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# The effect of paper versus realized losses on subsequent risk-taking: Field evidence from casino gambling

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In this paper, we test the realization effect, i.e., that risk-taking increases after a paper loss, whereas risk-taking decreases after a realized loss, using gambling data from a real casino. During a particular casino visit, losses are likely perceived as paper losses because the chance to offset prior losses remains effective until leaving the casino. However, when casino customers leave the casino, the final account balance is realized. Using individual-level slot machine gambling records, we find that risk-taking after paper losses increases during a visit and that this effect is more pronounced for larger losses. Conversely, risk-taking across multiple visits is not altered if the realized losses are comparatively small, whereas risk-taking is reduced if realized losses are comparatively large.

***Key words:*** decision making, realization effect, risk behavior, loss, field analysis

***JEL Classification:*** *D12, D14, D81*

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## 1. Introduction

How does a prior loss affect subsequent risk-taking behavior? Depending on how people engage in mental accounting activities, prior losses are evaluated differently (Thaler 1985). Within the same mental account, people evaluate several small losses jointly as one large loss, whereas across different mental accounts, people evaluate losses separately (Thaler 1999). Consequently, as long as losses are evaluated within the same mental account, losses are considered *paper losses* that are not regarded as final because there still exists a possibility to recoup these losses (Shefrin and Statman 1985). In contrast, if a mental account is closed, losses become *realized losses* that generate greater disutility than paper losses (Barberis and Xiong 2009, 2012; Ingersoll and Jin 2013).

Imas (2016) formalizes the effects of prior paper losses and prior realized losses on subsequent risk-taking, which he refers to as the realization effect. According to Imas (2016), a loss is realized when "money or another medium of value is transferred between accounts" (p. 2087). Based on the cumulative prospect theory by Tversky and Kahneman (1992), Imas (2016) predicts that individuals are likely to chase prior paper losses and thus increase subsequent risk-taking. In contrast, after realizing a loss, decision makers have internalized the loss and closed their mental account. When a decision maker closes a specific mental account, he or she also updates the reference point because subsequent prospects are evaluated relative to a new mental account. In turn, once the reference point is updated, decision makers no longer feel the urge to accept higher risks to avoid a loss. Imas (2016) even proposes that the level of risk-taking will be reduced after a prior realized loss because a decision maker is sensitized and thus exhibits a larger distaste for losses. Inspired by the work of Imas (2016), Merkle et al. (2019) further develop the theory of the realization effect. However, Merkle et al. (2019) predict that risk-taking after a realized loss will be the same as risk-taking before the realized loss because they assume that loss aversion remains constant.

So far, direct empirical evidence on the realization effect is scarce and only stems from experimental data.[1] Imas (2016) conducted several investment experiments that involve a sequence of four positively skewed lotteries. After the third lottery, individuals in the "paper treatment" simply continued to the fourth lottery, whereas individuals in the "realized treatment" had to transfer the amount lost to the experimenter before continuing. When comparing the investment amount in the third lottery to the fourth lottery of subjects that lost the first three lotteries, Imas (2016) finds that subjects in the "paper treatment" increased their investment in the fourth lottery, whereas subjects in the "realized treatment" decreased their investment. Thus, a decision maker engages in less risk-taking following a loss if the loss is realized and engages in more risk-taking if the loss is a paper loss. However, when Merkle et al. (2019) replicate the design by Imas (2016) using a larger sample size, they find only weak evidence for

[1] Several scholars have examined the effect of losses on individuals' risk-taking. Whereas some find that prior losses increase subsequent risk-taking (e.g., Barkan and Busemeyer 1999; Coval and Shumway 2005; Langer and Weber 2008; Smith et al. 2009), others find that prior losses reduce subsequent risk-taking (e.g., Shiv et al. 2005; Liu et al. 2010; Suhonen and Saastamoinen 2017). However, no prior study has addressed the difference between paper and realized losses in the field.

the realization effect.[2] Overall, even though the realization effect is intuitively appealing, it lacks empirical evidence.

In this paper, we test the realization effect using field data. We observe the risk-taking behavior of individual gamblers in a real-life Swiss casino within and across several visits. We thus follow earlier studies on risk-taking that have used data from casinos (e.g., Rüdisser et al. 2017; Flepp and Rüdisser 2019) or have implemented casino-style tasks in their experimental studies (e.g., Arkes et al. 1994; Weber and Zuchel 2005; Cárdenas et al. 2014). Moreover, the examination of casino customers is highly relevant because the majority of the population in western countries has participated in traditional forms of gambling such as wagering in casinos, betting or lottery gambling at least once in their lives (Potenza et al. 2002). For example, 86 percent of the general adult population has gambled in the United States (National Gambling Impact Study Commission 1999), and 69 percent of the general adult population has gambled in Switzerland (Dey and Haug 2019).

Our casino data allows us to differentiate between paper losses and realized losses. During a casino visit, a gambler's chance to offset prior losses remains effective until he or she leaves the casino. Moreover, all gamblers use a personalized playing card while gambling. Thus, no cash out occurs during their visit, and losses presumably remain paper losses. However, as soon as a casino customer leaves the casino, a money transfer takes place, and all losses are realized. Even Imas (2016) refers to the casino example of "cashing out and parting with the money after a loss" (p. 2087) when he illustrates the realization of losses. Furthermore, Merkle et al. (2019) conclude that a physical transfer of money is necessary to trigger the realization effect—a requirement that is also met by our setting. Thus, prior losses within a casino visit are likely treated as paper losses, whereas prior losses across casino visits are realized losses.

In addition to the clean separation of paper and realized prior losses, our field study offers several further advantages. First, losses occurring in the casino are indeed losses of one's own money rather than losses from an initial endowment, as in most laboratory studies. Second, losses in a casino are typically larger than losses in laboratory experiments, which reflects the size of prior outcomes of real-

[2] In addition, Merkle et al. (2019) and Nielsen (2019) find no realization effect for negatively skewed lotteries.

life decisions more accurately. Finally, the considerable variation in casino customers' loss sizes allows us to distinguish between the effects of smaller and larger prior losses.

Our data set contains individual-level gambling information of slot machine players that visited the casino at least once between October 1, 2015, and April 17, 2016 or between August 1, 2016, and November 30, 2016. For each session of a player, i.e., the gambling activity on a particular slot machine, we observe the date and the point in time within the day, which allows us to reconstruct each player's gambling behavior within and across visits. Most importantly, the data also include information on the amount wagered and the amount won or lost at a particular slot machine.

Using an individual player fixed-effects regression model, we find that during their casino visit, casino customers significantly increase their risk-taking in the presence of prior losses and that this effect further increases with the size of the loss. Conversely, when analyzing our data at the visit level where prior losses have been cashed out and thus are realized, we find that players significantly decrease their level of risk-taking if realized losses are larger than the median loss. However, realized losses below the median loss do not change the risk-taking behavior in the subsequent casino visit.

Our study contributes to the literature in several ways. Most importantly, we are the first to investigate the realization effect in the field. Using individual gambling data from a real casino allows us to distinguish between paper losses during a casino visit and realized losses across casino visits. Second, we find that individuals increase their risk-taking after paper losses during a particular casino visit, whereby this effect is more pronounced for larger losses. Thus, even small losses trigger greater risk-taking, but larger losses amplify this loss-chasing behavior. While the effect of the size of prior paper losses is implicitly contained in the model of Merkle et al. (2019), it has not been empirically tested so far. Finally, we show that risk-taking only decreases for larger prior realized losses across casino visits. Consequently, smaller realized losses do not seem to sensitize casino customers sufficiently to induce a change in their subsequent risk-taking behavior. This implies that a greater distaste for losses might only be triggered if losses are comparatively large.

The remainder of this paper is organized as follows. In Section 2, we describe the setting of the empirical examination and derive our hypotheses. In Section 3, we provide an overview of our data and estimation methods. In Section 4, we present our empirical results. In Section 5, we conclude.

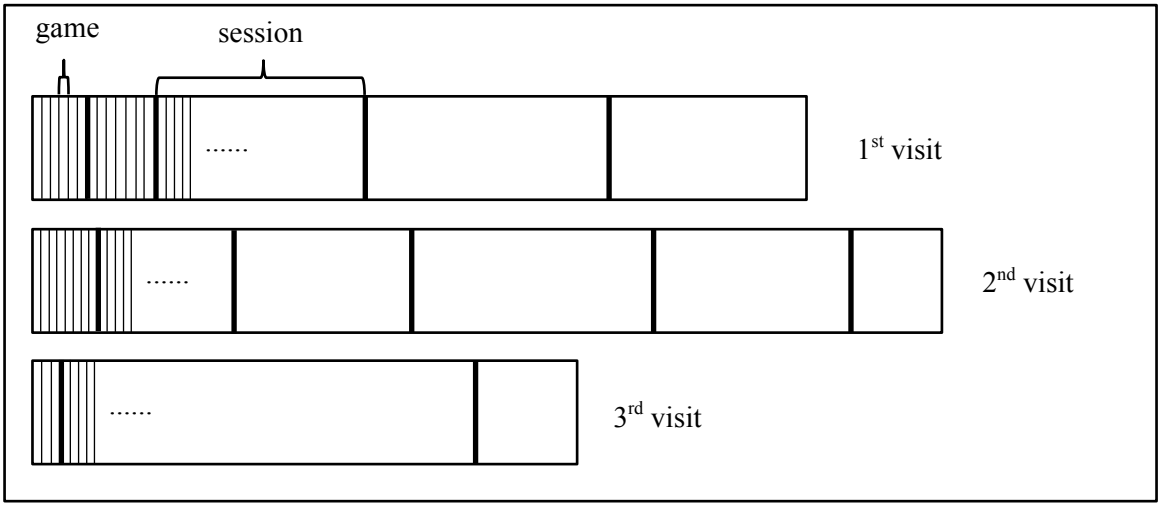
## 2. Casino Setting and Hypotheses

### 2.1. Casino Setting

In this study, we examine the gambling decisions of casino customers that are observed throughout and across their visits in a Swiss casino. Upon entering the casino, customers receive a personal playing card on which they load their preferred amount of money. This playing card must be used to play at slot machines and must be shown to the croupiers that operate the table games. Casino customers can reload their card at any point in time during their visit. At the end of the visit, the final account balance, i.e., the amount of money left on the playing card, is paid out and transferred back to the casino customers.

During the casino visit, customers may play one or more games at one particular slot machine or table. The aggregation of all games a customer plays at one particular slot machine or table before switching to a different gamble or leaving the casino is referred to as one session. In turn, a casino visit consists of one or more sessions played sequentially before leaving the casino. Figure 1 shows an illustrative example of a casino customer visiting the casino three times during a certain time period. This casino customer has five sessions throughout his or her first visit and plays six games in his or her first session.

**Figure 1.** Aggregation of Casino Data at the Visit, Session and Game Levels




The individual playing card allows the casino to systematically track the gambling behavior of casino customers throughout and across their visits. However, for their internal reporting procedures, the casino only records data at the session level. While slot machines automatically record the gambling

activity, the croupiers of the table games act as monitors and manually enter certain gambling data into the casino's system. Because croupiers record gambling data in less detail and accuracy than slot machines, the casino provided us with individual gambling records of slot machine players at the session level that can be aggregated at the visit level. Throughout all their visits, these casino customers gambled on slot machines only.

A casino constitutes an ideal setting to examine the risk-taking behavior of individuals. Indeed, other studies have used data from casinos to study risk-taking in the presence of prior outcomes (e.g., Rüdisser et al. 2017) or have implemented casino-style tasks in their experimental studies (e.g., Arkes et al. 1994; Weber and Zuchel 2005; Cárdenas et al. 2014). Moreover, casino data allow us to differentiate between paper losses and realized losses. On the one hand, it is presumable that a casino customer's mental account is not closed and the reference point is not updated between sessions within a visit. First, Merkle et al. (2019) find that a physical transfer of money is a necessary requirement to close an individual's mental account. In a casino, there is typically no physical transfer of the playing-card-money between sessions within a visit.[3] Second, casino customers who have experienced a loss throughout their previous session switch to a different slot machine at which the chance to offset prior losses remains effective as long as they stay in the casino. Third, Frydman et al. (2017) suggest that a mental account is rolled into the subsequent investment period if the reinvestment follows closely after the prior investment. In our setting, sessions typically directly follow one another.

On the other hand, at the end of a visit, casino customers realize their final account balance. When they go to the casino cashier, customers hand in their playing card and receive the accumulated amount of money in return, i.e., the final amount is physically transferred from the playing card to the casino customer. Consequently, after leaving the casino, a customer no longer has the chance to offset prior losses. Thus, we argue that casino customers realize their losses at the end of a visit and close their mental account accordingly.

[3] Even though the possibility exists, it seems unlikely that casino customers systematically cash out the money on their playing card and afterwards, instead of leaving the casino, reload the card to restart gambling. Such a behavior would only result in additional transaction costs in the form of lost gambling time.

## 2.2. Hypotheses

Individuals evaluate unrealized losses, i.e., paper losses, jointly within the same mental account (Thaler 1999). After experiencing such paper losses, decision makers feel hope that the upside of a lottery will erase the prior loss. Decision makers are therefore likely to increase their level of risk-taking due to the possibility to offset the prior losses (Imas 2016). In our study, we define paper losses as casino customers' losses at the end of a session within a visit. Thus, at the session level, we hypothesize that prior losses increase casino customers' levels of subsequent risk-taking. When analyzing casino customers' gambling behavior across sessions within the same visit, we test the following hypothesis:

*HYPOTHESIS 1. At the session level, casino customers increase their level of risk-taking after a loss.*

In contrast, individuals evaluate realized losses separately across different mental accounts (Thaler, 1999). After realizing a loss, a decision maker internalizes this loss, closes his or her mental account, and updates his or her reference point (Imas 2016). Thus, there is no option to break even anymore, and individuals stop chasing losses (Merkle et al. 2019). Moreover, Imas (2016) proposes that sensitization to further losses (Barberis et al. 2001; Thaler and Johnson 1990) translates into a larger distaste for losses.[4] Thus, the decision maker becomes more loss averse after a prior realized loss and is less willing to take on risks. As a consequence, the level of risk-taking is expected to be lower after a realized loss than before the loss. [5]

In our study, we define realized losses as the casino customer's losses at the end of a visit. Thus, at the visit level, we hypothesize that prior losses reduce a casino customer's level of risk-taking. When analyzing casino customers' gambling behavior across visits, we test the following hypothesis:

[4] Apart from sensitization, Imas (2016) refers to several further mechanisms such as the increased salience of the potential downside of risk (Bordalo et al. 2012), a change in mood (Loewenstein 1996) or a diminished capacity for dealing with negative events (e.g., Pagel 2017) that also produce a greater distaste for losses after a realized loss.

[5] In their model, Merkle et al. (2019) predict that individuals' risk-taking behavior is not affected after realized losses, while Imas (2016) argues that realized losses lead to an increase in the loss aversion parameter $\lambda$ and thus lower subsequent risk-taking. In contrast, Merkle et al. (2019) assume that realized losses have no effect on $\lambda$. Because the predictions by Imas (2016) and Merkle et al. (2019) are mutually exclusive, we solely rely on Imas (2016) to develop Hypothesis 2.

*HYPOTHESIS 2. At the visit level, casino customers reduce their level of risk-taking after a loss.*

Furthermore, we expect that the size of the prior loss affects the strength of the realization effect. Because individuals aim to recoup prior paper losses, they are willing to take greater subsequent risks (Imas, 2016). Therefore, individuals also care about the level of cumulative prior losses, and gambles that allow them to break even are especially attractive (Thaler and Johnson 1990; Suhonen and Saastamoinen 2017; Merkle et al. 2019). This implies that if prior paper losses are large, risk-taking must be even larger in order to break even. Indeed, Smith et al. (2009) find that the fraction of poker players playing more "loosely", i.e., putting money into the pot to hit a long-shot flop with a weak hand, consistently increases as the size of the prior loss increases. Thus, we hypothesize that larger prior losses during a visit lead to more pronounced risk-taking compared to smaller prior losses:

*HYPOTHESIS 3. At the session level, the size of the prior loss amplifies the increase in casino customers' level of risk-taking.*

Regarding the size of realized losses, Imas (2016) incorporates sensitization into his framework by allowing loss aversion to depend on prior realized losses. Therefore, a larger realized loss sensitizes the decision maker more than a smaller realized loss. Thus, we hypothesize that larger prior losses across visits lead to a more pronounced reduction in risk-taking compared to smaller prior losses:

*HYPOTHESIS 4. At the visit level, the size of the prior loss amplifies the decrease in casino customers' level of risk-taking.*

## 3. Data and Estimation Method

### 3.1. Data Set

Our data provided by a Swiss casino contain individual-level gambling information on slot machine players at the session and visit levels over the periods from October 1, 2015, to April 17, 2016, and from

August 1, 2016, to November 30, 2016.[6] First, we have information on the date of all the casino customers' visits and the chronology of the sessions within a visit. Second, the data set includes detailed information on the casino customers' gambling decisions. This information includes the total amount wagered, the number of games played, the amount of time spent, and the corresponding gambling outcomes, i.e., the total amount lost and won, on a specific slot machine.

Altogether, our data set contains 55,359 visits and 301,051 sessions of 7,467 casino customers. Table 1 contains descriptive statistics for our data set at both session and visit levels. A casino customer spends approximately two hours in the casino, on average, gambles on 5.44 slot machines and plays approximately 1,600 games per visit. During a visit, a casino customer wagers a total amount of approximately CHF 4,100 and loses CHF 228 on average.[7] At the session level, a casino customer spends on average approximately 23 minutes on a slot machine, gambles 295 games, wagers CHF 754 and loses CHF 42.

**Table 1.** Descriptive Statistics

| Variable | Mean | Median | Std. dev. |
|---|---|---|---|
| At visit level (N=55,359) | | | |
| *Number of minutes* | *124.87* | *82* | *133.15* |
| *Number of sessions* | *5.44* | *3* | *6.61* |
| *Number of games* | *1,605.41* | *867* | *2,041.38* |
| *Total amount wagered (CHF)* | *4099.87* | *1,457* | *10,860.02* |
| *Cumulative final balance (CHF)* | *-227.67* | *-100* | *1,500.63* |
| At session level (N=301,051) | | | |
| *Number of minutes* | *22.96* | *9* | *45.04* |
| *Number of games* | *295.21* | *108* | *637.61* |
| *Total amount wagered (CHF)* | *753.90* | *166* | *3,732.66* |
| *Cumulative final balance (CHF)* | *-41.87* | *-30* | *617.28* |

Notes: The table contains descriptive statistics of 7,467 casino customers at the session and visit levels.

Our data show that typical losses on an individual's casino visit are moderate. The median cumulative negative final balance at the end of a casino customer's visit is CHF 100. Relative to the median monthly income in Switzerland, this is a small amount of approximately 1.5%.[8] Moreover, the average

[6] The data from these two periods were initially provided in two separate files at two different arbitrary points in time. We requested the second file from the casino to address the issue of customers having visited the casino prior to the start of the data collection (see Section 3.2).

[7] The currency used in Switzerland is the Swiss franc (CHF). During the examination period, the CHF and the U.S. Dollar (USD) were approximately at par value.

[8] For detailed information on the monthly salaries in Switzerland compare the results published by the Swiss Federal Statistical Office (https://www.bfs.admin.ch/bfs/en/home/statistics/work-income/wages-income-employment-labour-costs.html).

casino customer in our data set visits the casino less than once a month, while the median figure is even lower. Thus, it is unlikely that the outcome of a casino visit significantly affects a casino customer's wealth, which, in turn, allows us to interpret casino customers' behavior as cognitive biases rather than wealth effects (Suhonen and Saastamoinen, 2017).

### 3.2. Data Preparation

To test the risk-taking behavior of casino customers after realized versus paper losses, we prepare our data separately at the session and visit levels. We follow Imas (2016) and employ sessions and visits in which casino customers have solely experienced losses. In his experiments, Imas (2016) examines individuals who have lost all their previous lotteries. This approach allows us to avoid the effects of gains on casino customers' risk-taking behavior and thus to isolate the effects of paper versus realized losses. At the session level, we focus on casino customers' first and second sessions of their visits. Specifically, we compare casino customers' risk level of their first session, i.e., their risk-taking when gambling at the reference point, with the corresponding second session if the first session ends with a loss, i.e., their risk-taking with a prior paper loss. Using this approach, we are left with 5,201 casino customers. In a further analysis, we compare casino customers' first session of a visit with all their subsequent consecutive loss sessions within the same visit, i.e., all subsequent sessions until the first gain session or until the customer leaves the casino.

At the visit level, we exploit the fact that our dataset consists of two different time periods—from October 1, 2015, to April 17, 2016, and from August 1, 2016, to November 30, 2016. If a realized loss actually decreases casino customers' risk-taking behavior in their subsequent visit, as we hypothesize in Section 2.2, we cannot employ the first visit of our dataset as the initial visit without any prior outcomes because this visit is potentially already influenced by its previous visit not included in our dataset. Thus, we restrict our dataset to casino customers that only appear in the second period of our dataset.[9] These casino customers have presumably not gambled at our casino before or are at least not regular

[9] Ideally, we would only analyze customers that visit the casino for the first time to ensure that there are no prior outcomes from gambling at this casino. However, the casino did not provide us with this information.

customers. We thus employ the first visit of those casino customers as a visit that is not influenced by prior outcomes and compare it with their second visit if the first visit ends with a loss. Using this approach, 815 casino customers remain for our visit-level analysis. Furthermore, we compare these casino customers' first visits with all their subsequent consecutive loss visits, i.e., all subsequent visits until the first gain visit or until the end of our dataset's time period.

### 3.3. Risk Variable

We employ the variable *total wager* as our risk measure. In our examination at the session level, the total wager is the total amount placed per session, whereas in our examination at the visit level, the total wager refers to the total amount wagered per visit. The higher the total wager is, the higher the potential return and, at the same time, the higher the potential loss. Thus, the total wager measures casino customers' level of risk-taking. A similar approach has been used in several other studies on individuals' risk-taking behavior (e.g., McGlothin 1956; Haigh and List 2005; Imas 2016; Rüdisser et al. 2017; Suhonen and Saastamoinen 2017; Flepp and Rüdisser 2019).

### 3.4. Independent Variables

We employ the variable *PriorLossDummy* as an indicator variable that denotes whether a casino customer has lost his or her prior session or visit. Thus, we are able to test how a prior loss affects risk-taking. Additionally, we include various control variables. To control for the effect of the gambling duration on our risk measure, we employ the number of games (*NumberOfGames*) casino customers play during their session or visit. To account for the differences between slot machines at the session level in terms of payout schemes, we include slot machine dummies (*SlotMachineDummies*). We further include a dummy variable for each calendar day (*DateDummies)* to account for differences between casino customers' visits and for differences between the point in time of casino visits, e.g., weekdays versus weekends or beginning versus end of the month. Additionally, we include individual player fixed effects to control for the different risk attitudes of casino customers. This allows us to control for unobserved but time-constant differences in casino customers' risk-taking behavior.

### 3.5. Estimation Equation

To analyze our unbalanced panel data set and to test our hypotheses presented in Section 2.2, we use an individual player fixed-effects ordinary least squares model. All our estimations use heteroscedasticity-robust standard errors. Our equation at the session level can be written as follows:

$$LogTotalWager_{is} = \alpha_i + \beta_1 PriorLossDummy_{is} + X'_{is}\beta + \varepsilon_{is}, \quad (1)$$

where *i* indicates the casino customer and *s* indicates the session. The dependent variable is the casino customer's total wager of a session measured on a logarithmic scale (*LogTotalWager*).[10] The variable of interest is *PriorLossDummy,* which is an indicator variable that denotes whether casino customer *i* has lost his or her prior session *s* within a visit. *X* contains the control variables *NumberOfGames*, *Slot-MachineDummies* and *DateDummies*.

Our equation at the visit level can be written as follows:

$$LogTotalWager_{iv} = \alpha_i + \beta_1 PriorLossDummy_{iv} + X'_{iv}\beta + \varepsilon_{iv}, \quad (2)$$

where *i* indicates the casino customer and *v* indicates the visit. The dependent variable is a casino customer's total wager of a visit measured on a logarithmic scale (*LogTotalWager*). The variable of interest (*PriorLossDummy*) is an indicator variable that denotes whether casino customer *i* has lost his or her prior visit. *X* contains the control variables *NumberOfGames* and *DateDummies*.

## 4. Results

### 4.1. Main Effect

To test the effect of paper losses on subsequent risk-taking, we estimate Equation (1) from Section 3.5. The results are displayed in columns (1) and (2) in Table 2. In column (1), we compare casino customers'

[10] We employ a logarithmic value in all our models because of the skewed distribution of the size of the wagers. Earlier studies have used a similar approach (e.g., Suhonen and Saastamoinen 2017; Flepp and Rüdisser 2019).

risk-taking behavior during the initial and second sessions if the initial session ends with a loss. In column (2), we compare casino customers' risk-taking behavior during the first session to all consecutive subsequent loss sessions.

Columns (1) and (2) show a positive and significant effect of a prior loss on the risk variable *LogTotalWager*. After an initial loss, the size of the total wager of the directly following session increases by 7.74% and for all following consecutive loss sessions together by 6.33%. Thus, our results support Hypothesis 1 that casino customers exhibit a higher level of risk-taking after losses within a visit. This finding suggests that casino customers become more risk-seeking after paper losses.

**Table 2.** Main Results at the Session Level

| | Dependent Variable = *LogTotalWager* | |
|---|---|---|
| | **Initial Loss Session** | **All Consecutive Loss Sessions** |
| | (1) | (2) |
| *PriorLossDummy* | 0.07735*** | 0.06328*** |
| | (8.75) | (7.61) |
| *NumberOfGames* | 0.00108*** | 0.00122*** |
| | (15.50) | (15.27) |
| *SlotMachine-Dummies* | X | X |
| *DateDummies* | X | X |
| Player Fixed Effects | X | X |
| Number of Casino Customers | 5,201 | 5,201 |
| Observations | 60,300 | 112,009 |
| Within $R^2$ | 0.35 | 0.35 |

Notes: We use heteroscedasticity-robust standard errors. The t-statistics are given in parentheses.

*** significant at 1%, ** significant at 5%, and * significant at 10%

Columns (1) and (2) in Table 3 display our results on the effect of realized losses on subsequent risk-taking from Equation (2) in Section 3.5. In column (1), we compare casino customers' risk-taking behavior during the first and second visits if the initial visit ends with a loss. In column (2), we compare casino customers' risk-taking behavior during the first visit to all subsequent consecutive loss visits.

Both columns (1) and (2) show insignificant results. Thus, losses from previous visits do not alter the level of subsequent risk-taking. In turn, our results do not support Hypothesis 2, which states that casino customers reduce their risk-taking behavior after a realized loss. However, sensitization to further

losses might be weak if realized prior losses are small. Thus, the size of the prior realized loss could constitute a critical factor in determining whether prior realized losses lead to less risk-taking.

**Table 3.** Main Results at the Visit Level

| | Dependent Variable = *LogTotalWager* | |
|---|---|---|
| | **Initial Loss Visit** | **All Consecutive Loss Visits** |
| | (1) | (2) |
| *PriorLossDummy* | -0.07935 | 0.00997 |
| | (-1.28) | (0.17) |
| *NumberOfGames* | 0.00057*** | 0.00051*** |
| | (12.43) | (10.53) |
| *DateDummies* | X | X |
| Player Fixed Effects | X | X |
| Number of Casino Customers | 815 | 815 |
| Observations | 1,630 | 2,653 |
| Within $R^2$ | 0.41 | 0.35 |

Notes: We use heteroscedasticity-robust standard errors. The t-statistics are given in parentheses.

*** significant at 1%, ** significant at 5%, and * significant at 10%

### 4.2. Loss Size Effect

Starting at the session level, we use two different approaches to test the effect of the loss size on casino customers' risk-taking behavior. First, as shown in columns (1) and (3) in Table 4, we add the variable *PriorCumulativeLoss* to Equation (1) from Section 3.5. In column (1), this variable measures the loss size of the initial session, whereas in column (3), the variable measures the cumulative losses of all the subsequent prior loss sessions within a casino customer's visit. Second, in columns (2) and (4) in Table 4, we replace the independent variable of interest in Equation (1) from Section 3.5 by two dummy variables that split the prior losses into prior losses below the median loss (i.e., *BelowMedianLossDummy* =1) and prior losses equal or above the median loss (i.e., *AboveMedianLossDummy*=1*)*.[11] In column (2), the median loss size of the first session is CHF 60, whereas in column (4), the median cumulative loss size of all consecutive loss sessions is CHF 146. This approach allows us to compare the risk taken in

[11] 30,150 sessions in column (2) and 81,859 sessions in column (4) contain a prior loss. We calculate the corresponding median cumulative loss based on these sessions containing a prior loss.

the initial session with the risk taken in subsequent sessions depending on whether the prior cumulative loss is smaller or larger than the median prior cumulative loss.

In columns (1) and (3), the variables *PriorLossDummy* and *PriorCumulativeLoss* are positive and significant. Thus, the higher the loss size of the prior sessions is, the more risk the casino customers take. Furthermore, both variables *BelowMedianLossDummy* and *AboveMedianLossDummy* in columns (2) and (4) are positive and significant. This finding implies that already small paper losses trigger increased risk-taking in subsequent gambling. Additionally, we conduct an F-test to evaluate whether the variables *BelowMedianLossDummy* and *AboveMedianLossDummy* are significantly different from each other. In column (2), the variables do not significantly differ from each other (p-value=0.1021), whereas in column (4), we find a significant difference (p-value=0.0000).

Overall, these results support Hypothesis 3, in that larger prior paper losses during a visit increase risk-taking more than smaller prior paper losses. However, the effect of small prior losses remains significant, implying that even small paper losses are able to trigger more risk-seeking behavior.

**Table 4.** Effect of Loss Size at the Session Level

| | Dependent Variable = *LogTotalWager* | | | |
|---|---|---|---|---|
| | **Initial Loss Session** | | **All Consecutive Loss Sessions** | |
| | (1) | (2) | (3) | (4) |
| *PriorLossDummy* | 0.07304*** | | 0.05427*** | |
| | (8.08) | | (6.23) | |
| *PriorCumulative-Loss* | 0.00003** | | 0.00003*** | |
| | (2.13) | | (2.88) | |
| *BelowMedi-anLossDummy* | | 0.0646*** | | 0.03709*** |
| | | (5.85) | | (4.15) |
| *AboveMedi-anLossDummy* | | 0.08910*** | | 0.09244*** |
| | | (7.42) | | (8.48) |
| *NumberOfGames* | 0.00108*** | 0.00108*** | 0.00122*** | 0.00122*** |
| | (15.48) | (15.50) | (15.26) | (15.27) |
| *SlotMachine-Dummies* | X | X | X | X |
| *DateDummies* | X | X | X | X |
| Player Fixed Effects | X | X | X | X |
| Number of Casino Customers | 5,201 | 5,201 | 5,201 | 5,201 |
| Observations | 60,300 | 60,300 | 112,009 | 112,009 |
| Within $R^2$ | 0.35 | 0.35 | 0.35 | 0.35 |

Notes: We use heteroscedasticity-robust standard errors. The t-statistics are given in parentheses.

*** significant at 1%, ** significant at 5%, and * significant at 10%

At the visit level, our approach to measure the effect of the loss size on subsequent risk-taking is analogous to the approach at session level. In columns (1) and (3) in Table 5, we add the variable *PriorCumulativeLoss* to Equation (2) from Section 3.5. In columns (2) and (4) in Table 5, we replace the variable of interest in Equation (2) from Section 3.5 with the variables *BelowMedianLossDummy* and *AboveMedianLossDummy*. [12] In column (2), the median loss size of the first visit is CHF 169, whereas in column (4), the median prior cumulative loss size of all consecutive loss visits is CHF 438.

In columns (1) and (3), the effect of a prior loss remains insignificant, whereas the continuous variable *PriorCumulativeLoss* is negative and significant. Thus, our results confirm that a prior realized loss per se does not change an individual's subsequent level of risk-taking. However, we find evidence that the size of a loss at the visit level has an effect on casino customers' risk-taking behavior. Moreover, in both columns (2) and (4), the variable *BelowMedianLossDummy* is insignificant, and the variable *AboveMedianLossDummy* is negative and significant. Using an F-test, we find that these two variables are significantly different from each other (p-value=0.0001 in column (2) and p-value=0.0036 in column (4)).

Altogether, we find evidence that risk-taking decreases with the size of the loss, which supports Hypothesis 4. However, small realized losses do not seem to induce a change in subsequent risk-taking behavior. Only comparatively large realized losses seem to trigger sensitization and thus a larger distaste for losses, which in turn translates into lower risk-taking of casino customers in their following visit.

[12] 815 visits in column (2) and 1,803 visits in column (4) contain a prior loss. We calculate the corresponding median cumulative loss based on these visits containing a prior loss.

**Table 5.** Effect of Loss Size at the Visit Level

| | Dependent Variable = *LogTotalWager* | | | |
|---|---|---|---|---|
| | **Initial Loss Visit** | | **All Consecutive Loss Visits** | |
| | (1) | (2) | (3) | (4) |
| *PriorLossDummy* | -0.04448<br>(-0.69) | | 0.01243<br>(0.20) | |
| *PriorCumulative-Loss* | -0.00008*<br>(-1.90) | | -0.00010***<br>(-2.99) | |
| *BelowMedi-anLossDummy* | | 0.10237<br>(1.30) | | 0.05227<br>(0.87) |
| *AboveMedi-anLossDummy* | | -0.25919***<br>(-3.54) | | -0.13818*<br>(-1.82) |
| *NumberOfGames* | 0.00057***<br>(12.34) | 0.00056***<br>(12.31) | 0.00050***<br>(10.56) | 0.00050***<br>(10.54) |
| *DateDummies* | X | X | X | X |
| Player Fixed Ef-fects | X | X | X | X |
| Number of Casino Customers | 815 | 815 | 815 | 815 |
| Observations | 1,630 | 1,630 | 2,653 | 2,653 |
| Within $R^2$ | 0.41 | 0.42 | 0.36 | 0.35 |

Notes: We use heteroscedasticity-robust standard errors. The t-statistics are given in parentheses.

*** significant at 1%, ** significant at 5%, and * significant at 10%

## 5. Conclusion

In this study, we examine the realization effect in the field using individual gambling data from a Swiss casino. This unique setting allows us to clearly differentiate between paper losses occurring during a casino customer's visit and realized losses across a casino customer's visits. We find evidence that casino customers increase risk-taking after paper losses within a visit and that this effect is more pronounced for larger losses. In contrast, our results on the visit level show that realized losses reduce subsequent risk-taking only if losses are comparatively large. Thus, it seems that small realized losses do not sensitize casino customers sufficiently to change their risk-taking behavior. Overall, these findings suggest that the size of the prior loss is an important determinant regarding subsequent risk-taking.

Our results have important implications for casino operators. Casinos typically aim to encourage their customers to stay longer and gamble more (Ho et al. 2019). While this behavior likely translates into higher revenues for casinos due to the increased risk-taking of gamblers during their visit, it might

be detrimental because gamblers will be more cautious in their subsequent visits if their prior losses are comparatively large. Indeed, the subgroup of casino customers in our visit-level analysis that experiences a loss above the median and do not win in their second visit lose, on average, approximately CHF 716 during their first visit but only approximately CHF 607 during their second visit. Thus, casino operators could more actively manage this trade-off by preventing customers from accumulating large losses within a visit. More generally, our findings also have significant managerial implications. Given that the size of paper losses further increases the propensity to take risks, it becomes crucial that any paper losses are recognized and realized as early as possible. For example, paper losses from investment decisions could be automatically reported to the overseeing department in order to close the mental account associated with the paper loss.

Although our casino setting offers many advantages, some limitations remain. First, we do not observe whether casino customers already exhibit prior outcomes from previous visits when we observe them for the first time in our data. We address this issue by restricting our visit-level analysis on casino customers that do not show up in the first of our two data periods. This step allows us to identify and exclude regular customers but not customers with prior outcomes who only rarely visit the casino. Second, our visit-level analysis is further restricted to customers who visit the casino at least twice within our second data period. However, one could interpret the decision not to visit the casino again after a realized loss as a sign of increased risk aversion. In this case, our results would indicate a lower boundary of the decreased risk-taking level found across visits.

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