The Role of Past Information, Time, and Emotional Pressure in Heuristic Decision-Making

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Abstract

Unlike classical rational choice theory assumptions, decision-makers are far less rational and not always self-interested. Decision makers normally have less than perfect information, are faced with limited time to make decisions, fall into cognitive biases and reciprocate. Behavioural economics argues that decision-makers normally face "bounded rationality" and adopt simple, intuitive "rules of thumb" instead of calculating optimal solutions for every decision they make. Using behavioural economics insights, this paper explores how people with economic goals make economic decisions under time and emotional pressure. It studies how a goalkeeper as an economic agent makes decisions during a penalty session using data from the Spanish Premier Football League from 2015 to 2020. Results show that when a goalkeeper is under time pressure, he ends up making more accurate choices and predictions owing to greater mental concentration on the issue that demands considerable attention. Moreover, the increased pressure on the ball kicker causes him to make poor decisions, giving the goalkeeper additional flexibility. However, emotions were found to influence poor prediction and decisions because they impair information processing and the capacity to solve issues through heuristic decision-making techniques. Thus, the study on how decision-making is influenced can significantly improve strategic policymaking.

Keywords: *Heuristics, Decision making, Choices, Time Pressure, Rationality, Emotions.*

JEL : *D03, D81, D91*

1. Introduction

Most of the choices we make in our lives are constrained by limited resources. The availability of few resources to satisfy unlimited wants obliges people to choose alternatives that give them maximum utility. (Barnett, 2018). In some circumstances, the process of deciding which alternative is the most desirable is done within a short, specified time limit. In some other cases, decisions may involve emotions depending on the situation the decision-makers are in. Time

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is one of the significant inputs into the decision-making process. [1] and in determining the rationality[2] of the decision to be made (Ariely & Zakay, 2001). Time constraints may pressure decision-makers, reducing their ability to concentrate and think logically, which can lead to irrational decisions. (Kocher et al., 2019; Yu et al., 2018). This is particularly evident in high-pressure situations, such as penalty kicks in football, where the goalkeeper is constrained by time to make decisions on which side to jump. The limitation of time often forces people to use rules of thumb (heuristics) to make quick decisions on the most pressing needs at the moment. (Cao et al., 2009; Klapproth, 2008). Rules of thumb can be beneficial in the face of imminent danger or minimally important decisions. (Thierry, 2007).

Emotions act to minimize and bind our thoughts, which in turn restrict the chance to reason more thoroughly. (Garcés & Finkel, 2019) Emotions are important in making choices. (Damasio, 1994). For instance, in demand theory, consumers usually choose a product to buy according to their preferences. (Levin & Milgrom, 2004). However, preference is subjected to the state of emotion an individual is in at the time of deciding to buy. In contrast to a logical decision, an emotional decision is relatively easier as it is reactive (and largely subconscious). An emotional state creates emotional pressure that makes someone fail to think logically and use rules of thumb (heuristics) to make a hurried decision that can relieve their tension. (Atsan, 2016).

Heuristics strategies are always employed as shortcuts in decision-making to simplify complex probability thinking about an uncertain future event. (Albar & Jetter, 2009; Benson & Ordonez, 1997; Del Campo et al., 2016; Tversky & Khaneman, 1974). Complex and valuable decisions such as how to curb economic shocks to minimize their economic impacts require ample time to carefully evaluate the alternatives. (Klapproth, 2008). In football, a goalkeeper must make a critical decision under pressure to save a penalty kick, which similarly demands swift judgment. Neutrality in emotional states is required to avoid prejudices and biases in making decisions. (Atsan, 2016). However, in a typical economic shock scenario such as the COVID-19 pandemic, when decision-makers (policymakers) do not have much information or time and are subjected to some emotions to save the lives of people, policymakers may be forced to rely on heuristic decisions and thus overlook a lot of necessary inputs in decision making. (Atsan, 2016; Conte et al., 2016; Hu et al., 2015; M et al., 2018).

One of the remedies to improve the performance of rules of thumb (heuristic decisions) is to build them based on past information and experiences. For

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1 In each decision case, decision making is the method of identifying possible courses of action and choosing a suitable alternative.

2 In economics, rationality basically means that you can pick the thing you want most when deciding.

example, at the onset of COVID-19, most decisions were based on the historical past when the world faced a pandemic of similar nature. Prior information and experience with the Spanish flu provided the first piece of information to form heuristics that speed up decision-making such as the use of lockdowns and masks for most countries (Beach et al., 2020).

This paper aims to analyze the extent to which past information or experiences and emotional pressure affect the performance of heuristics in making judgments under time pressure. The study used penalty shootouts in football games to study how past information can aid the goalkeeper as an economic decision-maker to form heuristics strategies that will prove helpful in saving penalty kicks by observing the tactics of the penalty kicker in previous games.

The study observed a penalty shootout in the Spanish League, commonly known as La Liga, from the 2015/2016 season to the 2019/2020 season to draw our conclusion on how past action can influence current decisions. This league was picked since it had a large number of the best penalty takers and best goalkeepers in the world during these seasons as evidenced by various awards earned by the league's clubs and players from the Union of European Football Associations (UEFA) and Federation Internationale de Football Association (FIFA) club world cup tournaments. Furthermore, there was consistency in terms of penalty kickers and goalkeepers in the team.

In addition, there was a low turnover of players since most of the players stayed in the same team for more than three seasons which can, influence goalkeeper or kicker actions by learning the past style of either player and applying them as the rule of thumb (heuristics) for the current game.

2. Methodology
2.1. Penalty Incidence as An Experiment

This study used a penalty incident in a football game to study how people make decisions when they are faced with time limits and emotional pressure. A penalty kick-out session is a non-cooperative game between two players, a goalkeeper, and a penalty taker, who are driven by competing motives, which are to save the penalty by the goalkeeper and or to score from a spot by the penalty taker. The penalty session is an ideal incidence for our kind of analysis because a penalty can often determine the outcome of the entire game, and it has the exact frame every time as compared to other moments of the game (Bar-Eli et al., 2009).

A penalty is awarded when an offense punishable by a direct free kick is committed by a player in their penalty area. A penalty kick is taken at any point twelve yards from the goal line, under the following conditions: all players, except the kicker and goalkeeper, must stand behind the ball and at

least ten yards away from it; the ball will be in play when the kick is made, and a penalty kick could result in a goal.
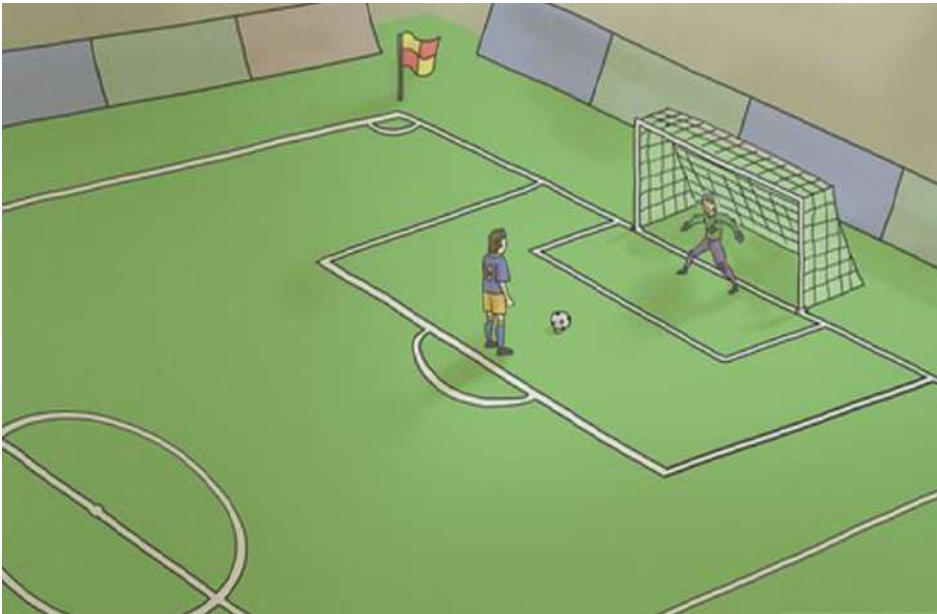

Figure 1: Example of Penalty Taking
Source: Soccer Games 2021

Saving a penalty is one of the most challenging tasks for a goalkeeper. Due to the short distance between the penalty spot and the goal, there is very little time for the goalkeeper to react. So, the defending goalkeeper has a limited amount of time to make an informed or right decision after observing the kick. When you look at it closely, human response time is around a tenth of a second (Palacios-Huerta, 2003). The average kicker hits the ball at 70 miles per hour, which implies that a goalkeeper will not see the direction of the ball until it is around 25 feet away. It will take him another 0.5 to 0.7 seconds to respond and grab the ball, but it will be over by then. (Palacios-Huerta, 2003).

In such a case, the goalkeepers must act on their best prediction about where the shot will be directed. These predictions will be based 'mostly on the goalkeepers' heuristics. Some goalkeepers may decide which side to dive on beforehand, thus giving themselves a good chance of moving in time. On other occasions, the goalkeeper may try to read the kicker's motion pattern before the ball is kicked and predict which side the ball will be kicked from the motion pattern. A goalkeeper may, in other instances, also rely on knowledge about the kicker's past behaviour to inform his decision. (Palacios-Huerta, 2003).

Both the penalty kicker and the goalkeeper's actions have economic motives such as maintaining or boosting their reputation to advance their careers, awards, salary increments, and securing the best deals available in the sports market. Apart from the individual gains, a positive outcome from the penalty benefits the collective team performance. The status of the game at the point when the penalty is to be taken (whether the game is in the first or the second half, whether the goalkeeper's or the kicker's team is leading or the game is at a draw, etc.) also brings about different emotional pressures.

Therefore, both the penalty taker and the defending goalkeeper will be psychologically pressured to perform their best which might elude the proper thinking pattern and make them commit more mistakes than normal to avoid this they have to turn to using heuristic strategies to simplify the decision-making process.

It is from this understanding that this study models the behaviour of a goalkeeper to understand how economic agents make decisions when faced with time and emotional pressure, which is a typical characteristic of the working environment.

The paper used data collected from the Spanish League, *La Liga* with a sample size of 608 observations. As shown in Error! Reference source not f ound. below.

Table 1. Total Number of Penalties in LaLiga from the 2015/2016 Season to the 2019/2020 Season

League Season	Number of Penalties
2015/2016	97
2016/2017	121
2017/2018	113
2018/2019	129
2019/2020	148
Total	**608**

Source: https://www.transfermarkt.com

The information about the matches that were awarded penalties was collected first from *https://www.transfermarkt.com* and the observation of the short highlights of these matches were observed from the following sources: *Skysports*, *Footballnews YouTube channel*, *Transfermarkt.com*, *DeportesyOtros YouTube channel*, *Catalan News*, *Barcablog.com*, *Dailymotion*, *Aken SPORTS youtube channel*, *Espn*, *Vavel*, *LaLiga television channel*, *Eurosport*, *LaLiga Youtube channel*, and *Elcomercio*.

All matches that were awarded penalties were sampled out first and observation of match highlights of those games was done on the *Laliga* YouTube channel. Thus, the population of this study was all the matches that

were played in the *Laliga* during this period. In this case, therefore, the study purposively sampled out only the matches that were awarded a penalty as the potential source of the data.

We analyzed cross-section data observed from video clips of penalties and detailed after-match information on how the match was. The data collected took keen consideration of commentators' general views on how the penalty was awarded and taken.

The unit of analysis in this study was a defending goalkeeper in penalty incidence. The study focused on modeling the behaviour of the goalkeeper as the main economic agent in how the goalkeeper responded to penalty kicks given the little time allocated to take a penalty and the huge sense of emotion that the goalkeeper possessed, from the fans, his team and personal drive to emerge victorious from the penalty session.

Information about the match day, players involved, and minutes in which the penalty occurred were obtained first. Then each penalty was observed from short time video clips with an average of 3 minutes long to see the response of the goalkeeper in this scenario. The direction and position of the goalkeeper were obtained by observing the goalkeeper's hands. The right hand gave the right-hand side while the left hand gave the left-hand side.

A decision was considered correct if the goalkeeper jumped to the side where the ball was sent, even if he did not catch the ball; otherwise, it was considered incorrect. Thus, if the ball was sent to the right-hand side of the goalkeeper, for instance, and the goalkeeper jumped to the right-hand side to save the penalty, even if he did not catch the ball, this would be considered a correct decision in the first scenario.

In the case of missed penalties whereby the kicker sends the ball over the goalpost, far right or left side of the goalpost, this observation was considered uncertain to classify whether the goalkeeper made a correct or incorrect decision. Finally, data regarding the time and emotions were deduced by checking whether the penalty was conceded in the first or second half, the team position in a league, and the score before the penalty, respectively.

2.2. Theoretical Framework
Decision-makers change their preferences over time due to changes in circumstances and economic motives which influence their decisions. This phenomenon is explained by Dynamic Inconsistency Theory, which outlines how preferences and choices can shift, leading to discrepancies between initial intentions and subsequent actions. The theory highlights how individuals may prioritize immediate gratification at the expense of long-term goals. However, critics argue that the theory overemphasizes irrationality, assumes that inconsistencies are predictable, and neglects broader psychological and

social factors. According to Dynamic Inconsistency Theory, the most optimal decision at a given moment may become less desirable or effective when that future moment arrives (Moloi & Marwala, 2020).

Taking the penalty kick-out session as an experiment, with the assumption that players mimic economic decision-makers, this theory can be vividly exemplified. Before the match, each team's players have the best optimal plan for the upcoming game. However, when this future time arrives, all the best optimal plans get eluded by the emotions of giving fans their best moment within a specified time limit. In this case, players become dynamically inconsistent with their previously planned behaviour. This situation also faces public planning officials, who face the challenge of delivering to society in a very short time without compromising their welfare.

This inconsistency is mainly caused by projection bias. The fact is that economic agents are short-sighted, and they base their decisions on current values, emotions, and beliefs that will not last long. Therefore, past optimal options cannot necessarily be optimal at the present moment or for the future period. (Loewenstein et al., 2003). To mitigate the impact of projection bias, decision-makers often rely on heuristics, or mental shortcuts, to simplify the complex process of identifying the best course of action. Heuristic theory explains how people use patterns, prior experiences, and quick judgments to make decisions, which can be efficient but sometimes lead to biased outcomes. This study aims to provide a clue about the extent to which time constraints and emotional pressure can force an economic agent to rely on past events and prove whether reliance on them can help to increase their level of satisfaction, which in this case is a correct heuristic decision. (Krusell & Smith, 1996).

2.3. Variables
This study used both categorical and continuous variables. The following variables were used in the analysis:

2.3.1. Dependent Variables
Since the goalkeeper does not have enough time to process all the information, he surely relies on heuristic strategies from past information to make a decision. Goalkeeper strategies are mainly formed from prior information on the kicker's dominant foot, kicker scoring rate, agility, goalkeeper's instincts, and training. These strategies can prompt him to make a correct or wrong decision. Nonetheless, these heuristic strategies can make a goalkeeper jump to the wrong side and fail to save the penalty because the heuristic does not guarantee a correct decision.

Thus, the outcome variable in this study is measured in two ways. The first measure captures whether the defending goalkeeper saved a penalty or not. The second measure captures whether the heuristic decision made by the

goalkeeper towards the penalty kick correctly predicted the side where the kicker sent the ball or not.

First Outcome Variable: Penalty Saving
The first outcome variable captures how successful the goalkeeper has been in attempting to save the penalty. It is expressed using a categorical variable with three categories, viz., correct, incorrect, and uncertain decisions.

Saved (Correct Decision)
The first category of this variable takes a value of 0 if a penalty was saved. That is, the goalkeeper successfully touched the ball and did not allow it to go into the net.
$$D_i = 0 \text{ if the penalty was saved}$$

Conceded (Incorrect Decision)
The second category of the outcome variable takes the value of 1 if a penalty was not saved by the goalkeeper and a goal was recorded accordingly and the referee's final decision indicated that the ball should be restarted at the center of the pitch.
$$D_i = 1 \text{ if the penalty was not saved}$$

Missed but not Saved (Uncertain Decision)
The third category of the outcome variable will take the value of 2 if a ball kicker missed the penalty, such that the kicker sent the ball over, far right or left of the goalpost, but not because it was saved by the goalkeeper.

$$D_i = 2 \text{ if a ball kicker missed the penalty } (\text{it is uncertain whether it would have been saved or not})$$

Second Outcome Variable: Prediction of the Ball Direction
The second outcome variable captures how accurately the goalkeeper predicted the direction of the ball regardless of whether he was successful in saving the penalty or not. It has two categories that are correct and incorrect decisions, as follows:

Correct Prediction
This would take a value of one if a goalkeeper jumped in the direction of the ball, such that if the ball was sent to the right-hand side of the goalkeeper, the goalkeeper jumped to his right-hand side, irrespective of whether he saved the ball or not and zero if not.
$$D_i = 0 \text{ if the goalkeeper jumped in the direction of the ball}$$

Incorrect Prediction
This takes a value of one if a goalkeeper failed to jump to the side where the ball was sent, such that if the kicker sent the ball to the right-hand side of the goalkeeper, but the goalkeeper jumped to his left-hand side.

$$D_i = 1 \; if \; the \; goalkeeper \; did \; not \; jump \; in \; the \; direction \; of \; the \; ball$$

2.3.2. Independent Variables
The main independent variables which explained the changes in the outcome variable were identified as follows:

Time Pressure
The time when a penalty is awarded determines the amount of pressure imposed on both the kicker and the goalkeeper. If the penalty is awarded in the early minutes of the match, less pressure is imposed as the teams have more time to play and change the results. Meanwhile, if the time remaining is short, then the punished team may not have enough time thereafter to reverse the results, thus mounting more pressure on the goalkeeper. This variable enables the study of the first objective on how time limits affect decision-making. It was measured through two categories, which are more time and less time, as follows:

First Half (Less Time Pressure)
This study assumed that if the penalty was conceded in the first half there would be more time for the opposite team to try their best to correct their mistake and win, thus less time pressure.

$$t_{0i} = 0 \; if \; the \; penalty \; was \; conceived \; in \; the \; first \; half.$$

Second Half (More Time Pressure)
This study assumed that if the penalty was conceded in the second half, there would be less time for the opposite team to level the score since it is easy for players in the team that is leading by the score to hold on and defend their goal.

$$t_{1i} = 1 \; if \; the \; penalty \; was \; conceived \; in \; the \; second \; half.$$

Emotions
Emotionally, people like to do things that make them happy and bring them comfort, and tend to be happier after they have fulfilled their goals. (Uchida & Oishi, 2016). In football, the goal is to win and secure the best position for international tournaments and awards. Thus, the emotional aspect in this study can be captured through winning pressure and a team position in a league and was measured as follows;

i. Winning Pressure Through Goal Difference
The promise of tremendous delight after winning a game puts pressure on players because if the team fails to win games, it implies that the players are not good enough or the coach is not doing well, and they must part ways with a club. To win a title and secure top deals for players and strong positions for the club in international tournaments, a team must perform at its best. Thus, the assumption here is that the players of the leading team have less pressure to win a game than the rival players. When the goalkeeper's team is behind

by either one or more goals, the goalkeeper will be under more pressure not to extend the deficit, but if the goalkeeper's team is leading by one or more goals, he will be a bit relaxed with less winning pressure since the chances of winning the game are high. Therefore, winning pressure can be measured through goal differences as follows:

Tie Score

Here, the assumption was that when no team has scored a goal or the score is in a tie, there is winning pressure that a goalkeeper should protect the goalpost well so that his team does not trail behind.

$E_{0i} = 0$ *if the penalty was conceived while the teams were in a tie.*

Trail by One Goal

This measures a relatively deep winning pressure when the goalkeeper's team is trailing by one goal behind, since if the rival team scores a goal, it will extend the deficit and add to the winning pressure.

$E_{1i} = 1$ *if the penalty was conceived while the goalkeeper's team was*

trailing by one goal.

Lead by One Goal

The slight winning pressure was measured when the goalkeeper's team was leading by one goal. It is average because this puts a goalkeeper's team under winning pressure to play well and defend their goal. Moreover, there is a high chance that the rival team will try their best to level the score, adding more winning pressure to the goalkeeper's side.

$E_{2i} = 2$ *if the penalty was conceived while the goalkeeper's team was*

leading by one goal.

Trail by More than One Goal

This measured rather less winning pressure and a sad state, since if a goalkeeper allows an additional goal, the chance of leveling out is very minimal.

$E_{3i} = 3$ *if the penalty was conceived while the goalkeeper's team was*

trailing by more than one goal.

Lead by More than One Goal

This occurs when the goalkeeper's team is leading by more than one goal. This implies that the goalkeeper's team will still be leading the game regardless of the outcomes of the penalty and therefore relatively less pressure and a happier state.

$E_{4i} = 4$ *if the penalty was conceived while the goalkeeper's team was*

leading by more than one goal.

ii. League Standing

The league standing is an ordered list of all the teams according to how many points they have collected in the league. The teams are presented in descending order, beginning with the team with the most points and ending with the team with the fewest points. The team that ends at the top of the *Laliga* table at the end of the season wins the league title and gets a seeded position in the UEFA Champions League. The four best teams compete in the UEFA Champions League tournament, while the fifth team competes in EUROPA competitions. The three teams with the fewest points are relegated to a lower division. So as the season approaches the end, the competition becomes too intense as teams try to better their position in the league's standing sending different emotional alerts to players according to their league position.

League Round

Each team in the leagues should play against other teams in the same league twice, home and away. Each round consists of teams playing against each opponent once. *La Liga* consists of 20 teams so each team will play the 19 opponent teams in the first and second rounds which sum to a total of 38 matches in a single season. Teams are far more comfortable in the first round because even if they lose their initial matches, they may still make it with a seemingly large number of matches ahead. However, in the second round, players are under extra pressure to win or to finish higher in the league standings. Accordingly, this variable is divided into two categories and is measured as follows.

$$LR_{0i} = 0 \; if \; a \; match \; was \; played \; in \; the \; first \; round$$

$$LR_{1i} = 1 \; if \; a \; match \; was \; played \; in \; the \; second \; round$$

Penalty Kicker's Team Position

The league standing in terms of a penalty kicker's team position places added pressure on a kicker to shoot the ball accurately and score. As long as the kicker's team is in the relegation zone, the kicker will be under more pressure to take the proper action. Furthermore, if the club is in the top three, missing a scoring opportunity means giving other championship contenders more chances to win the crown, so the kicker must be extremely cautious.

As a result, this variable will be divided into four groups and measured as follows:

$$KTP_{oi} = 0 \; Best \; position \; (1-3)$$

$$KTP_{1i} = 1 \; Better \; position \; (4-5)$$

$$KTP_{2i} = 2 \; Good \; position \; (6-17)$$

$$KTP_{3i} = 3 \; Bad \; position \; (18-20)$$

Goalkeeper's Team Position

The position of a goalkeeper's team in a league standing might indicate how a goalkeeper should act when defending a penalty kick (s). The position of a team in a league might motivate a goalkeeper to strive hard to save penalties to stay in the top position or avoid relegation, or it can be a fairly relaxing moment if, whether a team wins or loses, there will be no gain or loss to be tallied.

Therefore, this variable will have four categories and be measured as follows:

$$GTP_{oi} = 0 \; Best \; position \; (1-3)$$

$$GTP_{1i} = 1 \; Better \; position \; (4-5)$$

$$GTP_{2i} = 2 \; Good \; position \; (6-17)$$

$$GTP_{3i} = 3 \; Bad \; position \; (18-20)$$

Past Information

Because a goalkeeper does not have enough time to respond to a penalty kick (Palacios-Huerta, 2003), he will use a rule of thumb (heuristics) to speed up his decision-making process (Del Campo et al., 2016; Gigerenzer & Gaissmaier, 2011; Lerner et al., 2015). These heuristics are built from past information, which in this paper are captured as the kicker scoring rate, how frequently the penalty kicker and goalkeeper met in the previous games, and the goalkeeper's penalty saving rate for the last three penalties. Thus, past information can be measured by three variables:

Kicker's Scoring Rate

This variable is derived from the last three penalties taken by a penalty kicker in one season. It captures how good the kicker is in taking penalties. It is calculated as:

$$Scoring \; rate = \frac{Number \; of \; penalties \; scored}{Total \; number \; of \; penalties \; taken} \times 100$$

Goalkeeper's Saving Rate

This variable reflects the goalkeeper's ability to save penalties which can be regarded as a good experience and builds the confidence of the goalkeeper that he will be able to save other penalties in a respective season. This variable was obtained through the following formula:

$$Saving \; rate = \frac{Number \; of \; penalties \; saved}{Total \; number \; of \; penalties \; encountered} \times 100$$

Previous Meetings

The previous meetings capture if the goalkeeper and penalty kicker have ever met in penalty kicks or not in the respective season. This captures whether the two have a previous direct encounter. The first category of this variable is when a goalkeeper and penalty kicker have never met before in the season concerned and it takes the value of zero, such that.

$$M_i = 0 \; if \; they \; have \; not \; met \; before$$

The second category occurs when a goalkeeper and penalty kicker have met before in the respective season, which in this case takes the value of one.

$$M_i = 1 \; if \; they \; have \; met \; before$$

Players Estimated Market Value

The market value of a player serves as a proxy for his pay. Players having a high market value are those who are paid well and play for large teams. As a result, players always try to earn a high salary by excelling in all aspects, including penalty kicks. As a result, market value is a powerful motivator that changes the behaviour of players to perform in the best way possible to enhance their market value. (Frick, 2011).

Penalty Kicker's Market Value

For penalty kickers, scoring a penalty raises their market worth since it is one of the indicators that shows how capable they are in scoring goals and providing good results for the club, which may assist them in achieving the objective established before they begin a league. This study employed market value acquired amid the league, from December to January after the transfer window closed, because the market value of players is more stable at this time than during the transfer window.

Goalkeeper's Market Value

A goalkeeper's market value represents his ability to defend the goal area as well as his contribution to the squad. When a team is in the best possible position, the worth of its players rises, as does their market demand, which raises their market value even further. Goalkeepers in this scenario strive to perform to the best of their abilities to assist their club in achieving the highest place to increase their demand from other clubs or obtain a new contract with their present club at higher pay. Therefore, the market value depends on the goalkeeper's ability shown in the previous matches and the current position of his team in the league. This study employed market value acquired amid the league, from December to January after the transfer window closed, because the market value of players is more stable at this time than during the transfer window.

2.3. Econometric Approach to Estimation and Results

Because of the nature of the outcome variables, the paper used limited dependent variable models. In the case where the outcome variable is binary, the Probit model was used. For the outcomes with unordered multiple categories, the Multinomial Probit Model was used.

Model I: The Multinomial Probit Model for Estimation of the Penalty Saving Outcome

The first model will be the Multinomial Probit Model because the dependent variable has three unordered categories, namely, correct, incorrect, and uncertain. This model will be specified as follows.

$$Pr(D_i = 1) = \gamma + \beta_i timelimits_i + \delta_i Emotion_i + \alpha_i Past\ information_i + \theta_i Players'\ estimated\ market\ value_i + \mu_i \ \dots\dots\dots\dots\dots\dots\dots\dots\ (1)$$

Model II: The Probit Model for Estimating the Prediction of the Direction of the Ball

The second model will estimate the effect of decision-making under time and emotional pressure on the probability of predicting the direction of the ball incorrectly. Thus, a binary Probit model was adopted to estimate the model specified as follows.

$$Pr(D_j = 1) = \gamma + \beta_i timelimits_i + \delta_i Emotion_i + \alpha_i Past\ information_i + \theta_i Players'\ estimated\ market\ value_i + \mu_i \dots\dots\dots. (2)$$

3. RESULTS

3.1. Descriptive Statistics

This section explains the summary of quantitative features (mean, standard deviation, minimum and maximum value) of the sample from data collected between 2015 and 2020 from *Laliga* matches.

Table 1. Descriptive Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
Saving the Ball					
Saved (Correct Decision)	608	0.19	0.39	0	1
Conceded (Incorrect Decision)	608	0.77	0.42	0	1
Missed (Uncertain)	608	0.04	0.20	0	1
Prediction of the Direction of the Ball					
Correct Prediction	608	0.52	0.50	0	1
Incorrect Prediction	608	0.48	0.50	0	1
Previous Meeting Kicker and Goalkeeper					
Never Met Before	608	0.96	0.19	0	1
Met Before	608	0.04	0.19	0	1

Variables	Observations	Mean	Std. Dev.	Min	Max
Time Pressure					
Penalty in First Half (More Time)	608	0.39	0.49	0	1
Penalty in Second Half (Less Time)	608	0.61	0.49	0	1
Winning Pressure					
Tie Score	608	0.44	0.50	0	1
Trail by One Goal	608	0.17	0.38	0	1
Leading by One Goal	608	0.18	0.38	0	1
Trail by More than One Goal	608	0.10	0.30	0	1
Leading by More than One Goal	608	0.11	0.32	0	1
League Round					
First Round	608	0.49	0.50	0	1
Second Round	608	0.51	0.50	0	1
Penalty kicker's Team Position in a League					
Best Position	608	0.22	0.42	0	1
Better Position	608	0.10	0.29	0	1
Good Position	608	0.56	0.50	0	1
Bad Position	608	0.12	0.32	0	1
Goalkeeper's Team Position in a League					
Best Position	608	0.08	0.26	0	1
Better Position	608	0.08	0.28	0	1
Good Position	608	0.65	0.48	0	1
Bad Position	608	0.19	0.39	0	1
Kicker's Market Value (Million Euros)	608	24.02	36.05	0.2	180
Goalkeeper's Market Value (Million Euros)	608	9.00	15.68	0.2	100
Kicker's Scoring Rate (%)	608	78.72	34.40	0	100
Goalkeeper's Saving Rate (%)	608	19.91	28.31	0	100

From Error! Reference source not found. above, in about 77 percent of the cases, goalkeepers fail to save penalties, while the chances that a penalty is missed by being sent off the goal target are small (4 percent). On average about 19 percent of the penalties were saved by goalkeepers. Goalkeepers predicted and jumped to the correct side in 52 percent of all penalties taken.

Between 2015 and 2020, the chances that a goalkeeper faced a penalty kicker he has faced before was only 3 percent. This is because in each season, the goalkeeper and penalty kicker have only two matches in which they can meet,

and the probability of that match conceding a penalty to be taken by the same kicker and defended by the same goalkeeper is so minimal. In terms of time, approximately 61 percent of the penalties were conceded in the second half of the match because of time pressure which prompts people to make more mistakes than usual.

The majority of these penalties, 44 percent on average, were given when teams were tied. This is because both teams want to get the best results, so when they are in a tie, there is an emotional push to get better results than the other team, which makes players obsessed with results and forget the rules of the game, and hence prone to making more mistakes than normal. The difference between the proportion of penalties awarded in the first and second rounds of the league season is small (49 versus 51 percent).

Nevertheless, a high percentage of penalties, approximately 56 percent on the penalty kicker's side and 65 percent on the goalkeeper's side were conceded when their teams were in a good position (sixth to seventeenth position) in the league standings. The penalty kicker's market value, on average, was 24 million euros, while the goalkeeper's market value was 9 million euros. In addition, penalty kickers had a scoring rate that averaged 79 percent as compared to goalkeepers which had a saving rate of 20 percent because it is very difficult for the goalkeeper to save a penalty shot.

3.2 Regression Results

This section presents the results after estimating the Multinomial Probit model and Probit model. The first model investigates the effect of time, emotional pressure, and past information on saving a penalty due to heuristic decisions. The penalty saving variable has three unordered outcome categories namely, saved penalty (correct heuristic), conceded penalty (incorrect heuristic), and missed penalty (uncertain heuristic). Marginal effects at the mean values of the independent variables from the multinomial probit model estimation of penalty saving are presented in **Table 3**.

Table 2. Marginal Effects from the Multinomial Probit Model Estimation of Heuristic Penalty Saving

Variables	Categories	Categories of Penalty Outcomes		
		Saved	Conceded	Missed
Previous Meeting btn Kicker and Goalkeeper	Met Before=1	0.0634	-0.0533	-0.0101
		(0.0391)	(0.0360)	(0.0253)
Time Pressure	Second Half=1	-0.00610	-0.0326*	0.0387***
		(0.0180)	(0.0179)	(0.0146)
Winning Pressure *Base category=Tie score*	Trail by One Goal=1	0.0609**	-0.0167	-0.0442**
		(0.0265)	(0.0260)	(0.0177)
	Lead by One Goal=1	-0.0404*	0.0508**	-0.0104
		(0.0217)	(0.0225)	(0.0228)

Variables	Categories	Categories of Penalty Outcomes		
		Saved	Conceded	Missed
	Trail by More than One Goal=1	-0.0279	0.0758***	-0.0480***
		(0.0264)	(0.0259)	(0.0178)
	Lead by More than One Goal=1	-0.0529*	0.0840***	-0.0310
		(0.0318)	(0.0302)	(0.0226)
League Round	Second Round=1	0.0475***	-0.0404**	-0.00711
		(0.0159)	(0.0163)	(0.0139)
Penalty Kicker's Team Position *Base category=Best Position*	Better Position=1	0.0280	0.00535	-0.0334
		(0.0411)	(0.0406)	(0.0264)
	Good Position=1	0.0138	-0.0130	-0.000785
		(0.0353)	(0.0356)	(0.0296)
	Bad Position=1	0.0219	0.00665	-0.0285
		(0.0421)	(0.0413)	(0.0290)
Goalkeeper's Team Position *Base category=Best Position*	Better Position	0.0698	-0.0699	6.39e-05
		(0.0446)	(0.0440)	(0.0444)
	Good Position	0.0160	-0.0247	0.00873
		(0.0404)	(0.0381)	(0.0426)
	Bad Position	0.0350	-0.00773	-0.0273
		(0.0451)	(0.0424)	(0.0423)
Penalty Kicker's Scoring Rate		-0.00260***	0.0040***	-0.0014***
		(0.000246)	(0.0003)	(0.000263)
Goalkeeper's Saving Rate		0.00294***	-0.0018***	-0.0012***
		(0.000307)	(0.000372)	(0.000259)
Penalty Kicker's Market Value		-0.000351	0.000213	0.000138
		(0.000335)	(0.000341)	(0.000247)
Goalkeeper's Market Value		0.000201	-0.00002	-0.000177
		(0.00100)	(0.000969)	(0.000740)
Observations		608	608	608

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

NOTE: dy/dx for factor levels is the discrete change from the base level.

Results in **Table 3** show that the previous meeting between the goalkeeper and the kicker is not significantly correlated with penalty-saving. This is probably because goalkeepers and kickers can only meet twice in a season, and the chances of a penalty being conceded with the same goalkeeper and kicker are quite unlikely, so goalkeepers do not have many chances to learn the kickers from their meetings. Time pressure is significantly associated with penalty outcomes. Second-half penalties are associated with a higher likeliness of the kickers missing the target, and a lower probability of the goalkeeper's team conceding. Relative to the first half, the probability of the

kicker missing is higher by 3.9 percentage points, and the probability of a goalkeeper conceding is lower by 3 percentage points.

When the goalkeeper's team is trailing by one goal, the goalkeeper is more likely to save a penalty and the kickers are less likely to miss a penalty, that is, less likely to send the ball off target. The goalkeeper's team trailing by one goal is associated with 6.1 percentage points more probability of saving a penalty and 4.4 percentage points less probability of the kicker missing a penalty relative to when the teams are in a tie score. The goalkeeper's team trailing by more than one goal is associated with a higher probability of the goalkeeper conceding by 7.6 percentage points; and a lower probability of the penalty kicker missing a target by 4.8 percentage points compared to when the teams are in a tie.

In addition to that when the goalkeeper's team leads either by one or more goals (less winning pressure) the goalkeeper is more likely to fail to save the penalty. Relative to a tie score, leading by one goal is associated with 3.8 percentage points more probability of the goalkeeper failing to save a penalty; whereas leading by more than one goal is associated with 7.5 percentage points more probability that the goalkeeper concedes a penalty.

The second round of the league, being more intense as teams seek to position themselves better in the league's standings, is associated with better performance of the goalkeepers in saving penalties relative to kickers. A penalty occurring in the second round is associated with a higher probability of a goalkeeper saving a penalty kick by 4.7 percentage points and a lower probability of conceding from a penalty by 4 percentage points. The position of the teams in the league standing has no significant association with penalty outcomes.

The kicker's scoring rate and the goalkeeper's saving rate are both significantly associated with the penalty outcomes. This is reflective of the players' skills. Penalty takers with previous high penalty-scoring rates are more likely to score and less likely to miss or see their penalties saved. An increase of the kicker's scoring rate by 10 percentage points is associated with a 1.4 percentage points lower probability that the kicker will miss a penalty, 2.6 percentage points lower probability that the goalkeeper will save a penalty, and a 4 percentage points higher probability that the penalty will be scored.

Goalkeepers with previously high saving rates are more likely to save a penalty and less likely to concede. An increase of the goalkeeper's saving rate by 10 percentage points is associated with a 2.9 percentage points higher probability that the goalkeeper will save a penalty, 1.8 percentage points lower probability that the goalkeeper will concede, and 1.2 percentage points lower probability that the kicker will miss a target. On the other hand, the

kickers and goalkeepers' market values have no significant correlation with penalty outcomes. This is probably because their market value is associated with their skills and thus the effect of this variable is captured in the scoring and saving rate.

The second model examines the effect of time, emotional pressure; and past information on heuristic prediction of the direction of the ball by the goalkeeper during a penalty shootout. The penalty direction prediction variable has two outcomes: a correct heuristic prediction which occurs when a goalkeeper jumps in the direction in which the ball was sent by the kicker; and an incorrect heuristic prediction which occurs when the goalkeepers jump in a wrong direction. Marginal effects from the probit model estimation of the probability of incorrect heuristic prediction of ball direction are presented in **Table 4.**

Table 3. Marginal Effects from the Probit Model Estimation of Heuristic Prediction of Ball Direction

Variable	Categories	Heuristic Prediction of Ball Direction (Incorrect Prediction=1)
Previous Meeting btn Kicker and Goalkeeper	Met Before=1	-0.0611 (0.0943)
Time Pressure	Second Half=1	-0.112*** (0.0393)
Winning Pressure *Base category=Tie score*	Trail by One Goal=1	-0.0634 (0.0528)
	Lead by One Goal=1	0.0515 (0.0526)
	Trail by More than One Goal=1	0.0266 (0.0698)
	Lead by More than One Goal=1	0.158** (0.0615)
League Round	Second Round=1	-0.0238 (0.0369)
Penalty Kicker's Team Position *Base category=Best Position*	Better Position=1	-0.0906 (0.0801)
	Good Position=1	-0.00762 (0.0629)
	Bad Position=1	0.0357 (0.0823)
Goalkeeper's Team Position	Better Position	0.00960 (0.103)
	Good Position	0.00949

Variable	Categories	Heuristic Prediction of Ball Direction (Incorrect Prediction=1)
Base category=Best Position		(0.0915)
	Bad Position	0.0176
		(0.102)
Penalty Kicker's Scoring Rate		0.00445***
		(0.000655)
Goalkeeper's Saving Rate		-0.00353***
		(0.000843)
Penalty Kicker's Market Value		-0.000433
		(0.000728)
Goalkeeper's Market Value		0.00008
		(0.00151)
Observations		608

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

NOTE: dy/dx for factor levels is the discrete change from the base level.

Results in **Table 4** show that, only the time pressure factor, the goalkeeper's team leading by more than one goal, kicker's scoring rate, and goalkeeper's saving rate were found to be statistically significantly associated with the heuristic prediction of the direction of the ball. A penalty in the second half is associated with an 11 percentage points lower probability that the goalkeeper will predict the direction of the ball incorrectly.

When the goalkeeper's team is leading by more than one goal, the probability of the goalkeeper making incorrect predictions is higher. Leading by more than one goal is associated with a 15.8 percentage point more probability that the goalkeeper will predict the direction of the ball incorrectly.

When the goalkeeper's team leads by more than one goal, he may tend to be over-relaxed and thus increase the chances of jumping in the wrong direction of the ball. The kicker with a high-scoring rate is more likely to send the goalkeeper in the wrong direction. A 10-percentage point increase in the kicker's scoring rate is correlated with a 4.4 percent more probability of sending the keeper in the wrong direction. Goalkeepers with high saving rates are more likely to jump in the correct direction of the goal due to their skills. A 10-percentage point increase in the goalkeeper's saving rate is correlated with a 3.5 percent less probability of jumping in the wrong direction of the ball.

4. Discussion
Based on the above regression results, the following were deduced:

4.1. Time Pressure and decision making

Time is a very crucial element in decision-making processes. It is a medium in which decisions are made (Ariely & Zakay, 2001). From **Table 3** the second half, which has more time pressure, is associated with a higher probability of the penalty kicker missing the penalty and a lower probability of the goalkeeper making an incorrect heuristic decision and conceding.

Furthermore, from Error! Reference source not found., second-half time p ressure reduces the probability of the goalkeeper making an incorrect prediction of the direction of the ball compared to the first half which has less time pressure (first half) similar to the finding by Mullainathan and Shafir (2013). This implies that the second-half pressure forces goalkeepers to be keener and increase the chances of predicting the ball direction correctly, though that does not necessarily mean that the chances of saving the ball increase as shown in **Table 3**. On the other hand, the second-half pressure negatively affects the kickers and deters their chances to shoot on target and score.

Scarcity of time may be a factor in this occurrence. Due to a shortage of time, the goalkeeper becomes more cautious as his mind instinctively orients itself towards one goal: to make fewer mistakes and emerge victoriously. This affects his attention, and how he evaluates his choices and acts. This time pressure reduces the likelihood of making an incorrect decision. Furthermore, the penalty kicker's time pressure may force him to make rash decisions and miss the penalty or give the goalkeeper greater leeway to analyze the kicker's actions and save the penalty. Being pressured more to win is associated with taking more risks, from either the goalkeeper's or the kicker's side, which may come with rewarding or punitive results (Raghunathan & Pham, 1999).

The findings indicate that time pressure affects attention and choice assessment differently for goalkeepers and kickers, which has significant consequences for the theoretical framework and the application of decision-making procedures in this situation. Specifically, it emphasises that the cognitive processes underpinning decision-making in these two roles may differ, necessitating a more sophisticated use of the "rule of thumb" method. While the rule of thumb theory assumes a uniform, simplified strategy for making decisions under pressure, our findings suggest that economic agents (e.g., goalkeepers and kickers) may use different cognitive heuristics depending on their roles, experience, and the nature of the decision at hand. This distinction calls for further refining of the theoretical model, maybe incorporating role-specific biases and the variable influence of time pressure.

4.2. Emotions and decision making

Emotions are forces that can affect decision-making forces. Decisions can be seen as a conduit by which emotions drive daily attempts to escape negative feelings and increase positive feelings, even though they do so unconsciously

(Lerner et al., 2015). In this situation, football-related emotions were examined by three factors: winning pressure in terms of goal differences, league standing in terms of which round a match is being played, and a team's position in the league.

In terms of goal differences, as shown in **Table 3**, when the goalkeeper's team is trailing by one goal, the goalkeeper is more likely to save a penalty, and the kickers are less likely to miss a penalty. This implies that when the goalkeeper's side is trailing by one goal the kickers are also motivated to keep the lead and reduce the chances of missing the target, but the goalkeepers are keener to push the score to a tie, thus put their efforts to save the ball which, surpasses the kicker's motivation.

However, when the goalkeeper's side is leading by one goal or the gap between the keeper's and the kicker's team is more than one, either by leading or trailing, the goalkeepers are less likely to save the penalty. This implies that goalkeepers are relatively less keen on saving the penalty compared to the kickers when their teams are leading. When the goal margin is wide chances that the penalty incidence will change the results at the end are smaller, thus reducing the desire to keenly save the penalty.

In Error! Reference source not found., the goalkeeper's team leading by more t han one goal is associated with a higher probability of the goalkeeper making an incorrect prediction of the direction of the ball. This can be attributed to the fact that the goalkeeper becomes more confident that they can win the game due to the wider goal difference gap. Furthermore, being less pressured emotionally can cause one to make a boastful decision, which can lead to negative consequences in the future (Lerner et al., 2015).

Our findings show that the second round is correlated with a higher probability of a goalkeeper saving a penalty kick and a lower probability of a goalkeeper failing to save a penalty. The second round of the league season is normally intense with more pressure to win as teams fight to occupy higher positions in the league's standing. With a smaller number of matches to be played as the season is coming to an end goalkeeper are induced to increase mental concentration on the marking of the ball to avoid conceding (Mullainathan & Shafir, 2013).Generally, our findings indicate that positive emotions and negative emotions that seem out of control may relax the concentration and result in poor outcomes of heuristic decisions. Negative emotions that are within control motivate more concentration and produce desirable outcomes from heuristic decisions (Cahir & Thomas, 2010; Seo et al., 2007).

4.3. Kicker's scoring rate, goalkeeper's saving rate, and decision-making

A kicker's scoring rate is one of the indicators of a kicker's ability in a penalty session. Higher ability is expected to increase the probability of scoring from the spot (Krumer, 2020). If this information is known to the goalkeeper, it can serve as an alert on to what extent he should be prepared and be keen on the penalties. Our findings indicate that the scoring rate is not one-to-one with the increase in the probability of scoring by the kicker; a 10-percentage point increase in the scoring rate is associated with just a 4.4 percentage point increase in the probability of scoring from a spot. This indicates that goalkeepers are keener when they face prolific penalty-takers with high-scoring rates.

This might be attributable to the fact that saving a penalty is mostly dependent on the goalkeeper's quick reaction (Fariña et al., 2013). Saving a penalty requires the goalkeeper to respond quickly to the correct side where the ball was sent by the ball kicker. The goalkeeper must move quickly after guessing the side to jump and usually before the ball is kicked (Noël et al., 2021). However, most goalkeepers jump late after gaining more solid information regarding which side to jump on. As a result, even when they have prior information about the kicker, when they make their final decision and jump to a certain side, it is often too late and they end up failing to make a correct prediction and save a penalty (Fariña et al., 2013; Noël et al., 2021; Palacios-Huerta, 2003).

Goalkeepers with high saving rates are relatively more likely to predict the direction of the ball correctly, save a penalty, and less likely to concede during a penalty session. The saving rate of a goalkeeper in penalty kicks indicates his ability to secure the goal area and how much he can contribute to the team (Gelade, 2014). Furthermore, it constitutes the goalkeeper's (decision maker's) prior experience, which may be utilized as a learning platform and to improve technique and confidence when facing future penalties.

Past success affects present decisions because when a decision yields a good outcome, people are more likely to make the same decision in a comparable situation (Juliusson et al., 2005). Thus, if a goalkeeper makes a correct prediction and saves a penalty in the last game or play, it builds confidence in the goalkeeper that he can repeat the same tendency in the current play.

Furthermore, if a goalkeeper predicts correctly and saves a penalty in the last play, it lowers the confidence of the incoming penalty kicker, and he might end up failing to score. People, on the other hand, prefer to avoid making the same errors they have made in the past (Sagi & Friedland, 2007). So, when

kickers face good goalkeepers, they will also be keener, and at least the effort seems to improve the probability of directing the ball to the target but not that of scoring. Our findings generally indicate that past information and experience can, to some extent, improve heuristic decision-making.

5. Conclusion

Heuristic-based decision-making deserves more attention in an era where behavioural insights dominate policy interventions. The idea that policy contexts are complicated, as well as the idea that simple heuristic solutions could work well in some complicated situations, is not new. Heuristic studies provide a foundation for systematic examination of what works where and why, owing to their foundations in human behaviour (Mousavi, 2018).

This study aimed at analysing to what extent past information or experiences and emotional pressure affect the performance of heuristics in making decisions under time pressure. The study uses a penalty session in men's football to analyse the behaviour of a goalkeeper who has too little time to react to a penalty kick and much of his decision is based on heuristics. This mimics an economic decision-making context under time pressure, because the agent, in this case, the goalkeeper, has economic incentives to save the penalty to increase his market value and wages.

Using, data from all penalty incidences in Spanish *Laliga* from 2015 to 2020 (608 penalties), our findings indicate that, time and emotional pressure affect heuristic decision-making. Time pressure and the importance of the outcome may force an economic agent to increase his or her concentration which is associated with better outcomes of heuristic decisions. Positive emotions and negative emotions that are out of control may relax concentration and result in poor outcomes of heuristic decisions. Negative emotions that are within reach may motivate more concentration and produce desirable outcomes from heuristic decisions. Past information and experience can, to some extent, improve heuristic decision-making under time pressure.

Since heuristic decisions are made under time and emotional pressure, these two variables should be closely monitored, and if possible, the decision-making environment should be improved to accommodate emotional pressures to reduce the errors that may result from heuristic decisions. In the analytical arena, the results imply that models should factor in the state of the environment where decisions are made, for example in the parliaments or company boards.

In strategic policymaking, much of the literature assumes that the rational approach, which involves the selection of quantitative and objective features, is a fundamentally superior strategy. In constrained rationality theories,

decision-makers are considered to strive for it even though it cannot be fully achieved. However, this viewpoint is not unchallengeable. In a dynamic environment where decision-making processes must quickly respond to external changes, the capacity to update (imperfect) processes may be more important than the capacity to create a flawless process that is then frozen or only updated slowly (Krabuanrat & Phelps, 1998). Thus, the study on how decision-making is influenced can significantly improve strategic policymaking, in which this study has shown that time and emotional pressure can systematically alter the decision and hence affect the implementation of strategic policy.

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