still, as the data come from the immediate aftermath of the policy, the observed effect may partially reflect short-term adaptation or learning curves. Unobserved factors like coach overconfidence (Malmendier & Tate, 2005) could also play a role, and the study cannot directly observe cognitive processes during substitutions.

The unique COVID-19 context of this natural experiment warrants careful consideration. Most post-policy matches were played without spectators, which likely created a less emotionally charged environment (e.g., Ferraresi & Gucciardi, 2023; Scoppa, 2021). However, the absence of crowd pressure should theoretically lead to more deliberate, rational choices. The fact that I identify a significant negative performance effect even under these "low-pressure" conditions strengthens my interpretation that increased choice itself can be detrimental when performance expectations are not met. While the absence of crowds might have weakened the effect, other pandemic-related disruptions—such as player fatigue and fixture congestion—remain relevant contextual factors. Finally, while I argue that my exclusion restriction is plausible, unobserved policy effects on broader team strategy beyond the substitution channel cannot be entirely dismissed.

### 6.3 Implications and Future Research

My findings offer several implications. For behavioral theory, they provide strong field evidence on how loss aversion, action bias, and choice overload interact to impair real-time decision-making under

pressure. For management science and organizational design, the results serve as a cautionary tale: well-intentioned expansions of strategic flexibility can backfire if the behavioral responses of agents under pressure are not anticipated. This is particularly relevant for high-stakes domains beyond sports, such as emergency medicine and triage or crisis management, which share similar structural features: time pressure, high uncertainty, and the potential for increased choice sets to impair expert decision-making. My work also contributes novel evidence on the context-dependent value of managerial experience. The finding that senior coaches are more resilient to pressure-induced errors has important implications for leadership assignment in organizations. Future research could examine whether these behavioral patterns persist over time or attenuate with learning. Comparative analyses across sports with different substitution regimes (e.g., basketball, hockey) or non-sport managerial settings would help assess external validity. My findings also raise a broader question for organizational and regulatory design: How can flexibility be granted without triggering counterproductive behavioral responses? For regulators, this suggests that designing "smarter" flexibility—for instance, by linking additional options to specific game states—may be more effective than simply expanding choice sets. However, from a different policy perspective focused on competitive balance, such a "negative consequence" might not be entirely unintended, as it could serve to reduce the dominance of top teams by introducing more variance into match outcomes.

# 7 Conclusion

I leverage a natural experiment from the 2019/20 professional football season to quantify how an exogenous increase in the strategic choice set—the expansion of allowed substitutions from three to five—affects coaching decisions and match outcomes. Using an instrumental variable strategy, I show that while the policy raised substitution frequency in situations of underperformance ("loss frames"), it paradoxically worsened final scores.

These findings demonstrate how an increased choice set can degrade real-time decision quality under pressure, reflecting a combination of loss aversion, choice overload, and action bias. By integrating reference-dependent preferences with a clean causal identification strategy, my work contributes novel field evidence on the mechanisms of decision-making under pressure and complexity, qualifying the conditions under which loss frames can improve decision-making (cf. Bockstedt & Buckman, 2025).

Furthermore, my mechanism analysis reveals that the performance consequences of increased discretion are fundamentally heterogeneous, depending on the behavioral profile of the decision-maker. I provide novel evidence on the context-dependent value of managerial experience, finding that while the routine substitutions of senior coaches appear less effective on average, their decision-making proves significantly more robust under the pressure of a loss frame. This suggests that the capabilities ensuring routine optimization may be distinct from those that foster resilience in high-stakes environments, a finding with important implications for organizational design and leadership assignment.

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# Appendix A: Productivity Analysis

## Appendix A.1: First-Stage Estimates

The first-stage estimation equations are:

$$\begin{aligned} Substitution_{itm} = \beta_0 & \\ & + \beta_1 PolicyChange_i \\ & + \beta_2 PolicyChange_i \times LossFrame_{itm} \\ & + \beta_3 PolicyChange_i \times FirstHalf_i \\ & + \beta_4 PolicyChange_i \times LossFrame_{itm} \times FirstHalf_i \\ & + \boldsymbol{\beta_5} \cdot \mathbf{X}'_{itm} \\ & + \epsilon_{itm} \end{aligned} \tag{3}$$

$$\begin{aligned} Substitution_{itm} \times LossFrame_{itm} = \tilde{\beta}_0 & \\ & + \tilde{\beta}_1 PolicyChange_i \\ & + \tilde{\beta}_2 PolicyChange_i \times LossFrame_{itm} \\ & + \tilde{\beta}_3 PolicyChange_i \times FirstHalf_i \\ & + \tilde{\beta}_4 PolicyChange_i \times LossFrame_{itm} \times FirstHalf_i \\ & + \tilde{\boldsymbol{\beta}}_{\mathbf{5}} \cdot \mathbf{X}'_{itm} \\ & + \tilde{\epsilon_{itm}} \end{aligned} \tag{4}$$

The set of instruments used to predict the endogenous variables in Equations (3) and (4) consists of the *Policy Change* indicator and its interactions with *Loss Frame* and *First Half* (an indicator variable for the first half of the match, with the second half serving as the baseline). A separate main effect for *First Half* is not included as an instrument, as the identification strategy leverages the heterogeneous impact of the policy change across match halves, rather than treating the match half itself as an independent source of exogenous variation for substitution behavior beyond its interaction with the policy.

Tables 7 and 8 present the first-stage results.

Table 7: First Stage Estimates for (2SLS-5) and (2SLS-6)

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.030*** | 0.000 | | |
| | (0.000) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | 0.000 | 0.060*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half | -0.088*** | 0.000+ | -0.088*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.047*** | -0.015*** | 0.047*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.085*** | 0.003 | -0.085*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.012*** | 0.042*** | 0.013*** | 0.042*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.002* | -0.001 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000 | 0.001*** | 0.000* |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002* | -0.002 | -0.003* | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 830.79 | 537.85 | 828.51 | 534.56 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.014 | 0.040 | 0.013 | 0.040 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: First Stage Estimates for (2SLS-7) and (2SLS-8)

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change | 0.061*** | -0.001 | 0.059*** | -0.001 |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half | -0.088*** | 0.000 | -0.087*** | 0.000* |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.047*** | -0.015*** | 0.047*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.085*** | 0.002 | -0.085*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.013*** | 0.042*** | 0.014*** | 0.042*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.001+ | -0.001+ |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.002*** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002* | -0.002+ | -0.003* | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | | 0.019*** | 0.002* |
| | | | (0.002) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 796.17 | 528.56 | 771.86 | 522 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.013 | 0.039 | 0.013 | 0.039 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## Appendix A.2: Back-of-the-Envelope Calculation

The dependent variable is the total number of substitutions made by a team in the second half while in a loss frame. The sample is restricted to team-match observations that experienced a loss frame in the second half.

Table 9: Estimates for the Number of Substitutions in Second-Half Loss Frame

| | Number of Substitutions in Second-Half Loss Frame | | | |
|---|---|---|---|---|
| | (OLS-A) | (OLS-B) | (OLS-C) | (OLS-D) |
| **Intercept** | | | | |
| (Intercept) | 1.763*** | | 1.656*** | |
| | (0.043) | | (0.040) | |
| **Policy Change** | | | | |
| Policy Change | 0.426*** | 0.384*** | 0.395*** | 0.348*** |
| | (0.097) | (0.099) | (0.087) | (0.087) |
| **Control Variables** | | | | |
| Final goal difference | | | -0.358*** | -0.373*** |
| | | | (0.025) | (0.026) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| **Characteristics** | | | | |
| Num.Obs. | 786 | 786 | 786 | 786 |
| R2 | 0.029 | 0.130 | 0.216 | 0.304 |
| R2 Adj. | 0.027 | 0.034 | 0.214 | 0.226 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 10: Translating the LATE into an Implied Match-Level Effect

| | **Component** | **Value** |
|---|---|---|
| **Panel A: Component Estimates** | | |
| (1) | Causal effect of a substitution event on final goal difference ($\gamma$) | -3.398** |
| | *Source: 2SLS estimate (Table 6, Col. 4)* | (1.110) |
| (2) | Policy-induced increase in substitutions per match ($\Delta S$) | 0.348*** |
| | *Source: OLS estimate (Appendix Table 9, Col. 4)* | (0.087) |
| **Panel B: Implied Match-Level Effect and Uncertainty** | | |
| (3) | Implied match-level effect ($\gamma \times \Delta S$) | **-1.183** |
| (4) | Standard error of implied effect | 0.486 |
| | *Calculated via delta method* | |
| (5) | 95% confidence interval | [-2.135, -0.230] |

*Note:* This table translates the local average treatment effect (LATE) into a match-level performance consequence for complier matches. The standard error in row (4) is computed using the delta method:

$$SE(\gamma \Delta S) \approx \sqrt{(\Delta S)^2 \cdot SE(\gamma)^2 + (\gamma)^2 \cdot SE(\Delta S)^2}.$$

Values for $\gamma$, $\Delta S$, and their standard errors are taken from Panel A.

The implied match-level effect of -1.18 goals represents a substantial performance decline. Scaled by the standard deviation of the final goal difference (1.916), this corresponds to an effect size of approximately 0.62 standard deviations. This confirms that the estimated performance consequence for the complier group is not only statistically significant but also economically meaningful.

## Appendix A.3: Balancing Table

The coefficient for "Policy Change" represents the difference in means between the post- and pre-policy periods.

Table 11: Balancing Table: Pre- vs. Post-Policy Matches

| | Team position (prior) | Pre-match win prob. | Pre-match loss prob. | Top team dummy |
|---|---|---|---|---|
| **Policy Change** | | | | |
| Policy Change | 0.029 | 0.001 | 0.001 | -0.002 |
| | (0.236) | (0.008) | (0.008) | (0.020) |
| **Characteristics** | | | | |
| Num.Obs. | 2814 | 2892 | 2892 | 2892 |
| R2 | 0.000 | 0.000 | 0.000 | 0.000 |
| R2 Adj. | 0.000 | 0.000 | 0.000 | 0.000 |

*Note:*

Standard errors in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## Appendix A.4: Robustness Checks and Placebo-Tests

### Appendix A.4.1: Robustness Checks

Table 12: 2SLS Productivity Analysis of Substitutions (Opponent Robustness Check)

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.181*** | | | |
| | (0.031) | | | |
| **Substitutions** | | | | |
| Substitution | 0.522* | 0.655** | 0.312+ | 0.895*** |
| | (0.232) | (0.229) | (0.169) | (0.175) |
| Substitution x Loss Frame | -3.850** | -3.299** | -4.028*** | -3.399** |
| | (1.178) | (1.118) | (1.184) | (1.110) |
| **Control Variables** | | | | |
| Loss Frame | 0.461*** | 0.246** | 0.477*** | -0.012 |
| | (0.084) | (0.078) | (0.085) | (0.077) |
| Opponent Substitution (Lagged by 1 Minute) | -0.016* | -0.013+ | -0.015+ | -0.006 |
| | (0.008) | (0.007) | (0.008) | (0.007) |
| Exact goal difference | 1.085*** | 0.988*** | 1.086*** | 0.861*** |
| | (0.017) | (0.017) | (0.017) | (0.021) |
| Exact goal difference x Loss Frame | -0.122** | -0.065 | -0.129** | 0.053 |
| | (0.042) | (0.041) | (0.043) | (0.044) |
| Home | 0.264*** | 0.307*** | 0.283*** | 0.382*** |
| | (0.062) | (0.060) | (0.069) | (0.067) |
| Home x Policy Change | -0.068 | -0.070 | -0.142 | -0.125 |
| | (0.069) | (0.067) | (0.130) | (0.124) |
| Previous match events (red cards) | -0.379*** | -0.339*** | -0.382*** | -0.382*** |
| | (0.069) | (0.077) | (0.072) | (0.081) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.463 | 0.508 | 0.459 | 0.548 |
| R2 Adj. | 0.463 | 0.507 | 0.458 | 0.548 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

The results are also robust to including a longer opponent lag structure (sum of lags) of five minutes.

Table 13: 2SLS Productivity Analysis of Substitutions (Fixture Congestion Robustness Check)

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.160*** | | | |
| | (0.034) | | | |
| **Substitutions** | | | | |
| Substitution | 0.418* | 0.566** | 0.289+ | 0.874*** |
| | (0.187) | (0.186) | (0.167) | (0.171) |
| Substitution x Loss Frame | -3.786** | -3.217** | -3.902** | -3.353** |
| | (1.175) | (1.114) | (1.185) | (1.106) |
| **Control Variables** | | | | |
| Loss Frame | 0.445*** | 0.236** | 0.457*** | -0.015 |
| | (0.084) | (0.078) | (0.085) | (0.078) |
| Days since last Match | -0.004 | -0.003 | 0.004 | 0.000 |
| | (0.003) | (0.004) | (0.019) | (0.017) |
| Days since last Match x Policy Change | 0.004 | 0.003 | -0.004 | 0.000 |
| | (0.004) | (0.004) | (0.018) | (0.016) |
| Exact goal difference | 1.083*** | 0.988*** | 1.084*** | 0.863*** |
| | (0.017) | (0.017) | (0.017) | (0.022) |
| Exact goal difference x Loss Frame | -0.125** | -0.066 | -0.132** | 0.049 |
| | (0.042) | (0.041) | (0.043) | (0.044) |
| Home | 0.286*** | 0.326*** | 0.298*** | 0.395*** |
| | (0.066) | (0.063) | (0.070) | (0.068) |
| Home x Policy Change | -0.109 | -0.103 | -0.156 | -0.138 |
| | (0.095) | (0.092) | (0.132) | (0.125) |
| Previous match events (red cards) | -0.381*** | -0.338*** | -0.386*** | -0.380*** |
| | (0.071) | (0.079) | (0.074) | (0.083) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 257078 | 257078 | 257078 | 257078 |
| R2 | 0.492 | 0.528 | 0.492 | 0.570 |
| R2 Adj. | 0.492 | 0.528 | 0.492 | 0.569 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

### Appendix A.4.2: Placebo Policy Change Date

For the placebo analysis, I assign a "Placebo Policy Change Date" starting from matchday 20, but restrict the sample to matches up to matchday 23 (before the policy change).

Table 14: First Stage Estimates for (2SLS-5) and (2SLS-6) for Early Placebo Policy Change

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.030*** | 0.000 | | |
| | (0.000) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.028*** | 0.000 | 0.028*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half | -0.055*** | 0.000 | -0.055*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.013*** | 0.016*** | -0.013*** | 0.016*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.001 | -0.054*** | 0.001 | -0.054*** |
| | (0.004) | (0.003) | (0.004) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.013*** | 0.042*** | 0.014*** | 0.042*** |
| | (0.002) | (0.001) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.001+ | 0.000 | 0.001+ | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000 | 0.001*** | 0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.001 | -0.001 | -0.002 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 157.93 | 90.63 | 156.97 | 90.01 |
| **Characteristics** | | | | |
| Num.Obs. | 163896 | 163896 | 163896 | 163896 |
| R2 | 0.004 | 0.033 | 0.005 | 0.034 |
| R2 Adj. | 0.004 | 0.033 | 0.004 | 0.033 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 15: First Stage Estimates for (2SLS-7) and (2SLS-8) for Early Placebo Policy Change

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change x First Half | -0.055*** | 0.000 | -0.054*** | 0.000+ |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.013*** | 0.016*** | -0.013*** | 0.016*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.001 | -0.054*** | 0.001 | -0.054*** |
| | (0.004) | (0.003) | (0.004) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.013*** | 0.042*** | 0.015*** | 0.043*** |
| | (0.002) | (0.001) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.001+ | 0.000 | 0.001+ | 0.001 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.002*** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.001 | -0.001 | -0.002 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | | 0.021*** | 0.002+ |
| | | | (0.002) | (0.001) |
| **Fixed Effects** | | | | |
| Num.Obs. | 163896 | 163896 | 163896 | 163896 |
| R2 | 0.005 | 0.033 | 0.005 | 0.034 |
| Fixed Effects: Team | | | x | x |
| **Diagnostics** | | | | |
| Fixed Effects: Matchday x League | x | x | x | x |
| **Characteristics** | | | | |
| Fixed Effects: Opponent | | | x | x |
| F-Statistic | 210.46 | 120.06 | 200.8 | 117.45 |
| R2 Adj. | 0.004 | 0.033 | 0.004 | 0.032 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 16: 2SLS Productivity Analysis of Substitutions (Early Placebo Policy Change)

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.190*** | | | |
| | (0.040) | | | |
| **Substitutions** | | | | |
| Substitution | 0.035 | 0.506 | 0.031 | 1.542*** |
| | (0.339) | (0.328) | (0.340) | (0.355) |
| Substitution x Loss Frame | -5.049 | -5.397 | -5.025 | -5.284 |
| | (3.743) | (3.465) | (3.748) | (3.512) |
| **Control Variables** | | | | |
| Loss Frame | 0.526** | 0.332* | 0.531** | 0.048 |
| | (0.173) | (0.162) | (0.174) | (0.165) |
| Exact goal difference | 1.069*** | 0.969*** | 1.071*** | 0.829*** |
| | (0.024) | (0.023) | (0.024) | (0.027) |
| Exact goal difference x Loss Frame | -0.105+ | -0.083 | -0.112+ | 0.053 |
| | (0.059) | (0.055) | (0.061) | (0.059) |
| Home | 0.267*** | 0.311*** | 0.270** | 0.378*** |
| | (0.079) | (0.075) | (0.084) | (0.079) |
| Home x Policy Change | -0.022 | -0.018 | -0.048 | -0.036 |
| | (0.100) | (0.098) | (0.198) | (0.194) |
| Previous match events (red cards) | | | | -0.404*** |
| | | | | (0.108) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 163896 | 163896 | 163896 | 163896 |
| R2 | 0.431 | 0.476 | 0.432 | 0.529 |
| R2 Adj. | 0.431 | 0.476 | 0.432 | 0.529 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

This ensures that only pre-policy and placebo-effect periods are included in the analysis and that the proportion of the matches played before and after the (placebo) policy change are comparable to those in the main specification.

In the placebo analysis, I find that the key interaction term "Substitution x Loss Frame" is statistically insignificant, supporting my identification strategy. While the main effect "Substitution"

is significant in one specification, this is less concerning as it captures general substitution patterns within the post-policy period rather than the specific, pressure-induced mechanism isolated by the interaction term.

Additionally, I utilize another placebo analysis on the matches played after the policy change, in particular after matchday 29 with the "Placebo Policy Change Date" set for matchday 32.

Table 17: First Stage Estimates for (2SLS-5) and (2SLS-6) for Late Placebo Policy Change

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.044*** | 0.000 | | |
| | (0.002) | (0.001) | | |
| **Policy Change** | | | | |
| Policy Change | 0.044*** | 0.000 | 0.044*** | 0.000 |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Policy Change x First Half | -0.086*** | 0.000 | -0.086*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.035*** | 0.011 | -0.035*** | 0.010 |
| | (0.008) | (0.007) | (0.008) | (0.007) |
| Policy Change x First Half x Loss Frame | 0.007+ | -0.079*** | 0.006+ | -0.079*** |
| | (0.004) | (0.003) | (0.004) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.028*** | 0.071*** | 0.028*** | 0.071*** |
| | (0.007) | (0.007) | (0.008) | (0.007) |
| **Control Variables** | | | | |
| Home | -0.002 | -0.001 | -0.003 | -0.001 |
| | (0.002) | (0.002) | (0.002) | (0.001) |
| Home x Policy Change | 0.002 | 0.000 | 0.003 | 0.000 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Exact goal difference | 0.000 | 0.000 | 0.001 | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference x Loss Frame | -0.005+ | -0.004+ | -0.005+ | -0.004+ |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 272.51 | 151.3 | 270.93 | 147.97 |
| **Characteristics** | | | | |
| Num.Obs. | 57638 | 57638 | 57638 | 57638 |
| R2 | 0.019 | 0.047 | 0.020 | 0.047 |
| R2 Adj. | 0.019 | 0.046 | 0.018 | 0.046 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

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

Table 18: First Stage Estimates for (2SLS-7) and (2SLS-8) for Late Placebo Policy Change

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change x First Half | -0.086*** | 0.000 | -0.085*** | 0.000 |
| | (0.001) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame | -0.035*** | 0.011 | -0.037*** | 0.009 |
| | (0.008) | (0.007) | (0.008) | (0.007) |
| Policy Change x First Half x Loss Frame | 0.006+ | -0.079*** | 0.005 | -0.079*** |
| | (0.004) | (0.003) | (0.004) | (0.004) |
| **Loss Frame** | | | | |
| Loss Frame | 0.028*** | 0.071*** | 0.033*** | 0.073*** |
| | (0.008) | (0.007) | (0.008) | (0.007) |
| **Control Variables** | | | | |
| Home | -0.002 | -0.001 | -0.003+ | -0.001 |
| | (0.002) | (0.002) | (0.002) | (0.001) |
| Home x Policy Change | 0.002 | 0.000 | 0.002 | 0.000 |
| | (0.002) | (0.002) | (0.002) | (0.001) |
| Exact goal difference | 0.000 | 0.000 | 0.002* | 0.000* |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference x Loss Frame | -0.005 | -0.004 | -0.005+ | -0.004 |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Previous match events (red cards) | | | 0.014+ | 0.004 |
| | | | (0.008) | (0.004) |
| **Fixed Effects** | | | | |
| Num.Obs. | 57638 | 57638 | 57638 | 57638 |
| R2 | 0.020 | 0.047 | 0.020 | 0.048 |
| Fixed Effects: Team | | | x | x |
| **Diagnostics** | | | | |
| Fixed Effects: Matchday x League | x | x | x | x |
| **Characteristics** | | | | |
| Fixed Effects: Opponent | | | x | x |
| F-Statistic | 362.96 | 200.18 | 347.97 | 193.72 |
| R2 Adj. | 0.019 | 0.046 | 0.017 | 0.044 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 19: 2SLS Productivity Analysis of Substitutions (Late Placebo Policy Change)

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.134* | | | |
| | (0.062) | | | |
| **Substitutions** | | | | |
| Substitution | -0.036 | 0.223 | -0.041 | 0.834*** |
| | (0.225) | (0.208) | (0.226) | (0.209) |
| Substitution x Loss Frame | -2.605 | -1.746 | -2.718 | -2.260 |
| | (2.614) | (2.313) | (2.641) | (2.124) |
| **Control Variables** | | | | |
| Loss Frame | 0.356 | 0.070 | 0.365 | -0.170 |
| | (0.228) | (0.207) | (0.232) | (0.195) |
| Exact goal difference | 1.121*** | 0.954*** | 1.121*** | 0.726*** |
| | (0.030) | (0.028) | (0.030) | (0.042) |
| Exact goal difference x Loss Frame | -0.069 | 0.025 | -0.075 | 0.171+ |
| | (0.067) | (0.079) | (0.068) | (0.087) |
| Home | 0.173 | 0.245+ | 0.131 | 0.326 |
| | (0.155) | (0.144) | (0.231) | (0.230) |
| Home x Policy Change | 0.045 | 0.047 | 0.100 | 0.071 |
| | (0.138) | (0.132) | (0.273) | (0.261) |
| Previous match events (red cards) | | | | -0.264 |
| | | | | (0.179) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 57638 | 57638 | 57638 | 57638 |
| R2 | 0.498 | 0.584 | 0.496 | 0.660 |
| R2 Adj. | 0.498 | 0.584 | 0.495 | 0.659 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In the placebo analysis, I overall find that loss frame substitutions are associated with a negative, but statistically insignificant effect on the final goal difference. This supports the notion that the main effect is not driven by spurious correlations in periods without an actual policy change.

## Appendix A.4.3: Yellow Cards

Table 20: First Stage Estimates for (2SLS-5) and (2SLS-6) for Yellow Cards

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.030*** | 0.000 | | |
| | (0.000) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | 0.000 | 0.060*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half | -0.088*** | 0.000+ | -0.088*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.047*** | -0.015*** | 0.047*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.085*** | 0.003 | -0.085*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.012*** | 0.042*** | 0.013*** | 0.042*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.002* | -0.001 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000 | 0.001*** | 0.000* |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002* | -0.002 | -0.003* | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 830.79 | 537.85 | 828.51 | 534.56 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.014 | 0.040 | 0.013 | 0.040 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 21: First Stage Estimates for (2SLS-7) and (2SLS-8) for Yellow Cards

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change | 0.061*** | -0.001 | 0.059*** | -0.001 |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half | -0.088*** | 0.000 | -0.087*** | 0.000* |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.047*** | -0.015*** | 0.047*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.085*** | 0.002 | -0.085*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.013*** | 0.042*** | 0.014*** | 0.042*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.001+ | -0.001+ |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.002*** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002* | -0.002+ | -0.003* | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | | 0.019*** | 0.002* |
| | | | (0.002) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 796.17 | 528.56 | 771.86 | 522 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.013 | 0.039 | 0.013 | 0.039 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 22: 2SLS Analysis of Substitutions for Yellow Cards (Placebo Test)

| | Final yellow cards | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | 2.307*** | | | |
| | (0.039) | | | |
| **Substitutions** | | | | |
| Substitution | -1.136*** | -1.244*** | 0.064 | -0.044 |
| | (0.315) | (0.293) | (0.218) | (0.208) |
| Substitution x Loss Frame | 0.418 | -0.327 | 0.393 | 0.178 |
| | (1.456) | (1.364) | (1.318) | (1.202) |
| **Control Variables** | | | | |
| Loss Frame | 0.053 | 0.112 | 0.028 | 0.108 |
| | (0.097) | (0.088) | (0.089) | (0.080) |
| Exact goal difference | -0.056*** | -0.022 | -0.053*** | -0.018 |
| | (0.015) | (0.016) | (0.014) | (0.015) |
| Exact goal difference x Loss Frame | 0.087 | 0.041 | 0.058 | 0.059 |
| | (0.059) | (0.053) | (0.054) | (0.050) |
| Home | -0.142** | -0.143** | -0.259*** | -0.276*** |
| | (0.051) | (0.051) | (0.054) | (0.051) |
| Home x Policy Change | 0.004 | -0.037 | 0.420*** | 0.428*** |
| | (0.082) | (0.078) | (0.096) | (0.092) |
| Previous match events (red cards) | | | | 0.050 |
| | | | | (0.095) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | -0.020 | 0.090 | 0.136 | 0.254 |
| R2 Adj. | -0.020 | 0.090 | 0.135 | 0.253 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## Appendix A.4.4: Alternative Test: Final Shots on Target

Table 23: First Stage Estimates for (2SLS-5) and (2SLS-6) for Final Shots on Target

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.030*** | 0.000 | | |
| | (0.000) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | 0.000 | 0.060*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half | -0.088*** | 0.000+ | -0.088*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.047*** | -0.015*** | 0.047*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.085*** | 0.003 | -0.085*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.012*** | 0.042*** | 0.013*** | 0.042*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.002* | -0.001 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000 | 0.001*** | 0.000* |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002* | -0.002 | -0.003* | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 830.79 | 537.85 | 828.51 | 534.56 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.014 | 0.040 | 0.013 | 0.040 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 24: First Stage Estimates for (2SLS-7) and (2SLS-8) for Final Shots on Target

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change | 0.061*** | -0.001 | 0.059*** | -0.001 |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half | -0.088*** | 0.000 | -0.087*** | 0.000* |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.047*** | -0.015*** | 0.047*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.085*** | 0.002 | -0.085*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Loss Frame** | | | | |
| Loss Frame | 0.013*** | 0.042*** | 0.014*** | 0.042*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.002*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.001+ | -0.001+ |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.002*** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002* | -0.002+ | -0.003* | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | | 0.019*** | 0.002* |
| | | | (0.002) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 796.17 | 528.56 | 771.86 | 522 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.013 | 0.039 | 0.013 | 0.039 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 25: 2SLS Productivity Analysis of Substitutions (Final Shots on Target)

| | Final shots on target | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | 4.273*** | | | |
| | (0.063) | | | |
| **Substitutions** | | | | |
| Substitution | -0.580 | -0.420 | -0.728 | 0.579 |
| | (0.566) | (0.498) | (0.446) | (0.374) |
| Substitution x Loss Frame | -5.908* | -3.683 | -5.675* | -4.075+ |
| | (2.910) | (2.497) | (2.630) | (2.250) |
| **Control Variables** | | | | |
| Loss Frame | 1.288*** | 0.752*** | 1.215*** | 0.432** |
| | (0.181) | (0.155) | (0.162) | (0.144) |
| Exact goal difference | 0.762*** | 0.563*** | 0.756*** | 0.404*** |
| | (0.029) | (0.029) | (0.029) | (0.029) |
| Exact goal difference x Loss Frame | -0.365** | -0.242* | -0.352** | -0.056 |
| | (0.120) | (0.111) | (0.111) | (0.096) |
| Home | 0.549*** | 0.666*** | 0.585*** | 0.742*** |
| | (0.099) | (0.091) | (0.105) | (0.093) |
| Home x Policy Change | -0.244 | -0.335* | -0.344+ | -0.338+ |
| | (0.152) | (0.137) | (0.199) | (0.176) |
| Previous match events (red cards) | | | | -0.800*** |
| | | | | (0.150) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.086 | 0.276 | 0.192 | 0.381 |
| R2 Adj. | 0.086 | 0.276 | 0.191 | 0.381 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## Appendix A.5: Difference-In-Differences Approach

### Appendix A.5.1: Catch-Up Matches

An exploratory DID analysis using a small sample of seven catch-up matches played under the new policy (see Table 29 for the exact matches played) showed an overall increase in substitution frequency.

Table 26: Number of Substitutions per Minute (Catch-Up Matches)

| | Number of Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Difference-In-Differences** | | | | |
| Treated | -0.003+ | -0.001 | -0.002 | -0.002 |
| | (0.002) | (0.001) | (0.002) | (0.002) |
| Treated x Post | 0.017*** | 0.012*** | 0.017*** | 0.017*** |
| | (0.002) | (0.003) | (0.002) | (0.003) |
| **Control Variables** | | | | |
| Exact goal difference | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | 0.034*** | | -0.005 |
| | | (0.006) | | (0.005) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 10600 | 10600 | 10600 | 10600 |
| R2 | 0.001 | 0.002 | 0.048 | 0.048 |
| R2 Adj. | -0.005 | -0.004 | 0.033 | 0.033 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 27: Number of Substitutions in Loss Frame per Minute

| | Number of Substitutions in Loss Frame per Minute (Catch-Up Matches) | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Difference-In-Differences** | | | | |
| Treated | -0.007** | -0.007** | -0.007** | -0.007** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Treated x Post | -0.004 | -0.004 | -0.004 | -0.003 |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| **Control Variables** | | | | |
| Exact goal difference | -0.003*** | -0.003*** | -0.003*** | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | 0.003 | | -0.003 |
| | | (0.004) | | (0.004) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 10600 | 10600 | 10600 | 10600 |
| R2 | 0.013 | 0.013 | 0.029 | 0.029 |
| R2 Adj. | 0.007 | 0.007 | 0.014 | 0.014 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 28: Fraction of Loss Frame per Minute (Catch-Up Matches)

| | Fraction of Loss Frame per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Difference-In-Differences** | | | | |
| Treated | -0.200** | -0.199** | -0.202** | -0.204*** |
| | (0.061) | (0.062) | (0.061) | (0.062) |
| Treated x Post | -0.080 | -0.084 | -0.080 | -0.074 |
| | (0.074) | (0.076) | (0.074) | (0.076) |
| **Control Variables** | | | | |
| Exact goal difference | -0.047*** | -0.047*** | -0.047*** | -0.048*** |
| | (0.012) | (0.012) | (0.012) | (0.012) |
| Previous match events (red cards) | | 0.025 | | -0.042 |
| | | (0.068) | | (0.070) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 10600 | 10600 | 10600 | 10600 |
| R2 | 0.353 | 0.354 | 0.387 | 0.388 |
| R2 Adj. | 0.349 | 0.350 | 0.378 | 0.378 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

However, contrary to the main OLS findings, fewer substitutions per minute were observed within loss frames in these specific rescheduled games, which also saw teams spending less time in a loss frame. Given the limited number of such matches (N=7) and their unique context, these particular results should be interpreted with caution and may reflect specific circumstances not generalizable to the broader sample.

Table 29: Data of Catch-Up Matches

| Hometeam | Awayteam | League | Matchday | DID Group |
|---|---|---|---|---|
| Augsburg | M'gladbach | Bundesliga | 24 | Control-Post |
| Bologna | Udinese | Serie A | 25 | Control-Post |
| Bournemouth | Chelsea | Premier League | 28 | Control-Post |
| Brescia | Napoli | Serie A | 25 | Control-Post |
| Brighton | Crystal Palace | Premier League | 28 | Control-Post |
| Dortmund | Freiburg | Bundesliga | 24 | Control-Post |
| Everton | Man United | Premier League | 28 | Control-Post |
| FC Koln | Schalke 04 | Bundesliga | 24 | Control-Post |
| Fiorentina | Milan | Serie A | 25 | Control-Post |
| Fortuna Dusseldorf | Hertha | Bundesliga | 24 | Control-Post |
| Genoa | Lazio | Serie A | 25 | Control-Post |
| Hoffenheim | Bayern Munich | Bundesliga | 24 | Control-Post |
| Mainz | Paderborn | Bundesliga | 24 | Control-Post |
| Newcastle | Burnley | Premier League | 28 | Control-Post |
| Norwich | Leicester | Premier League | 28 | Control-Post |
| RB Leipzig | Leverkusen | Bundesliga | 24 | Control-Post |
| Roma | Lecce | Serie A | 25 | Control-Post |
| Spal | Juventus | Serie A | 25 | Control-Post |
| Tottenham | Wolves | Premier League | 28 | Control-Post |
| Union Berlin | Wolfsburg | Bundesliga | 24 | Control-Post |
| Watford | Liverpool | Premier League | 28 | Control-Post |
| West Ham | Southampton | Premier League | 28 | Control-Post |
| Bayern Munich | Paderborn | Bundesliga | 23 | Control-Pre |
| Bologna | Genoa | Serie A | 24 | Control-Pre |
| Burnley | Bournemouth | Premier League | 27 | Control-Pre |
| Chelsea | Tottenham | Premier League | 27 | Control-Pre |
| Crystal Palace | Newcastle | Premier League | 27 | Control-Pre |
| Freiburg | Fortuna Dusseldorf | Bundesliga | 23 | Control-Pre |
| Hertha | FC Koln | Bundesliga | 23 | Control-Pre |
| Juventus | Brescia | Serie A | 24 | Control-Pre |
| Lecce | Spal | Serie A | 24 | Control-Pre |
| Leverkusen | Augsburg | Bundesliga | 23 | Control-Pre |
| Liverpool | West Ham | Premier League | 27 | Control-Pre |
| M'gladbach | Hoffenheim | Bundesliga | 23 | Control-Pre |
| Man United | Watford | Premier League | 27 | Control-Pre |
| Schalke 04 | RB Leipzig | Bundesliga | 23 | Control-Pre |
| Wolfsburg | Mainz | Bundesliga | 23 | Control-Pre |
| Wolves | Norwich | Premier League | 27 | Control-Pre |
| Aston Villa | Sheffield United | Premier League | 28 | Treated-Post |
| Atalanta | Sassuolo | Serie A | 25 | Treated-Post |
| Inter | Sampdoria | Serie A | 25 | Treated-Post |
| Man City | Arsenal | Premier League | 28 | Treated-Post |
| Torino | Parma | Serie A | 25 | Treated-Post |
| Verona | Cagliari | Serie A | 25 | Treated-Post |
| Werder Bremen | Ein Frankfurt | Bundesliga | 24 | Treated-Post |
| Arsenal | Everton | Premier League | 27 | Treated-Pre |
| Atalanta | Roma | Serie A | 24 | Treated-Pre |
| Cagliari | Napoli | Serie A | 24 | Treated-Pre |
| Ein Frankfurt | Union Berlin | Bundesliga | 23 | Treated-Pre |
| Lazio | Inter | Serie A | 24 | Treated-Pre |
| Leicester | Man City | Premier League | 27 | Treated-Pre |
| Milan | Torino | Serie A | 24 | Treated-Pre |
| Sampdoria | Fiorentina | Serie A | 24 | Treated-Pre |
| Sassuolo | Parma | Serie A | 24 | Treated-Pre |
| Sheffield United | Brighton | Premier League | 27 | Treated-Pre |
| Southampton | Aston Villa | Premier League | 27 | Treated-Pre |
| Udinese | Verona | Serie A | 24 | Treated-Pre |
| Werder Bremen | Dortmund | Bundesliga | 23 | Treated-Pre |

### Appendix A.5.2: Ghost Matches

Furthermore, a DID analysis of a small set of matches (N=8) played under "ghost game" conditions (i.e., without spectators) but still under the old three-substitution policy was conducted to explore whether the absence of crowd pressure alone might explain changes in substitution behavior (see Table 33 for the information on the exact matches; in the Serie A, the matchday used for the control-pre group was matchday 24 instead of matchday 25, as matchday 25 had several catch-up matches, see Table 29).

Table 30: Number of Substitutions per Minute (Ghost Matches)

| | Number of Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Difference-In-Differences** | | | | |
| Treated | 0.001 | -0.001 | 0.001 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Treated x Post | 0.001 | 0.003+ | 0.001 | 0.000 |
| | (0.001) | (0.002) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Exact goal difference | -0.002 | -0.001 | -0.002 | -0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | 0.028** | | -0.008 |
| | | (0.009) | | (0.009) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 10578 | 10578 | 10578 | 10578 |
| R2 | 0.000 | 0.001 | 0.048 | 0.048 |
| R2 Adj. | -0.006 | -0.005 | 0.033 | 0.033 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 31: Number of Substitutions in Loss Frame per Minute

| | Number of Substitutions in Loss Frame per Minute (Ghost Matches) | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Difference-In-Differences** | | | | |
| Treated | 0.010+ | 0.010+ | 0.010+ | 0.010+ |
| | (0.006) | (0.005) | (0.006) | (0.006) |
| Treated x Post | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Control Variables** | | | | |
| Exact goal difference | -0.004*** | -0.004*** | -0.004*** | -0.004*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | 0.002 | | -0.002 |
| | | (0.004) | | (0.004) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 10578 | 10578 | 10578 | 10578 |
| R2 | 0.010 | 0.010 | 0.032 | 0.032 |
| R2 Adj. | 0.005 | 0.004 | 0.017 | 0.017 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 32: Fraction of Loss Frame per Minute

| | Fraction of Loss Frame per Minute (Ghost Matches) | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Difference-In-Differences** | | | | |
| Treated | 0.193+ | 0.188 | 0.193 | 0.191+ |
| | (0.117) | (0.115) | (0.117) | (0.116) |
| Treated x Post | 0.005 | 0.012 | 0.006 | 0.008 |
| | (0.061) | (0.061) | (0.061) | (0.061) |
| **Control Variables** | | | | |
| Exact goal difference | -0.088*** | -0.086*** | -0.088*** | -0.087*** |
| | (0.019) | (0.018) | (0.019) | (0.018) |
| Previous match events (red cards) | | 0.079 | | 0.030 |
| | | (0.090) | | (0.093) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 10578 | 10578 | 10578 | 10578 |
| R2 | 0.337 | 0.339 | 0.365 | 0.365 |
| R2 Adj. | 0.333 | 0.335 | 0.355 | 0.356 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

The results from this exploratory DiD analysis show no overall statistically significant difference in the number of substitutions per minute (Table 30) or in substitutions per minute within loss frames (Table 31) attributable to the "ghost game" status. The fraction of time spent in a loss frame did not significantly change in these matches (Table 32). While the small sample size necessitates caution, these findings lend tentative support to the interpretation that the primary driver of the behavioral shifts observed in my main analysis is indeed the policy change, rather than solely the altered social dynamics of playing in empty stadiums.

Table 33: Data of Ghost Matches

| Hometeam | Awayteam | League | Matchday | DID Group |
|---|---|---|---|---|
| Ath Bilbao | Osasuna | La Liga | 24 | Control-Post |
| Barcelona | Getafe | La Liga | 24 | Control-Post |
| Bayern Munich | RB Leipzig | Bundesliga | 21 | Control-Post |
| Cagliari | Roma | Serie A | 26 | Control-Post |
| Ein Frankfurt | Augsburg | Bundesliga | 21 | Control-Post |
| Freiburg | Hoffenheim | Bundesliga | 21 | Control-Post |
| Granada | Valladolid | La Liga | 24 | Control-Post |
| Hertha | Mainz | Bundesliga | 21 | Control-Post |
| Lazio | Bologna | Serie A | 26 | Control-Post |
| Lecce | Atalanta | Serie A | 26 | Control-Post |
| Leganes | Betis | La Liga | 24 | Control-Post |
| Leverkusen | Dortmund | Bundesliga | 21 | Control-Post |
| Mallorca | Alaves | La Liga | 24 | Control-Post |
| Napoli | Torino | Serie A | 26 | Control-Post |
| Real Madrid | Celta | La Liga | 24 | Control-Post |
| Schalke 04 | Paderborn | Bundesliga | 21 | Control-Post |
| Sevilla | Espanol | La Liga | 24 | Control-Post |
| Valencia | Ath Madrid | La Liga | 24 | Control-Post |
| Villarreal | Levante | La Liga | 24 | Control-Post |
| Werder Bremen | Union Berlin | Bundesliga | 21 | Control-Post |
| Wolfsburg | Fortuna Dusseldorf | Bundesliga | 21 | Control-Post |
| Atalanta | Roma | Serie A | 24 | Control-Pre |
| Ath Madrid | Granada | La Liga | 23 | Control-Pre |
| Augsburg | Werder Bremen | Bundesliga | 20 | Control-Pre |
| Betis | Barcelona | La Liga | 23 | Control-Pre |
| Cagliari | Napoli | Serie A | 24 | Control-Pre |
| Celta | Sevilla | La Liga | 23 | Control-Pre |
| Dortmund | Union Berlin | Bundesliga | 20 | Control-Pre |
| Espanol | Mallorca | La Liga | 23 | Control-Pre |
| Fortuna Dusseldorf | Ein Frankfurt | Bundesliga | 20 | Control-Pre |
| Getafe | Valencia | La Liga | 23 | Control-Pre |
| Hertha | Schalke 04 | Bundesliga | 20 | Control-Pre |
| Hoffenheim | Leverkusen | Bundesliga | 20 | Control-Pre |
| Levante | Leganes | La Liga | 23 | Control-Pre |
| Mainz | Bayern Munich | Bundesliga | 20 | Control-Pre |
| Osasuna | Real Madrid | La Liga | 23 | Control-Pre |
| Paderborn | Wolfsburg | Bundesliga | 20 | Control-Pre |
| Valladolid | Villarreal | La Liga | 23 | Control-Pre |
| Eibar | Sociedad | La Liga | 24 | Treated-Post |
| Juventus | Inter | Serie A | 26 | Treated-Post |
| M'gladbach | FC Koln | Bundesliga | 21 | Treated-Post |
| Milan | Genoa | Serie A | 26 | Treated-Post |
| Parma | Spal | Serie A | 26 | Treated-Post |
| Sampdoria | Verona | Serie A | 26 | Treated-Post |
| Sassuolo | Brescia | Serie A | 26 | Treated-Post |
| Udinese | Fiorentina | Serie A | 26 | Treated-Post |
| Alaves | Eibar | La Liga | 23 | Treated-Pre |
| Bologna | Genoa | Serie A | 24 | Treated-Pre |
| FC Koln | Freiburg | Bundesliga | 20 | Treated-Pre |
| Juventus | Brescia | Serie A | 24 | Treated-Pre |
| Lazio | Inter | Serie A | 24 | Treated-Pre |
| Lecce | Spal | Serie A | 24 | Treated-Pre |
| Milan | Torino | Serie A | 24 | Treated-Pre |
| RB Leipzig | M'gladbach | Bundesliga | 20 | Treated-Pre |
| Sampdoria | Fiorentina | Serie A | 24 | Treated-Pre |
| Sassuolo | Parma | Serie A | 24 | Treated-Pre |
| Sociedad | Ath Bilbao | La Liga | 23 | Treated-Pre |
| Udinese | Verona | Serie A | 24 | Treated-Pre |

## Appendix A.6: Gain Frames

### Appendix A.6.1: Policy Impact on Substitution Behavior

Table 34: Number of substitutions per Minute

| | Number of Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.034*** | 0.032*** | -0.003* | -0.003* |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| Loss Frame x Policy Change | 0.020*** | 0.020*** | 0.017*** | 0.017*** |
| | (0.005) | (0.005) | (0.004) | (0.004) |
| **Gain Frame and Policy Change** | | | | |
| Gain Frame | 0.026*** | 0.025*** | -0.010*** | -0.010*** |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| Gain Frame x Policy Change | 0.014** | 0.014** | 0.011*** | 0.011*** |
| | (0.005) | (0.005) | (0.003) | (0.003) |
| **Control Variables** | | | | |
| Exact goal difference | 0.001 | 0.001* | 0.001 | 0.001 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.047*** | | 0.002 |
| | | (0.003) | | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.005 | 0.006 | 0.046 | 0.046 |
| R2 Adj. | -0.006 | -0.005 | 0.036 | 0.036 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

## Appendix A.6.2: Productivity Analysis

Table 35: OLS Productivity Analysis of Substitutions for Gain Frames

| | Final goal difference | | | |
|---|---|---|---|---|
| | (OLS-5) | (OLS-6) | (OLS-7) | (OLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.071* | | | |
| | (0.032) | | | |
| **Substitutions** | | | | |
| Substitution | -0.014* | -0.024*** | -0.016* | -0.025*** |
| | (0.007) | (0.007) | (0.007) | (0.006) |
| Substitution x Gain Frame | 0.177*** | 0.175*** | 0.177*** | 0.160*** |
| | (0.028) | (0.027) | (0.028) | (0.025) |
| **Control Variables** | | | | |
| Exact goal difference | 1.088*** | 0.984*** | 1.089*** | 0.860*** |
| | (0.017) | (0.017) | (0.017) | (0.021) |
| LossFrame x Exact goal difference | -0.111** | -0.017 | -0.119** | 0.060 |
| | (0.042) | (0.044) | (0.042) | (0.043) |
| Gain Frame | -0.290*** | -0.084+ | -0.293*** | 0.163** |
| | (0.053) | (0.050) | (0.054) | (0.051) |
| Home | 0.269*** | 0.316*** | 0.289*** | 0.383*** |
| | (0.062) | (0.060) | (0.069) | (0.067) |
| Home x Policy Change | -0.079 | -0.074 | -0.152 | -0.125 |
| | (0.066) | (0.065) | (0.131) | (0.124) |
| Previous match events (red cards) | | | | -0.393*** |
| | | | | (0.080) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.488 | 0.525 | 0.489 | 0.569 |
| R2 Adj. | 0.488 | 0.525 | 0.488 | 0.569 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 36: First Stage Estimates for (2SLS-5) and (2SLS-6) for Gain Frames

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Gain Frame | Substitution | Substitution x Gain Frame |
| **Intercept** | | | | |
| (Intercept) | 0.029*** | 0.000 | | |
| | (0.000) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.063*** | 0.000 | 0.063*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half | -0.089*** | 0.000 | -0.089*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Gain Frame | -0.019*** | 0.043*** | -0.019*** | 0.043*** |
| | (0.003) | (0.002) | (0.002) | (0.002) |
| Policy Change x First Half x Gain Frame | 0.008** | -0.082*** | 0.007** | -0.082*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| **Gain Frame** | | | | |
| Gain Frame | 0.008*** | 0.038*** | 0.009*** | 0.038*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | 0.001*** | 0.000 | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | -0.001 | 0.001 | -0.001+ | 0.001 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | -0.001*** | 0.000 | -0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Gain Frame | 0.005*** | 0.004** | 0.005*** | 0.004** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 841.01 | 564.75 | 837.6 | 561.39 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.042 | 0.014 | 0.042 |
| R2 Adj. | 0.014 | 0.042 | 0.013 | 0.041 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 37: First Stage Estimates for (2SLS-7) and (2SLS-8) for Gain Frames

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Gain Frame | Substitution | Substitution x Gain Frame |
| **Policy Change** | | | | |
| Policy Change | 0.063*** | -0.001 | 0.061*** | -0.001 |
| | (0.003) | (0.001) | (0.003) | (0.001) |
| Policy Change x First Half | -0.089*** | 0.000 | -0.088*** | 0.000*** |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x Gain Frame | -0.020*** | 0.043*** | -0.019*** | 0.043*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Policy Change x First Half x Gain Frame | 0.008** | -0.082*** | 0.007* | -0.082*** |
| | (0.003) | (0.002) | (0.003) | (0.002) |
| **Gain Frame** | | | | |
| Gain Frame | 0.008*** | 0.038*** | 0.009*** | 0.038*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | 0.001*** | 0.000 | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | -0.001 | 0.001 | -0.001* | 0.001 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference | -0.001*** | 0.000 | -0.001*** | 0.000+ |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Gain Frame | 0.005*** | 0.004** | 0.005*** | 0.004** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Previous match events (red cards) | | | 0.019*** | 0.004*** |
| | | | (0.002) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 805.64 | 554.74 | 781.93 | 546.45 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.042 | 0.014 | 0.042 |
| R2 Adj. | 0.013 | 0.041 | 0.013 | 0.041 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 38: 2SLS Productivity Analysis of Substitutions for Gain Frames

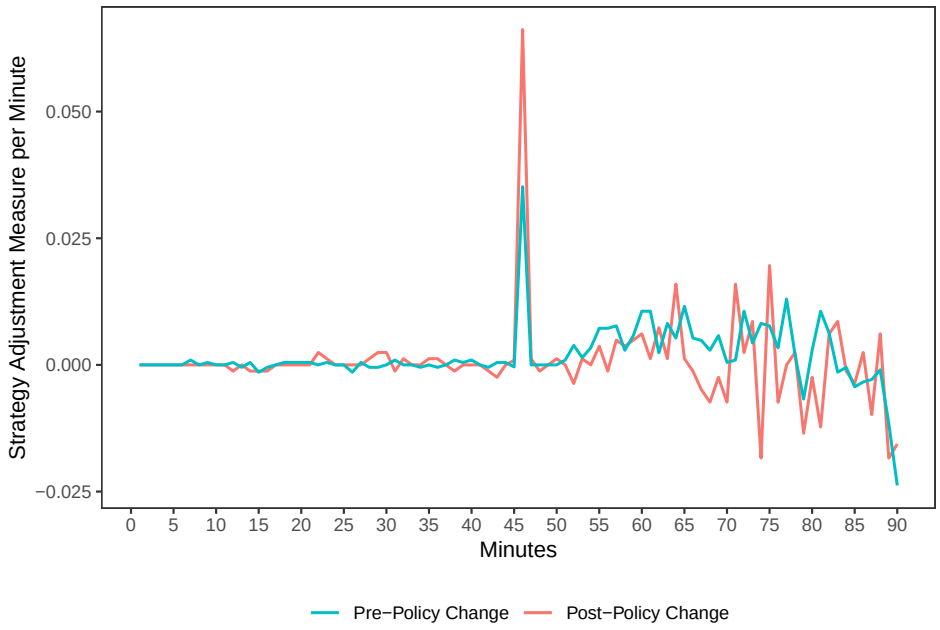
| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.074* | | | |
| | (0.032) | | | |
| **Substitutions** | | | | |
| Substitution | 0.071 | -0.250 | -0.086 | -0.458** |
| | (0.243) | (0.238) | (0.158) | (0.165) |
| Substitution x Gain Frame | 4.246*** | 4.250*** | 4.169*** | 3.413** |
| | (1.237) | (1.247) | (1.252) | (1.167) |
| **Control Variables** | | | | |
| Gain Frame | -0.466*** | -0.257** | -0.465*** | 0.027 |
| | (0.083) | (0.080) | (0.084) | (0.076) |
| Exact goal difference | 1.088*** | 0.984*** | 1.089*** | 0.860*** |
| | (0.017) | (0.017) | (0.017) | (0.021) |
| Exact goal difference x Gain Frame | -0.127** | -0.030 | -0.133** | 0.050 |
| | (0.042) | (0.044) | (0.042) | (0.044) |
| Home | 0.271*** | 0.317*** | 0.288*** | 0.382*** |
| | (0.062) | (0.059) | (0.069) | (0.067) |
| Home x Policy Change | -0.089 | -0.079 | -0.149 | -0.122 |
| | (0.069) | (0.067) | (0.130) | (0.124) |
| Previous match events (red cards) | | | | -0.396*** |
| | | | | (0.081) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.454 | 0.495 | 0.458 | 0.552 |
| R2 Adj. | 0.454 | 0.495 | 0.457 | 0.551 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

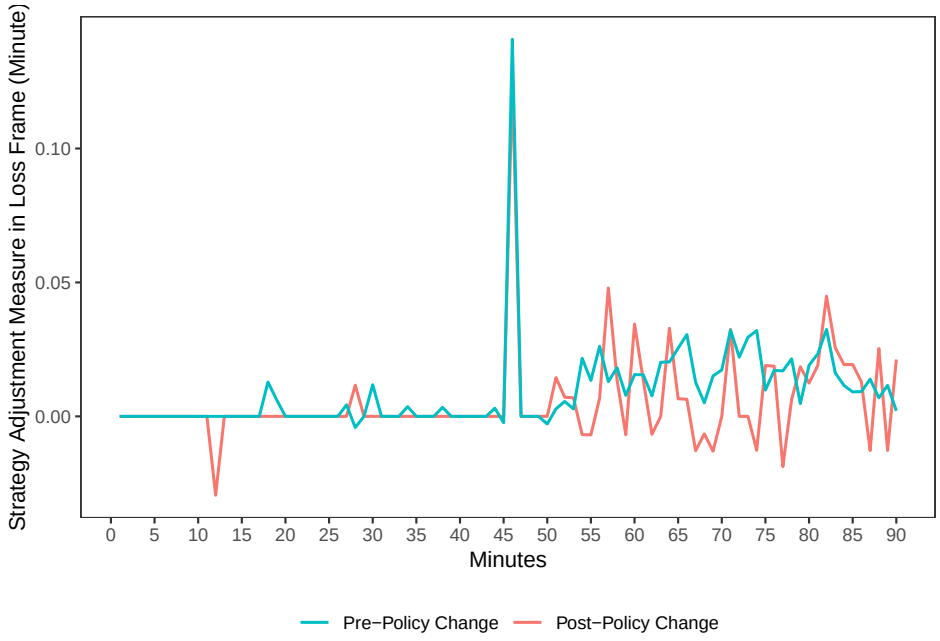
Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## Appendix A.7: Strategy Adjustment Measure




**(a)** Overall




**(b)** In Loss Frames

Figure 8: Dynamics of Strategy Adjustment Measure during the Match

Table 39: Strategy Adjustment Measure per Minute

| | Strategy Adjustment Measure per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.011*** | 0.012*** | 0.011*** | 0.012*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Loss Frame x Policy Change | -0.008* | -0.008* | -0.008* | -0.008* |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| **Control Variables** | | | | |
| Exact goal difference | -0.006*** | -0.006*** | -0.006*** | -0.007*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | -0.022*** | | -0.021*** |
| | | (0.003) | | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.013 | 0.013 | 0.015 | 0.016 |
| R2 Adj. | 0.002 | 0.002 | 0.004 | 0.004 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

# Appendix B: Mechanism Analysis: The Role of Psychological Pressure

## Appendix B.1: Expectation Pressure: The Paradox of Strong Favorites

### Appendix B.1.1: Loss Frame

Table 40: First Stage Estimates for (2SLS-5) and (2SLS-6) by Clear Favorites

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.031*** | 0.000 | | |
| | (0.000) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | 0.000 | 0.060*** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half | -0.089*** | 0.000 | -0.089*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame | -0.011** | 0.051*** | -0.012** | 0.050*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| Policy Change x First Half x Loss Frame | 0.001 | -0.088*** | 0.002 | -0.088*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| **Loss Frame** | | | | |
| Loss Frame | 0.009*** | 0.039*** | 0.010*** | 0.039*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | 0.000 | 0.002* | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Exact goal difference | 0.001** | 0.000 | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002 | -0.001 | -0.002 | -0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 424.42 | 279.95 | 423.01 | 275.61 |
| **Characteristics** | | | | |
| Num.Obs. | 134266 | 134266 | 134266 | 134266 |
| R2 | 0.013 | 0.038 | 0.014 | 0.038 |
| R2 Adj. | 0.013 | 0.038 | 0.013 | 0.038 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 41: First Stage Estimates for (SLS-7) and (2SLS-8) by Clear Favorites

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change | 0.065*** | -0.002 | 0.062*** | -0.003 |
| | (0.003) | (0.002) | (0.003) | (0.003) |
| Policy Change x First Half | -0.089*** | 0.000 | -0.088*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame | -0.012** | 0.050*** | -0.012** | 0.050*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| Policy Change x First Half x Loss Frame | 0.000 | -0.088*** | 0.001 | -0.087*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| **Loss Frame** | | | | |
| Loss Frame | 0.009*** | 0.039*** | 0.012*** | 0.039*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.001** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | 0.001 | 0.002+ | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Exact goal difference | 0.001** | 0.000 | 0.001*** | 0.000+ |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.002 | -0.001 | -0.002 | -0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Previous match events (red cards) | | | 0.021*** | 0.003+ |
| | | | (0.003) | (0.002) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 407.66 | 273.75 | 393.58 | 265.55 |
| **Characteristics** | | | | |
| Num.Obs. | 134266 | 134266 | 134266 | 134266 |
| R2 | 0.014 | 0.039 | 0.014 | 0.039 |
| R2 Adj. | 0.012 | 0.037 | 0.012 | 0.037 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 42: 2SLS Productivity Analysis of Substitutions by Clear Favorites

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.275*** | | | |
| | (0.045) | | | |
| **Substitutions** | | | | |
| Substitution | 0.400 | 0.533+ | 0.219 | 1.026*** |
| | (0.321) | (0.300) | (0.208) | (0.217) |
| Substitution x Loss Frame | -7.194*** | -6.517*** | -7.470*** | -6.780*** |
| | (2.005) | (1.963) | (2.047) | (1.924) |
| **Control Variables** | | | | |
| Loss Frame | 0.885*** | 0.383** | 0.925*** | 0.073 |
| | (0.129) | (0.117) | (0.133) | (0.118) |
| Exact goal difference | 1.128*** | 0.938*** | 1.130*** | 0.795*** |
| | (0.020) | (0.022) | (0.020) | (0.028) |
| Exact goal difference x Loss Frame | -0.115 | 0.025 | -0.123 | 0.167* |
| | (0.073) | (0.071) | (0.075) | (0.069) |
| Home | 0.374*** | 0.330*** | 0.386*** | 0.317** |
| | (0.093) | (0.088) | (0.103) | (0.101) |
| Home x Policy Change | -0.012 | -0.012 | -0.074 | -0.019 |
| | (0.104) | (0.101) | (0.194) | (0.188) |
| Previous match events (red cards) | | | | -0.420*** |
| | | | | (0.119) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 134266 | 134266 | 134266 | 134266 |
| R2 | 0.465 | 0.542 | 0.457 | 0.587 |
| R2 Adj. | 0.465 | 0.542 | 0.457 | 0.586 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 43: First Stage Estimates for (2SLS-5) and (2SLS-6) by Close Favorites

| | (2SLS-5) | | (2SLS-6) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Intercept** | | | | |
| (Intercept) | 0.029*** | 0.000 | | |
| | (0.001) | (0.000) | | |
| **Policy Change** | | | | |
| Policy Change | 0.059*** | 0.001 | 0.058*** | 0.001 |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Policy Change x First Half | -0.085*** | 0.000 | -0.085*** | 0.000 |
| | (0.003) | (0.000) | (0.003) | (0.000) |
| Policy Change x Loss Frame | -0.017** | 0.043*** | -0.018** | 0.041*** |
| | (0.006) | (0.005) | (0.006) | (0.005) |
| Policy Change x First Half x Loss Frame | 0.004 | -0.082*** | 0.003 | -0.082*** |
| | (0.007) | (0.006) | (0.007) | (0.006) |
| **Loss Frame** | | | | |
| Loss Frame | 0.014*** | 0.042*** | 0.015*** | 0.042*** |
| | (0.002) | (0.002) | (0.003) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.001 | 0.000 | -0.002* | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Home x Policy Change | 0.000 | -0.002 | 0.002 | -0.001 |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Exact goal difference | 0.001+ | 0.000 | 0.002* | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference x Loss Frame | -0.005* | -0.004* | -0.006** | -0.005* |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 141.16 | 92.78 | 138.85 | 89.92 |
| **Characteristics** | | | | |
| Num.Obs. | 51836 | 51836 | 51836 | 51836 |
| R2 | 0.012 | 0.039 | 0.013 | 0.039 |
| R2 Adj. | 0.012 | 0.039 | 0.011 | 0.038 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 44: First Stage Estimates for (2SLS-7) and (2SLS-8) by Close Favorites

| | (2SLS-7) | | (2SLS-8) | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution | Substitution x Loss Frame |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | 0.001 | 0.075*** | 0.006* |
| | (0.001) | (0.003) | (0.005) | (0.003) |
| Policy Change x First Half | -0.085*** | 0.000 | -0.083*** | 0.000 |
| | (0.003) | (0.000) | (0.003) | (0.000) |
| Policy Change x Loss Frame | -0.017** | 0.042*** | -0.018** | 0.040*** |
| | (0.006) | (0.005) | (0.007) | (0.005) |
| Policy Change x First Half x Loss Frame | 0.004 | -0.081*** | 0.000 | -0.082*** |
| | (0.007) | (0.006) | (0.007) | (0.006) |
| **Loss Frame** | | | | |
| Loss Frame | 0.015*** | 0.043*** | 0.018*** | 0.043*** |
| | (0.003) | (0.002) | (0.003) | (0.003) |
| **Control Variables** | | | | |
| Home | -0.001 | 0.000 | -0.006*** | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Home x Policy Change | 0.000 | -0.002 | 0.004* | -0.001 |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Exact goal difference | 0.002* | 0.000+ | 0.003*** | 0.001** |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Exact goal difference x Loss Frame | -0.007** | -0.005* | -0.009** | -0.006** |
| | (0.002) | (0.002) | (0.003) | (0.002) |
| Previous match events (red cards) | | | 0.033*** | 0.005* |
| | | | (0.004) | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 133.88 | 88.29 | 127.57 | 84.56 |
| **Characteristics** | | | | |
| Num.Obs. | 51836 | 51836 | 51836 | 51836 |
| R2 | 0.013 | 0.040 | 0.014 | 0.040 |
| R2 Adj. | 0.010 | 0.037 | 0.008 | 0.035 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 45: 2SLS Productivity Analysis of Substitutions by Close Favorites

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | 0.051 | | | |
| | (0.062) | | | |
| **Substitutions** | | | | |
| Substitution | 0.251 | 0.095 | 0.056 | 0.184 |
| | (0.558) | (0.537) | (0.443) | (0.448) |
| Substitution x Loss Frame | 0.370 | 1.074 | 0.312 | 0.913 |
| | (2.176) | (2.102) | (2.237) | (1.914) |
| **Control Variables** | | | | |
| Loss Frame | -0.046 | -0.058 | -0.043 | -0.107 |
| | (0.154) | (0.148) | (0.165) | (0.144) |
| Exact goal difference | 0.888*** | 0.846*** | 0.886*** | 0.753*** |
| | (0.047) | (0.044) | (0.049) | (0.049) |
| Exact goal difference x Loss Frame | 0.035 | 0.039 | 0.040 | 0.106 |
| | (0.069) | (0.073) | (0.086) | (0.087) |
| Home | -0.079 | -0.027 | -0.060 | 0.521** |
| | (0.120) | (0.116) | (0.133) | (0.184) |
| Home x Policy Change | -0.081 | -0.114 | -0.153 | -0.597* |
| | (0.142) | (0.135) | (0.271) | (0.271) |
| Previous match events (red cards) | | | | -0.308* |
| | | | | (0.134) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 51836 | 51836 | 51836 | 51836 |
| R2 | 0.400 | 0.462 | 0.403 | 0.534 |
| R2 Adj. | 0.400 | 0.461 | 0.401 | 0.531 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

### Appendix B.1.2: Gain Frame

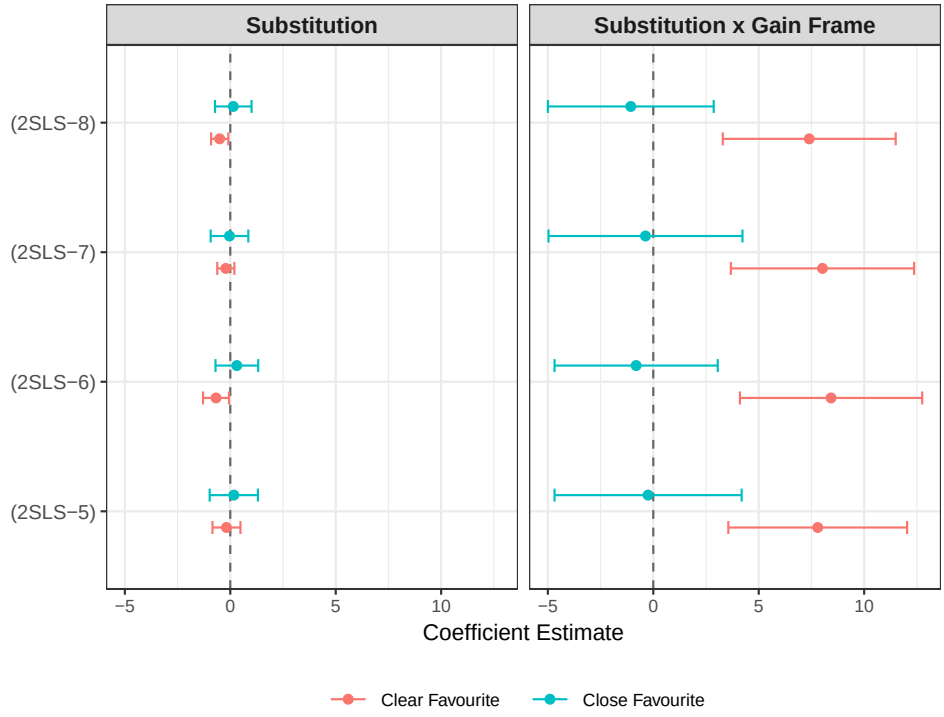



Figure 9: Mechanism Analysis by Favourite Status for Gain Frames

*Note: Coefficient estimates with 95% confidence intervals for substitution effects.*

## Appendix B.2: Behavioral Response: Evidence for Action Bias

### Appendix B.2.1: Offensive Substitutions

Table 46: Number of Offensive Substitutions per Minute

| | Number of Offensive Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.012*** | 0.012*** | 0.004*** | 0.004*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Policy Change | 0.000 | 0.000 | -0.001 | -0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Exact goal difference | -0.002*** | -0.002*** | -0.003*** | -0.003*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.006*** | | -0.003* |
| | | (0.001) | | (0.002) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.011 | 0.011 | 0.023 | 0.023 |
| R2 Adj. | 0.000 | 0.000 | 0.012 | 0.012 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

## Appendix B.2.2: Neutral Substitutions

Table 47: Number of Neutral Substitutions per Minute

| | Number of Neutral Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.021*** | 0.020*** | -0.002+ | -0.002+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Policy Change | 0.014*** | 0.014*** | 0.013*** | 0.013*** |
| | (0.004) | (0.004) | (0.003) | (0.003) |
| **Control Variables** | | | | |
| Exact goal difference | 0.004*** | 0.004*** | 0.001*** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.020*** | | -0.007** |
| | | (0.003) | | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.007 | 0.007 | 0.033 | 0.033 |
| R2 Adj. | -0.004 | -0.004 | 0.022 | 0.022 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

## Appendix B.2.3: Defensive Substitutions

Table 48: Number of Defensive Substitutions per Minute

| | Number of Defensive Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.003** | 0.002* | -0.005*** | -0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Policy Change | 0.006*** | 0.006*** | 0.005*** | 0.005*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Exact goal difference | 0.002*** | 0.003*** | 0.002*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.022*** | | 0.012*** |
| | | (0.002) | | (0.002) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.009 | 0.011 | 0.022 | 0.022 |
| R2 Adj. | -0.002 | 0.000 | 0.010 | 0.011 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

## Appendix B.3: Coping with Pressure: The Role of Managerial Experience and Style

### Appendix B.3.1: Managerial Experience

To explore whether coaching experience, proxied by age, moderates the behavioral response to being in a loss frame, I categorize the 137 unique coaches in my sample based on the age distribution.

My analysis focuses on comparing coaches at the distinct ends of the age spectrum observed during the 2019/20 season. "Senior Coaches" are defined as those born before 1965, representing 20.4% (N=28) of the most senior unique coaches in the sample. "Young Coaches" are defined as those born after 1974, constituting 32.1% (N=44) of the most junior unique coaches.

Table 49 lists the coaches within the data set and the respective birth dates.

Table 49: Coach Birthdays

| Coach | Birthday | Coach | Birthday | Coach | Birthday | Coach | Birthday |
|---|---|---|---|---|---|---|---|
| A. Covic | 1975-08-31 | Abelardo | 1970-03-19 | Aguirre | 1958-12-01 | Alkiza | 1970-10-26 |
| Ancelotti | 1959-06-10 | Andreazzoli | 1953-11-15 | Arrasate | 1978-04-22 | Arteta | 1982-03-26 |
| Asier Garitano | 1969-12-06 | Azkargorta | 1953-09-26 | Baumgart | 1972-01-05 | Beierlorzer | 1967-11-20 |
| Benetti | 1981-02-27 | Bordalas | 1964-03-05 | Bosz | 1963-11-21 | Bruce | 1960-12-31 |
| Burgos | 1969-04-16 | Calleja | 1978-05-12 | Carillo | 1965-05-24 | Celades | 1975-09-29 |
| Conte | 1969-07-31 | Coppola | 1982-05-11 | Corini | 1970-07-30 | Di Biagio | 1971-06-03 |
| Dyche | 1971-06-28 | Emery | 1971-11-03 | Espinola | 1981-05-03 | Farke | 1976-10-30 |
| Farris | 1971-02-24 | Favre | 1957-11-02 | Ferguson | 1971-12-27 | Fischer | 1966-02-20 |
| Flick | 1965-02-24 | Fran Escriba | 1965-05-03 | Frustalupi | 1971-01-12 | Funkel | 1953-12-10 |
| Gallego | 1972-01-26 | Garcia | 1973-04-26 | Garitano | 1975-07-09 | Gasperini | 1958-01-26 |
| Gattuso | 1978-01-09 | Giampaolo | 1967-08-02 | Gisdol | 1969-08-17 | Glasner | 1974-08-28 |
| Gotti | 1967-09-13 | Gritti | 1958-10-26 | Grosso | 1977-11-28 | Guardiola | 1971-01-18 |
| Hasenhüttl | 1967-08-09 | Herrlich | 1971-12-03 | Hodgson | 1947-08-09 | Hoffmann | 1972-06-29 |
| Howe | 1977-11-29 | Hütter | 1970-02-11 | Iachini | 1964-05-07 | Imanol Alguacil | 1971-07-04 |
| Inzaghi | 1976-04-05 | Javi Gracia | 1970-05-01 | Juric | 1975-08-25 | Kaltenbach | 1985-06-02 |
| Klinsmann | 1964-07-30 | Klopp | 1967-06-16 | Kohfeldt | 1982-10-05 | Kovac | 1971-10-15 |
| Labbadia | 1966-02-08 | Lampard | 1978-06-20 | Lichte | 1980-01-12 | Liverani | 1976-04-29 |
| Ljungberg | 1977-04-16 | Longo | 1976-02-14 | Lopetegui | 1966-08-28 | Lopez | 1974-08-22 |
| Luis Cembranos | 1972-06-06 | Machin | 1975-04-07 | Maran | 1963-07-14 | Marcelino | 1965-08-14 |
| Marco Silva | 1977-07-12 | Martinez | 1980-12-16 | Martusciello | 1971-08-19 | Mazzarri | 1961-10-01 |
| Mendilibar | 1961-03-14 | Mihajlovic | 1969-02-20 | Montella | 1974-06-18 | Moreno | 1977-09-19 |
| Motta | 1982-08-28 | Mourinho | 1963-01-26 | Moyes | 1963-04-25 | Mullins | 1979-03-27 |
| Muniz | 1968-03-14 | Mutarelli | 1978-01-13 | Nagelsmann | 1987-07-23 | Nicola | 1973-03-05 |
| Nouri | 1979-08-20 | Nuno Espirito Santo | 1974-01-25 | Paco Lopez | 1967-09-19 | Paro | 1983-03-17 |
| Paulo Fonseca | 1973-03-05 | Pearson | 1963-08-21 | Pellegrini | 1953-09-16 | Pellegrino | 1971-10-05 |
| Pioli | 1965-10-20 | Pochettino | 1972-03-02 | Potter | 1975-05-20 | Quique Alvarez | 1975-07-20 |
| Quique Flores | 1965-02-05 | Quique Setien | 1958-09-27 | Ranieri | 1951-10-20 | Rodgers | 1973-01-26 |
| Rose | 1976-09-11 | Rubi | 1970-02-13 | Rufete | 1976-11-20 | Rösler | 1968-11-15 |
| Sanz | 1978-03-09 | Sarri | 1959-01-10 | Schmidt | 1967-04-10 | Schreuder | 1972-11-02 |
| Schwarz | 1978-10-17 | Semplici | 1967-07-18 | Sergio | 1976-11-10 | Simeone | 1970-04-28 |
| Smith | 1971-03-19 | Solskjaer | 1973-02-26 | Streich | 1965-06-11 | Tanjga | 1964-01-22 |
| Trujillo | 1965-10-30 | Tudor | 1978-04-16 | Valverde | 1964-02-09 | Voro | 1963-10-09 |
| Wagner | 1971-10-19 | Wilder | 1967-09-23 | Zellner | 1977-09-11 | Zenga | 1960-04-28 |
| Zidane | 1972-06-23 | d'Aversa | 1975-08-12 | de Leo | 1978-07-05 | de Zerbi | 1979-06-06 |
| di Francesco | 1969-09-08 | | | | | | |

*Note:*
N=137

Figure 10 presents the histogram of coaches' birth years.

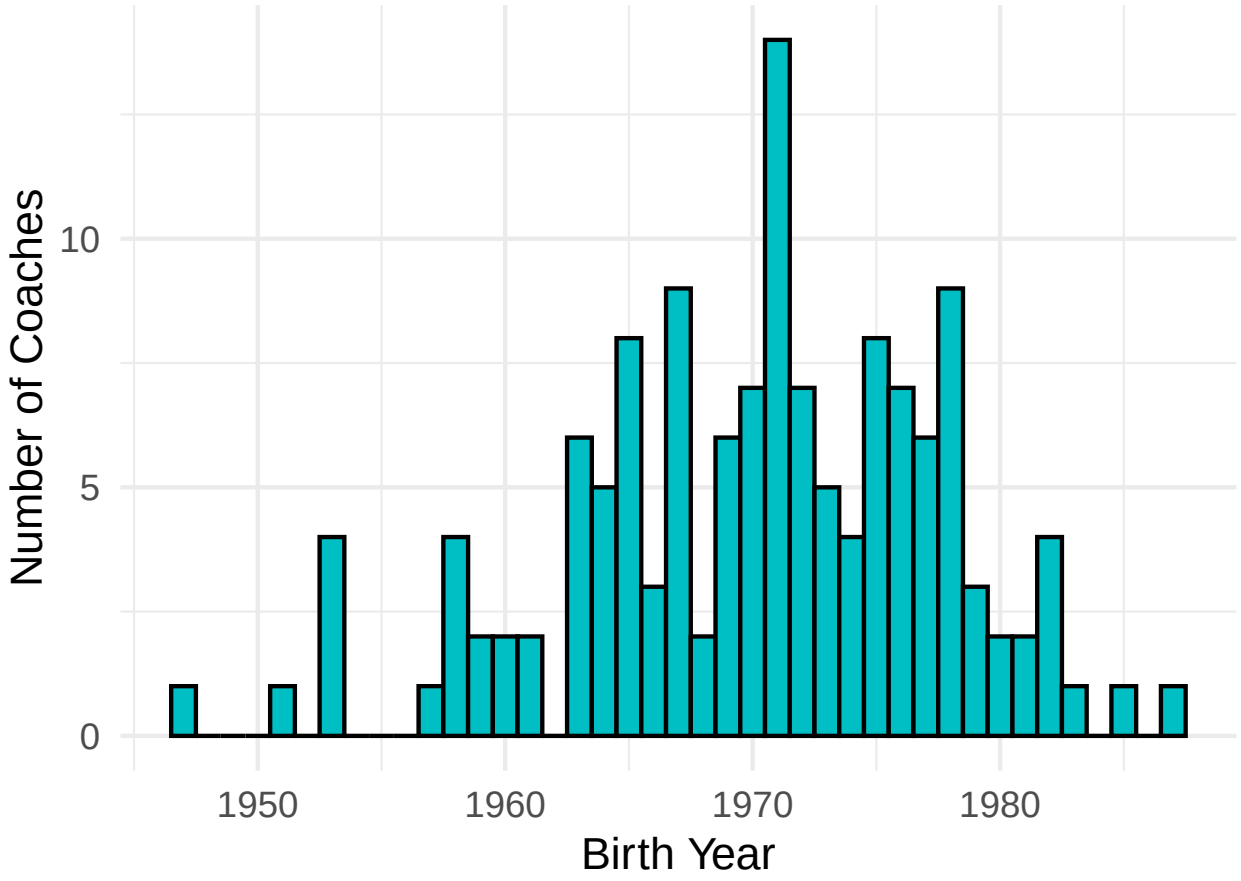



Figure 10: Histogram of Coaches' Birth Years

Table 50: Number of Substitutions per Minute by Senior Coaches

| | Number of Substitutions per Minute | | | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-3) | (OLS-4) |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.038*** | 0.036*** | -0.003+ | -0.003+ |
| | (0.003) | (0.003) | (0.002) | (0.002) |
| Loss Frame x Policy Change | 0.020** | 0.020** | 0.018*** | 0.018*** |
| | (0.007) | (0.007) | (0.004) | (0.004) |
| Loss Frame x Senior Coach | -0.002 | -0.002 | 0.000 | 0.000 |
| | (0.004) | (0.004) | (0.003) | (0.003) |
| Loss Frame x Policy Change x Senior Coach | 0.001 | 0.001 | -0.003 | -0.003 |
| | (0.010) | (0.010) | (0.007) | (0.007) |
| **Control Variables** | | | | |
| Exact goal difference | 0.004*** | 0.004*** | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.049*** | | 0.001 |
| | | (0.003) | | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.004 | 0.005 | 0.046 | 0.046 |
| R2 Adj. | -0.007 | -0.006 | 0.035 | 0.035 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 51: First stage estimates for (2SLS-5) by Senior Coaches

| | (2SLS-5) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Senior Coach | Substitution x Loss Frame x Senior Coach |
| **Intercept** | | | | |
| (Intercept) | 0.030*** | 0.000 | 0.000** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| **Policy Change** | | | | |
| Policy Change | 0.062*** | 0.000 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x First Half | -0.089*** | 0.000 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.013*** | 0.050*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x Senior Coach | -0.004* | 0.000 | 0.059*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.001 | -0.089*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Senior Coach | 0.003+ | 0.000 | -0.086*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Senior Coach | -0.003 | -0.007 | -0.016*** | 0.043*** |
| | (0.006) | (0.005) | (0.004) | (0.004) |
| Policy Change x First Half x Loss Frame x Senior Coach | 0.005 | 0.008 | 0.006 | -0.080*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| **Loss Frame and Senior Coach** | | | | |
| Senior Coach | 0.000 | 0.000 | 0.030*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Loss Frame | 0.012*** | 0.041*** | -0.001 | -0.001+ |
| | (0.002) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Senior Coach | 0.000 | 0.000 | 0.013*** | 0.043*** |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.001*** | 0.000 | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003* | -0.002+ | -0.002** | -0.001+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | | |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 415.81 | 270.01 | 402.71 | 267.16 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.030 | 0.043 |
| R2 Adj. | 0.014 | 0.040 | 0.030 | 0.043 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 52: First stage estimates for (2SLS-6) by Senior Coaches

| | (2SLS-6) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Senior Coach | Substitution x Loss Frame x Senior Coach |
| **Policy Change** | | | | |
| Policy Change | 0.062*** | 0.000 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x First Half | -0.089*** | 0.000 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.014*** | 0.049*** | 0.000 | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x Senior Coach | -0.004* | 0.000 | 0.059*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.001 | -0.089*** | 0.000 | 0.000+ |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Senior Coach | 0.004+ | 0.000 | -0.086*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Senior Coach | -0.003 | -0.006 | -0.016*** | 0.043*** |
| | (0.006) | (0.005) | (0.004) | (0.004) |
| Policy Change x First Half x Loss Frame x Senior Coach | 0.005 | 0.009 | 0.005 | -0.080*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| **Loss Frame and Senior Coach** | | | | |
| Senior Coach | 0.000 | 0.000 | 0.030*** | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Loss Frame | 0.013*** | 0.042*** | -0.001 | -0.001+ |
| | (0.002) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Senior Coach | 0.000 | 0.000 | 0.013*** | 0.043*** |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.001*** | 0.000* | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003* | -0.002+ | -0.002** | -0.001+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 414.65 | 268.27 | 400.27 | 264.84 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.030 | 0.043 |
| R2 Adj. | 0.013 | 0.040 | 0.030 | 0.043 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 53: First stage estimates for (2SLS-7) by Senior Coaches

| | (2SLS-7) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Senior Coach | Substitution x Loss Frame x Senior Coach |
| **Policy Change** | | | | |
| Policy Change | 0.062*** | -0.001 | 0.001 | 0.000 |
| | (0.003) | (0.002) | (0.001) | (0.000) |
| Policy Change x First Half | -0.089*** | 0.000 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.014*** | 0.049*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x Senior Coach | -0.004* | 0.000 | 0.059*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.000 | -0.089*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Senior Coach | 0.003+ | 0.000 | -0.086*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Senior Coach | -0.002 | -0.006 | -0.016*** | 0.043*** |
| | (0.006) | (0.005) | (0.004) | (0.004) |
| Policy Change x First Half x Loss Frame x Senior Coach | 0.005 | 0.008 | 0.006 | -0.080*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| **Loss Frame and Senior Coach** | | | | |
| Senior Coach | 0.001+ | 0.000 | 0.030*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Loss Frame | 0.013*** | 0.042*** | -0.001+ | -0.001+ |
| | (0.002) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Senior Coach | -0.001 | 0.000 | 0.014*** | 0.043*** |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003* | -0.002+ | -0.002** | -0.001+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | | |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 398.46 | 265.25 | 396.6 | 264.59 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.030 | 0.043 |
| R2 Adj. | 0.013 | 0.039 | 0.030 | 0.042 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 54: First stage estimates for (2SLS-8) by Senior Coaches

| | (2SLS-8) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Senior Coach | Substitution x Loss Frame x Senior Coach |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | -0.001 | 0.000 | 0.000 |
| | (0.003) | (0.002) | (0.001) | (0.001) |
| Policy Change x First Half | -0.088*** | 0.000* | 0.000*** | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.013*** | 0.049*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x Senior Coach | -0.004* | 0.000 | 0.059*** | 0.000 |
| | (0.002) | (0.000) | (0.001) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.000 | -0.089*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Senior Coach | 0.004+ | 0.000 | -0.086*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Senior Coach | -0.003 | -0.006 | -0.016*** | 0.043*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| Policy Change x First Half x Loss Frame x Senior Coach | 0.005 | 0.009 | 0.005 | -0.080*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| **Loss Frame and Senior Coach** | | | | |
| Senior Coach | 0.001 | 0.000 | 0.030*** | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Loss Frame | 0.014*** | 0.042*** | 0.000 | -0.001+ |
| | (0.002) | (0.001) | (0.001) | (0.001) |
| Loss Frame x Senior Coach | -0.001 | 0.000 | 0.014*** | 0.043*** |
| | (0.002) | (0.002) | (0.002) | (0.001) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | -0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.001+ | -0.001+ | 0.000 | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.002*** | 0.000*** | 0.001*** | 0.000* |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003** | -0.002+ | -0.002** | -0.001+ |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | x | x | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 386.3 | 261.93 | 389.57 | 261.11 |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.014 | 0.040 | 0.031 | 0.043 |
| R2 Adj. | 0.013 | 0.039 | 0.029 | 0.042 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 55: 2SLS Productivity Analysis of Substitutions by Senior Coaches

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.232*** | | | |
| | (0.038) | | | |
| **Substitutions** | | | | |
| Substitution | 0.794* | 1.050** | 0.586+ | 1.290*** |
| | (0.358) | (0.350) | (0.330) | (0.305) |
| Substitution x Loss Frame | -4.649** | -4.170** | -4.857*** | -4.164** |
| | (1.413) | (1.399) | (1.425) | (1.386) |
| Substitution x Senior Coach | -1.370+ | -1.600* | -1.387+ | -1.081 |
| | (0.798) | (0.765) | (0.802) | (0.724) |
| Substitution x Loss Frame x Senior Coach | 2.186 | 2.238 | 2.233 | 1.721 |
| | (2.392) | (2.250) | (2.417) | (2.186) |
| **Loss Frame and Age** | | | | |
| Loss Frame | 0.490*** | 0.279** | 0.510*** | 0.018 |
| | (0.106) | (0.101) | (0.108) | (0.101) |
| Loss Frame x Senior Coach | -0.085 | -0.093 | -0.092 | -0.071 |
| | (0.167) | (0.158) | (0.171) | (0.156) |
| Senior Coach | 0.126* | 0.265** | 0.129* | 0.282** |
| | (0.063) | (0.098) | (0.064) | (0.096) |
| **Goal Difference** | | | | |
| Exact goal difference | 1.088*** | 0.991*** | 1.089*** | 0.860*** |
| | (0.017) | (0.017) | (0.018) | (0.021) |
| Exact goal difference x Loss Frame | -0.117** | -0.062 | -0.125** | 0.051 |
| | (0.042) | (0.042) | (0.043) | (0.044) |
| **Control Variables** | | | | |
| Home | 0.265*** | 0.308*** | 0.286*** | 0.382*** |
| | (0.063) | (0.060) | (0.069) | (0.067) |
| Home x Policy Change | -0.066 | -0.068 | -0.145 | -0.122 |
| | (0.070) | (0.067) | (0.130) | (0.123) |
| Previous match events (red cards) | | | | -0.381*** |
| | | | | (0.081) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.456 | 0.501 | 0.450 | 0.545 |
| R2 Adj. | 0.456 | 0.501 | 0.450 | 0.544 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

## Appendix B.3.2: Managerial Style: Offensive Coaches

Table 56: Coaches by Offensive Coaching Style

| Coach Name | Offensive Coach | Coach Name | Offensive Coach |
|---|---|---|---|
| Abelardo | - | Lopetegui | - |
| Aguirre | Offensive Coach | Lopez | - |
| Alguacil, Imanol | - | Longo | - |
| Alkiza | - | Luis Cembranos | Offensive Coach |
| Andreazzoli | Offensive Coach | Machin | - |
| Ancelotti | - | Maran | - |
| Arteta | - | Marcelino | - |
| Arrasate | - | Marco Silva | Offensive Coach |
| Asier Garitano | Offensive Coach | Martinez | Offensive Coach |
| Baumgart | - | Martusciello | - |
| Beierlorzer | Offensive Coach | Mazzarri | - |
| Bordalas | Offensive Coach | Mendilibar | - |
| Bosz | Offensive Coach | Mihajlovic | - |
| Bruce | Offensive Coach | Montella | Offensive Coach |
| Burgos | Offensive Coach | Moreno | Offensive Coach |
| Calleja | - | Mourinho | - |
| Celades | - | Motta | - |
| Conte | - | Moyes | - |
| Coppola | - | Mullins | - |
| Corini | - | Nagelsmann | - |
| Covic, A. | - | Nicola | - |
| d'Aversa | - | Nouri | - |
| de Zerbi | - | Nuno Espirito Santo | - |
| Di Biagio | - | Paco Lopez | - |
| di Francesco | Offensive Coach | Paulo Fonseca | - |
| Dyche | - | Pearson | - |
| Emery | - | Pellegrini | Offensive Coach |
| Espinola | Offensive Coach | Pellegrino | Offensive Coach |
| Farke | - | Pioli | - |
| Favre | - | Pochettino | - |
| Ferguson | - | Potter | Offensive Coach |
| Fischer | - | Quique Alvarez | Offensive Coach |
| Flick | - | Quique Flores | - |
| Fran Escriba | - | Quique Setien | - |
| Frustalupi | Offensive Coach | Ranieri | - |
| Funkel | - | Rodgers | - |
| Gallego | - | Rose | - |
| Garcia | - | Rubi | Offensive Coach |
| Garitano | - | Rösler | - |
| Gasperini | - | Sarri | - |
| Gattuso | - | Schmidt | - |
| Giampaolo | - | Schreuder | Offensive Coach |
| Gisdol | Offensive Coach | Schwarz | Offensive Coach |
| Glasner | - | Semplici | - |
| Gotti | - | Sergio | - |
| Grosso | Offensive Coach | Simeone | - |
| Guardiola | - | Smith | - |
| Hasenhüttl | - | Solskjaer | - |
| Hodgson | - | Streich | - |
| Howe | - | Tanjga | Offensive Coach |
| Hütter | - | Tudor | - |
| Iachini | Offensive Coach | Valverde | - |
| Inzaghi | - | Wagner | - |
| Javi Gracia | Offensive Coach | Wilder | - |
| Juric | - | Zidane | - |
| Klinsmann | - | | |
| Klopp | - | | |
| Kohfeldt | Offensive Coach | | |
| Kovac | - | | |
| Lampard | - | | |
| Lichte | Offensive Coach | | |
| Liverani | - | | |
| Ljungberg | - | | |

*Note:*

N=118

Table 57: Number of Substitutions per Minute by Offensive Coaches

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | OLS | OLS | OLS | OLS |
| **Loss Frame and Policy Change** | | | | |
| Loss Frame | 0.035*** | 0.033*** | -0.003+ | -0.003+ |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Loss Frame x Policy Change | 0.017** | 0.017** | 0.015*** | 0.015*** |
| | (0.006) | (0.006) | (0.004) | (0.004) |
| Loss Frame x Offensive Coach | 0.010* | 0.009+ | 0.002 | 0.002 |
| | (0.005) | (0.005) | (0.003) | (0.003) |
| Loss Frame x Policy Change x Offensive Coach | 0.014 | 0.014 | 0.009 | 0.009 |
| | (0.012) | (0.012) | (0.009) | (0.009) |
| **Control Variables** | | | | |
| Exact goal difference | 0.004*** | 0.004*** | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Previous match events (red cards) | | 0.049*** | | 0.002 |
| | | (0.003) | | (0.003) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| Fixed Effects: Minutes | | | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 257654 | 257654 | 257654 | 257654 |
| R2 | 0.004 | 0.005 | 0.046 | 0.046 |
| R2 Adj. | -0.007 | -0.006 | 0.035 | 0.035 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 58: First stage estimates for (2SLS-5) by Offensive Coaches

| | (2SLS-5) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Offensive Coach | Substitution x Loss Frame x Offensive Coach |
| **Intercept** | | | | |
| (Intercept) | 0.030*** | 0.000 | 0.000*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| **Policy Change** | | | | |
| Policy Change | 0.059*** | 0.000 | 0.000* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x First Half | -0.087*** | 0.000 | 0.000* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.014*** | 0.046*** | 0.000* | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x Offensive Coach | 0.006** | 0.000 | 0.066*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.004 | -0.084*** | 0.000 | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Offensive Coach | -0.006* | 0.000 | -0.093*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Offensive Coach | -0.005 | 0.001 | -0.019*** | 0.047*** |
| | (0.006) | (0.005) | (0.005) | (0.005) |
| Policy Change x First Half x Loss Frame x Offensive Coach | 0.001 | -0.005 | 0.004 | -0.089*** |
| | (0.007) | (0.006) | (0.006) | (0.005) |
| **Loss Frame and Offensive Coach** | | | | |
| Offensive Coach | 0.001** | 0.000 | 0.030*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Loss Frame | 0.012*** | 0.041*** | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.000) | (0.000) |
| Loss Frame x Offensive Coach | 0.003 | 0.004* | 0.016*** | 0.046*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | 0.000*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.001* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.001*** | 0.000 | 0.000** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003* | -0.002+ | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.000) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | | |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 383.9 | 246.65 | 378.99 | 229.82 |
| **Characteristics** | | | | |
| Num.Obs. | 257654 | 257654 | 257654 | 257654 |
| R2 | 0.013 | 0.039 | 0.035 | 0.045 |
| R2 Adj. | 0.013 | 0.039 | 0.035 | 0.045 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 59: First stage estimates for (2SLS-6) by Offensive Coaches

| | (2SLS-6) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Offensive Coach | Substitution x Loss Frame x Offensive Coach |
| **Policy Change** | | | | |
| Policy Change | 0.059*** | 0.000 | 0.000* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x First Half | -0.087*** | 0.000 | 0.000* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.046*** | 0.000 | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x Offensive Coach | 0.006** | 0.000 | 0.066*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.084*** | 0.000 | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Offensive Coach | -0.006* | 0.000 | -0.093*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Offensive Coach | -0.005 | 0.002 | -0.019*** | 0.047*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| Policy Change x First Half x Loss Frame x Offensive Coach | 0.001 | -0.004 | 0.004 | -0.088*** |
| | (0.007) | (0.006) | (0.006) | (0.005) |
| **Loss Frame and Offensive Coach** | | | | |
| Offensive Coach | 0.002 | 0.000 | 0.029*** | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Loss Frame | 0.012*** | 0.041*** | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.000) | (0.000) |
| Loss Frame x Offensive Coach | 0.003 | 0.004* | 0.017*** | 0.046*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | 0.000*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.001* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.000* | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003** | -0.002+ | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.000) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | | | | |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 382.91 | 245.1 | 376.06 | 228.4 |
| **Characteristics** | | | | |
| Num.Obs. | 257654 | 257654 | 257654 | 257654 |
| R2 | 0.013 | 0.039 | 0.035 | 0.045 |
| R2 Adj. | 0.013 | 0.039 | 0.035 | 0.045 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 60: First stage estimates for (2SLS-7) by Offensive Coaches

| | (2SLS-7) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Offensive Coach | Substitution x Loss Frame x Offensive Coach |
| **Policy Change** | | | | |
| Policy Change | 0.060*** | -0.002 | 0.001 | 0.000 |
| | (0.004) | (0.002) | (0.001) | (0.000) |
| Policy Change x First Half | -0.087*** | 0.000 | 0.000* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.015*** | 0.046*** | 0.000 | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x Offensive Coach | 0.006** | 0.000 | 0.066*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.084*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Offensive Coach | -0.006* | 0.000 | -0.093*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Offensive Coach | -0.006 | 0.001 | -0.020*** | 0.047*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| Policy Change x First Half x Loss Frame x Offensive Coach | 0.002 | -0.004 | 0.004 | -0.088*** |
| | (0.007) | (0.006) | (0.006) | (0.005) |
| **Loss Frame and Offensive Coach** | | | | |
| Offensive Coach | 0.001+ | 0.000 | 0.030*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Loss Frame | 0.012*** | 0.041*** | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.000) | (0.000) |
| Loss Frame x Offensive Coach | 0.003 | 0.004* | 0.017*** | 0.047*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | 0.000*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.002* | -0.001 | 0.001* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.001*** | 0.000+ | 0.000* | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003* | -0.002+ | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.000) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | | | |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | | | | |
| **Diagnostics** | | | | |
| F-Statistic | 367.6 | 242.08 | 372.52 | 226.19 |
| **Characteristics** | | | | |
| Num.Obs. | 257654 | 257654 | 257654 | 257654 |
| R2 | 0.013 | 0.039 | 0.035 | 0.045 |
| R2 Adj. | 0.012 | 0.039 | 0.035 | 0.044 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 61: First stage estimates for (2SLS-8) by Offensive Coaches

| | (2SLS-8) | | | |
|---|---|---|---|---|
| | Substitution | Substitution x Loss Frame | Substitution x Offensive Coach | Substitution x Loss Frame x Offensive Coach |
| **Policy Change** | | | | |
| Policy Change | 0.058*** | -0.002 | 0.000 | 0.000 |
| | (0.003) | (0.002) | (0.001) | (0.000) |
| Policy Change x First Half | -0.086*** | 0.000* | 0.000* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Policy Change x Loss Frame | -0.014*** | 0.046*** | 0.000 | 0.000 |
| | (0.003) | (0.003) | (0.000) | (0.000) |
| Policy Change x Offensive Coach | 0.006** | 0.000 | 0.066*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x First Half x Loss Frame | 0.003 | -0.084*** | 0.000 | 0.000 |
| | (0.004) | (0.003) | (0.000) | (0.000) |
| Policy Change x First Half x Offensive Coach | -0.006* | 0.000 | -0.093*** | 0.000 |
| | (0.002) | (0.000) | (0.002) | (0.000) |
| Policy Change x Loss Frame x Offensive Coach | -0.006 | 0.002 | -0.020*** | 0.047*** |
| | (0.006) | (0.005) | (0.005) | (0.004) |
| Policy Change x First Half x Loss Frame x Offensive Coach | 0.001 | -0.004 | 0.004 | -0.088*** |
| | (0.007) | (0.006) | (0.006) | (0.005) |
| **Loss Frame and Offensive Coach** | | | | |
| Offensive Coach | 0.000 | 0.000 | 0.029*** | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Loss Frame | 0.013*** | 0.041*** | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.000) | (0.000) |
| Loss Frame x Offensive Coach | 0.003 | 0.004+ | 0.018*** | 0.047*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| **Control Variables** | | | | |
| Home | -0.002*** | 0.000 | 0.000** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Home x Policy Change | 0.001+ | -0.001 | 0.001* | 0.000 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| Exact goal difference | 0.002*** | 0.000*** | 0.000+ | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Exact goal difference x Loss Frame | -0.003** | -0.002+ | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | x | x | x | x |
| Fixed Effects: Matchday x League | x | x | x | x |
| Fixed Effects: Opponent | x | x | x | x |
| **Diagnostics** | | | | |
| F-Statistic | 356.56 | 239.33 | 367.5 | 222.9 |
| **Characteristics** | | | | |
| Num.Obs. | 257654 | 257654 | 257654 | 257654 |
| R2 | 0.014 | 0.040 | 0.035 | 0.045 |
| R2 Adj. | 0.012 | 0.038 | 0.034 | 0.044 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 62: 2SLS Productivity Analysis of Substitutions by Offensive Coaches

| | Final goal difference | | | |
|---|---|---|---|---|
| | (2SLS-5) | (2SLS-6) | (2SLS-7) | (2SLS-8) |
| **Intercept** | | | | |
| (Intercept) | -0.127*** | | | |
| | (0.035) | | | |
| **Substitutions** | | | | |
| Substitution | -0.280 | -0.116 | -0.473+ | 0.430+ |
| | (0.307) | (0.299) | (0.283) | (0.261) |
| Substitution x Loss Frame | -4.485*** | -3.858** | -4.742*** | -3.967** |
| | (1.340) | (1.271) | (1.342) | (1.256) |
| Substitution x Offensive Coach | 2.386** | 2.064** | 2.279** | 1.834* |
| | (0.857) | (0.798) | (0.869) | (0.775) |
| Substitution x Loss Frame x Offensive Coach | 5.613* | 3.758 | 5.982* | 3.867 |
| | (2.528) | (2.549) | (2.594) | (2.411) |
| **Loss Frame and Squad** | | | | |
| Loss Frame | 0.506*** | 0.286*** | 0.527*** | 0.024 |
| | (0.093) | (0.087) | (0.094) | (0.087) |
| Loss Frame x Offensive Coach | -0.462* | -0.246 | -0.480* | -0.240 |
| | (0.183) | (0.181) | (0.188) | (0.180) |
| Offensive Coach | -0.289*** | -0.542*** | -0.298*** | -0.571*** |
| | (0.075) | (0.155) | (0.078) | (0.161) |
| **Goal Difference** | | | | |
| Exact goal difference | 1.083*** | 0.989*** | 1.084*** | 0.855*** |
| | (0.018) | (0.018) | (0.018) | (0.022) |
| Exact goal difference x Loss Frame | -0.117** | -0.057 | -0.125** | 0.057 |
| | (0.043) | (0.042) | (0.044) | (0.043) |
| **Control Variables** | | | | |
| Home | 0.274*** | 0.318*** | 0.291*** | 0.384*** |
| | (0.063) | (0.061) | (0.069) | (0.067) |
| Home x Policy Change | -0.072 | -0.093 | -0.143 | -0.118 |
| | (0.073) | (0.071) | (0.134) | (0.127) |
| Previous match events (red cards) | | | | -0.387*** |
| | | | | (0.084) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team | | x | | x |
| Fixed Effects: Matchday x League | | | x | x |
| Fixed Effects: Opponent | | | | x |
| **Characteristics** | | | | |
| Num.Obs. | 257654 | 257654 | 257654 | 257654 |
| R2 | 0.437 | 0.490 | 0.431 | 0.537 |
| R2 Adj. | 0.437 | 0.490 | 0.431 | 0.536 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

*Note:*

Standard errors clustered at the match level in parentheses.

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

## Appendix B.4: Time Pressure and Narrow Loss Frames

For this exploratory sub-analysis, I define a narrow loss frame as a situation in which a team is in a loss frame and trailing by exactly one goal.

The variable "Late" is a dummy equal to 1 if the match is in the 75th minute or later, and 0 otherwise.

Table 63: Mechanism Analysis by Substitution Usage by Timing and Narrow Loss Frames

| | Substitutions Fully Used | | Substitutions Fully Used | |
|---|---|---|---|---|
| | (OLS-1) | (OLS-2) | (OLS-1A) | (OLS-2A) |
| **Late** | | | | |
| Late | 0.471*** | 0.470*** | 0.216*** | 0.217*** |
| | (0.008) | (0.008) | (0.008) | (0.008) |
| Late x Policy Change | -0.179*** | -0.179*** | -0.336*** | -0.337*** |
| | (0.016) | (0.016) | (0.012) | (0.012) |
| **Narrow Loss and Policy Change** | | | | |
| Narrow Loss | -0.013*** | -0.013*** | -0.012*** | -0.012*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Narrow Loss x Policy Change | -0.014*** | -0.014*** | -0.045*** | -0.045*** |
| | (0.003) | (0.003) | (0.005) | (0.005) |
| Narrow Loss x Late | 0.126*** | 0.125*** | 0.108*** | 0.109*** |
| | (0.015) | (0.015) | (0.013) | (0.013) |
| Narrow Loss x Late x Policy Change | -0.112*** | -0.112*** | -0.070** | -0.070** |
| | (0.032) | (0.032) | (0.026) | (0.026) |
| **Control Variables** | | | | |
| Exact goal difference | -0.018*** | -0.018*** | -0.006*** | -0.006*** |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| Previous match events (substitutions) | | | 0.131*** | 0.131*** |
| | | | (0.002) | (0.002) |
| Previous match events (red cards) | | 0.027* | | -0.023* |
| | | (0.012) | | (0.010) |
| **Fixed Effects** | | | | |
| Fixed Effects: Team x Match | x | x | x | x |
| **Characteristics** | | | | |
| Num.Obs. | 264214 | 264214 | 264214 | 264214 |
| R2 | 0.397 | 0.397 | 0.526 | 0.527 |
| R2 Adj. | 0.397 | 0.397 | 0.526 | 0.526 |
| Std.Errors | by: Match | by: Match | by: Match | by: Match |

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