METHODS

Survivorship bias on the momentum effect: Evidence from the Portuguese market

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This study reports survivorship bias for the momentum effect. Effectively, this study shows that the Portuguese stock market does not exhibit the "momentum effect" when all listed stocks are considered spanning the period from January 1991 to December 2016. However, this phenomenon was detected when only survivor stocks are used. This study also shows that average returns for momentum portfolios were similar before and after the 2007 financial crisis.

Keywords: momentum strategy, survivorship bias, portfolio investment

1. Introduction

Jegadeesh and Titman (1) were the first to document the "momentum effect." They evaluated the North American market over a 24-year period (starting in 1965) and showed that over 3–12-month periods, stocks with best (or worst) performance had higher (or lower) rentabilities compared to the immediately subsequent period. The authors concluded that buying past winner stocks and the sale of past loser stocks, based on 3–12-month periods, allowed the acquisition of supernormal earnings. Jegadeesh and Titman (2) conducted the same analysis from 1990 and 1998 and obtained similar results. This phenomenon was also documented for other geographical regions, including 12 European markets (3).

Several studies have suggested that the abnormal returns of momentum effect strategies are not explained by risk. Jegadeesh and Titman (4) used Fama and French (5) three-factor model to alter the profitability of momentum strategies to account for systematic risk, but the strategy's anomalous returns continued. Avramov and Chordia (6) used the Carhart (7) model, which adds a momentum variable to the three-factor model of Fama and French (5), to capture differences in the stock portfolios of winners and losers.

These studies demonstrate that the momentum effect is not due to the exposure to risk factors that generate returns.

A sub-reaction to new information might provide a viable explanation for the momentum effect (2, 8, 9). Other studies link the performance of momentum strategies with the characteristics of stocks. For instance, the profits collected through the momentum effect appear to be negatively linked with the characteristics of the issuers (1–3). In comparison, other studies state that there is no evidence that the higher returns of momentum strategies are only associated with stocks of small size but are present in every dimension category.

Avramov et al. (10) argued that the stocks of companies with high levels of rating do not show the momentum effect, whereas issuing stocks with low levels of ratings do. Some studies on momentum have demonstrated a certain degree of seasonality. Jegadeesh and Titman (1) observed that, between 1965 and 1989, momentum strategies lose in January. In comparison, positive returns were obtained in the subsequent months. The same study identified December as the month with the high profits under the momentum strategy. Grinblatt and Moskowitz (11) also identified December as the month with higher profitability for the momentum strategy, followed by April and November.

This study aimed to advance our understanding of the momentum effect in Portugal. First, 26 years of data (January 1991 to December 2006) were used to detect whether the momentum effect. Second, this study investigates whether survival bias exists within the momentum effect. Namely, differences in the strategy results were analyzed when using different groups, including (1) stocks that survived in the market and (2) all stocks that were listed only during certain parts of the sampling period. The first objective was selected because recent studies have detected the disappearance of the momentum effect over the past decade (12, 13). The second objective was selected because there is currently no published literature on the effect of (eventual) survival bias in relation to the momentum effect. Survival bias has been detected in relation to the performance of stock portfolios, particularly investment funds [e.g., (14, 15)]. Basically, metrics undervalue performance when only considering market survivors. The momentum effect might be equally undervalued if it is only calculated using surviving stocks, overlooking all other stocks that have entered and left the market, due to insolvency, fusion, takeover, or other reasons.

2. Methodology and data

This study was based on the Portuguese stock market. The time period of the study spanned January 1991 to December 2016. The factors data of Fama and French (5) were obtained from the Professor Kenneth R. French web page. The rest of the information came from the Thomson Reuters Datastream database.

The momentum strategy portfolio (winner and loser portfolio) was calculated using the methodology of Jegadeesh and Titman (1, 2). The momentum strategies were built by picking stocks based on their returns during the previous J months ($J = 3, 6, 9, 12$) and detecting them over the following K months ($K = 3, 6, 9, 12$). The stocks were ordered by ascending order of past profitability and were then divided into deciles, giving the same weight to all stocks. Stocks with lesser profitability (losers) were found in the first decile, whereas stocks with better returns were found in the final decile (winners). The momentum strategy involves a short position (sale) for loser stocks and a long position (purchase) for winner stocks in each T month, during the K months immediately subsequent to the formation of the portfolio.

In a subsequent period, we aimed to verify whether there was an abnormal return of the momentum strategy using the Fama and French (5) model. Specifically, we aimed to verify whether the alpha coefficient of equation (1) was distinct from zero and whether it was positive or negative.

$$RWmL \, t = \alpha + \beta_i \, (RM - RF) + s_i SMB + h_i HML + \varepsilon i \quad (1)$$

In this equation, two factors were added to the market excess return over the risk-free rate (RM-RF): (1) the small-minus-big (SMB) effect, which refers to the difference in returns

between portfolios with small versus large capitalizations, and (2) the difference in returns between stocks having high and low book-to-market ratios, also known as the high-minus-low effect (HML).

Finally, to detect distinct results for the period before and after the financial crisis of 2007, including the comparison of the medium returns of momentum portfolios before and after the crisis, we added a variable DUMMY to the model. This variable took zero values for the period before the crisis and values after the crisis.

3. Results and discussion

3.1. Momentum returns when applying the Jegadeesh and Titman approach

Table 1 presents the results obtained for different winner and loser portfolios, as well as for the momentum portfolio. These results consider all listed stocks listed, not just surviving stocks.

Only a momentum portfolio presents a positive result that is statistically significant (to the 5% level, corresponding to $J = K = 12$). A larger momentum portfolio could produce positive and statistically relevant results. Some momentum portfolios had negative results, including all portfolios with holding periods of 3 months.

There was a large contribution to the negative returns obtained in winner portfolios over 3, 6, and 9 months observation periods, with holding periods of 3–6 months. All winner portfolios had negative returns that were statistically relevant.

For loser portfolios, only strategy $J = K = 12$ obtained negative profitability that was statistically relevant. This strategy significantly contributed to the momentum portfolio, leading to positive profitability. We obtained positive returns for loser portfolios with observation periods of 3, 6, and 9 months and holdings of 3 months. For all remaining portfolios, results that were statistically distinct from zero were not reached.

Therefore, during the observation period, the momentum effect was only evidenced for strategy $J = K = 12$. For all the other temporal horizons, there was no evidence of this effect. Thus, the obtained results were consistent with those of Hwang and Rubesam (12) and Daniel and Moskowitz (13), who detected low or no expression of the momentum strategy in recent years.

Table 2 presents the result of an identical exercise, but only considering stocks that did not leave the stock market. In January 1991, our sample contained 17 stocks, while it contained 45 stocks in December 2016, with an average of 35 stocks.

The results obtained with the momentum strategy noticeably differed to those presented in **Table 1**. In this instance, most momentum portfolios obtained

TABLE 1 | Monthly returns of momentum strategy portfolios (all stocks included).

	Holding period 3 months			Holding period 6 months			Holding period 9 months			Holding period 12 months		
	Winners	*Losers*	*Momentum*	*Winners*	*Losers*	*Momentum*	*Winners*	*Losers*	*Momentum*	*Winners*	*Losers*	*Momentum*
Observation period: 3 months												
Average	−0.0089***	0.0079***	-0.0168***	−0.0066**	−0.0008	−0.0058	−0.0024	−0.0018	−0.0006	−0.0037	−0.0017	−0.0021
t-stat	(−3.47)	(2.58)	(−4.38)	(−2.54)	(−0.25)	(−1.51)	(−1.12)	(−0.65)	(−0.19)	(−1.37)	(−0.54)	(−0.56)
Standard deviation	0.0442	0.0532	0.0663	0.0453	0.0537	0.0673	0.0371	0.0478	0.0543	0.0473	0.0526	0.0650
Reward-to-risk ratio	−0.2004	0.1490	−0.2531	−0.1466	−0.0146	−0.0869	−0.0638	−0.0372	−0.0108	−0.0793	−0.0314	−0.0323
Observation period: 6 months												
Average	−0.0099***	0.0069**	−0.0167***	−0.0041*	−0.0005	−0.0037	−0.0032	−0.0013	−0.0019	−0.0035	−0.0012	−0.0023
t-stat	(−4.14)	(2.34)	(−4.82)	(−1.89)	(−0.14)	(−1.02)	(−1.44)	(−0.50)	(−0.61)	(−1.60)	(−0.39)	(−0.66)
Standard deviation	0.0413	0.0508	0.0602	0.0377	0.0547	0.0623	0.0393	0.0472	0.0548	0.0375	0.0522	0.0594
Reward-to-risk ratio	−0.2391	0.1350	−0.2781	−0.1093	−0.0083	−0.0588	−0.0824	−0.0284	−0.0347	−0.0921	−0.0226	−0.0383
Observation period: 9 months												
Average	−0.0059***	0.0056*	−0.0115***	−0.0037*	0.0017	−0.0054	−0.0024	−0.0010	−0.0014	−0.0006	−0.0036	0.0030
t-stat	(−2.75)	(1.91)	(−3.29)	(−1.71)	(0.55)	(−1.61)	(−1.02)	(−0.33)	(−0.38)	(−0.25)	(−1.18)	(0.88)
Standard deviation	0.0372	0.0502	0.0602	0.0376	0.0518	0.0576	0.0402	0.0527	0.0618	0.0387	0.0520	0.0592
Reward-to-risk ratio	−0.1596	0.1109	−0.1911	−0.0993	0.0319	−0.0935	−0,0594	−0.0193	−0.0221	−0.0144	−0.0684	0.0506
Observation period: 12 months												
Average	−0.0028	0.0030	−0.0058*	0.0005	−0.0010	0.0015	0.0003	−0.0023	0.0026	0.0026	−0.0057*	0.0083**
t-stat	(−1.21)	(1.07)	(−1.69)	(0.23)	(−0.32)	(0.41)	(0.15)	(−0.72)	(0.73)	(1.14)	(−1.82)	(2.15)
Standard deviation	0.0394	0.0495	0.0595	0.0409	0.0520	0.0633	0.0393	0.0548	0.0624	0.0395	0.0540	0.0666
Reward-to-risk ratio	−0.0698	0.0616	−0.0974	0.0130	−0.0186	0.0237	0.0087	−0.0419	0.0423	0.0660	−0.1050	0..1243

Obs.: portfolios of the momentum strategy are formed based on the stock's performance of the last *J* months (observation period) and held during *K* months (holding period). In the first row and column, the *J* and *K* values for the various techniques are indicated. The stocks were ordered in ascending order at the end of each month based on their performance over the previous *J* months. Subsequently, the stocks were divided into 10 equally weighted deciles, each decile corresponding to a portfolio of stocks. The portfolio of the first decile (worst performance) is designated as the loser, while the portfolio of the last decile (best performance) is indicated by the winner. Finally, stocks are held during *K* months. This table shows the average returns for the winners, losers, and WmL (winners minus losers) portfolios built using all stocks listed in Euronext Lisbon between January 1991 and December 2016 (300 months). The risk-reward ratio is the split between the average and standard deviation. t-stat refers to Student's *t*-test for the null hypothesis of average equal zero.
*Statistical significance at 10%,
**Statistical significance at 5%,
***Statistical significance at 1%.

positive results that were statistically relevant (13/16). The major contributors of the momentum strategy were the loser portfolios.

The momentum strategy *J* = *K* = 3 produced the highest profitability of all strategies, followed by *J* = 3 and *K* = 12. Overall, these three strategies had a monthly average profitability that was slightly higher than 1%. By analyzing the returns of the winner portfolios, only 2 of 16 cases produced statistically relevant positive results. However, most of the loser portfolios produced statistically relevant negative results (13/16).

These contrasting results provide evidence for survival bias in the momentum strategy. Survival bias is an effect that has been detected in financial markets, particularly investment funds. There is a clear difference between skewed and non-skewed portfolios. Non-skewed portfolios are those constituted by all available stocks or funds in the market during the analyzed period. Skewed portfolios are only the stocks or funds that survive to the final period (15). The results obtained by this study demonstrate that only

portfolios without non-surviving stocks obtain positive and statistically relevant results.

This study did not aim to explain why the results diverged between skewed and non-skewed portfolios. One possible reason is the departure of stocks from the stock market as a sequence of takeover. If a stock departs the stock market after a period where their returns registered a higher performance, this stock would be substituted in the subsequent period for another stock that has a lower performance, leading to the momentum effect, with it having lower performance than the first stock if it had remained in the stock market. This phenomenon would cause the momentum effect to fade when considering all stocks together.

3.2. Abnormal returns when using the Fama and French three-factor model

Panels I and II in **Table 3** present estimations of the equation alphas using the explained variable for the momentum strategy returns. In panel 1 (all stocks), only an alpha was positive and statistically relevant. This alpha belonged to

TABLE 2 | Monthly returns of momentum strategy portfolios (survivors stocks sample).

	Holding period 3 months			Holding period 6 months			Holding period 9 months			Holding period 12 months		
	Winners	*Losers*	*Momentum*	*Winners*	*Losers*	*Momentum*	*Winners*	*Losers*	*Momentum*	*Winners*	*Losers*	*Momentum*
Observation period: 3 months												
Average	0.0044*	−0.0060**	0.0103***	0.0025	−0.0053**	0.0079***	0.0024	−0.0064***	0.0088***	0.0046**	−0.0056**	0.0102***
t-stat	(1.91)	(−2.53)	(3.69)	(1.13)	(−2.26)	(2.83)	(1.27)	(−2.83)	(3.71)	(2.03)	(−2.45)	(3.92)
Standard deviation	0.0395	0.0408	0.0485	0.0387	0.0409	0.0480	0.0334	0.0397	0.0417	0.04	0.0395	0.0451
Reward-to-risk ratio	0.1103	−0.1462	0.2129	0.0651	−0.1307	0.1636	0.0727	−0.1618	0.2124	0.115	−0.1418	0.2262
Observation period: 6 months												
Average	0.0029	−0.0064**	0.0093***	−0.0003	−0.0044*	0.0040	0.0015	−0.0069**	0.0084***	0.0013	−0.0045*	0.0058**
t-stat	(1.24)	(−2.46)	(2.98)	(−0.15)	(−1.69)	(1.34)	(0.73)	(−2.51)	(2.99)	(0.59)	(−1.84)	(2.13)
Standard deviation	0.0411	0.0450	0.0542	0.0402	0.0448	0.0520	0.0367	0.0483	0.0495	0.0387	0.0421	0.0470
Reward-to-risk ratio	0.0714	−0.1421	0.1722	−0.0084	-0.0975	0.0775	0.0418	−0.1430	0.1706	0.0339	−0.1064	0.1232
Observation period: 9 months												
Average	0.0025	−0.0055*	0.0080**	0.0038	−0.0055*	0.0093***	0.0018	−0.0048*	0.0065**	0.0035	−0.0052**	0.0087***
t-stat	(1.02)	(−1.94)	(2.40)	(1.64)	(−1.94)	(2.88)	(0.75)	(−1.78)	(2.02)	(1.61)	(−1.85)	(2.74)
Standard deviation	0.0421	0.0484	0.0571	0.0396	0.0491	0.0558	0.0403	0.0462	0.0491	0.0375	0.0492	0.0551
Reward-to-risk ratio	0.0592	−0.1128	0.1394	0.0950	−0.1128	0.1665	0.0437	−0.1035	0.1333	0.0927	−0.1066	0.1582
Observation period: 12 months												
Average	0.0016	−0.0052*	0.0068**	0.0019	−0.0027	0.0046	0.0033	−0.0034	0.0067**	0.0015	−0.0033	0.0048
t-stat	(0.74)	(−1.84)	(2.21)	(0.86)	(−0.98)	(1.53)	(1.40)	(−1.21)	(2.33)	(0.71)	(−1.28)	(1.63)
Standard deviation	0.0379	0.0491	0.0536	0.0383	0.0473	0.0519	0.0404	0.0481	0.0494	0.0367	0.0454	0.0513
Reward-to-risk ratio	0.0430	−0.1061	0.1276	0.0496	−0.0565	0.0881	0.0815	−0.0702	0.1350	0.0408	−0.0736	0.0943

Obs.: portfolios of the momentum strategy are formed based on the stock's performance of the last J months (observation period) and held during k months (holding period). In the first row and column, the *J* and *K* values for the various techniques are indicated. The stocks were ordered in ascending order at the end of each month based on their performance over the previous J months. Subsequently, the stocks were divided into 10 equally weighted deciles, each decile corresponding to a portfolio of stocks. The loser is the portfolio in the first decile (the worst performance), while the winner is the portfolio in the final decile (the highest performance). Finally, stocks are held during K months. This table shows the average returns for the winners, losers, and WmL (winners minus losers) portfolios built using only the stocks listed in Euronext Lisbon between January 1991 and December 2016 (300 months) that stay listed (Survivors Stock Sample). The risk-reward ratio is the split between the average and standard deviation. t-stat refers to Student's *t*-test for the null hypothesis of average equal zero.
*Statistical significance at 10,
**Statistical significance at 5%,
***Statistical significance at 1%.

the *J* = *K* = 12 portfolio and was consistent with the data reported in **Table 1**. Panel II (survivors stocks) only presents data of surviving stocks, and the results were consistent with those presented in **Table 2**. In fact, most of the alpha values were positive and statistically relevant (14/16). Thus, even after applying risk factors to the momentum portfolio returns, positive abnormal returns were still obtained. The most profitable strategy was still *J* = *K* = 12, closely followed by *J* = 9 and *K* = 6, both with monthly average returns slightly above 1%.

When controlling the model factors of Fama and French (5), there was evidence of abnormal positive returns for momentum when only considering surviving stocks, but not when using all stocks.

Panels I and II of **Table 3** present the estimated alphas based on the returns of winner and loser portfolios as dependent variables, respectively, using a survivor sample in both cases. The winner portfolios did not present abnormal results, whereas the loser portfolios presented abnormal negative results. Thus, the momentum effect detected when just using surviving stocks was caused by the persistence

of abnormal negative performance. These results were consistent with those reported in **Table 2**.

3.3. Momentum before and after the financial crisis

Finally, we examined whether the financial crisis influenced the momentum effect. We examined the return structure for a series of both winner and loser momentum portfolios. Evidence of a break in the structure was not detected. The results of the momentum strategy for January 1991 to December 2007 (before the crisis) and for January 2008 to December 2006 (after crisis) were assessed. We then calculated the average returns for each period, as well as their differences, and we tested the average difference. **Table 4** presents the average return before the crisis minus the average return after the crisis. The hypothesis that the average return of the momentum portfolio was equals before and after crisis was rejected when considering all stocks combined.

TABLE 3 | Fama-French abnormal returns of momentum strategy portfolios (winner minus loser portfolios).

	Holding Period							
	3 months	6 months	9 months	12 months	3 months	6 months	9 months	12 months
	Panel I - Momentum Portfolio and All Stocks Sample				**Panel II- Momentum Portfolio and Survivors Stocks Sample**			
Observation Period: 3 months								
Alpha	−1.598***	−0.684**	0.012	−0.328	1.079***	0.757***	0.913***	0.541**
t-stat	−4.14	−1.74	0.04	−0.87	3.81	2.69	3.83	1.88
Observation Period: 3 months								
Alpha	−1.596***	−0.345	−0.175	−0.149	0.913***	0.398*	0.809***	0.586**
t-stat	−4.59	−0.94	−0.56	−0.43	2.90	1.31	2.92	2.13
Observation Period: 9 months								
Alpha	−1.070***	−0.505*	−0.088	0.345	0.866***	1.008***	0.702**	0.988***
t-stat	−3.02	−1.49	−0.24	0.99	2.59	3.09	2.25	3.10
Observation Period: 12 months								
Alpha	−0.386	0.276	0.349	0.942***	0.746***	0.500*	0.661**	0.545**
t-stat	−1.12	0.74	0.96	2.41	2.37	1.64	2.30	1.81
	Panel III - Losers Portfolio and Survivors Stocks Sample				**Panel IV - Losers Portfolio and Survivors Stocks Sample**			
Observation Period: 3 months								
Alpha	0.274	0.053	0.125	−0.031	−0.805***	−0.704***	−0.788***	−0.572***
t-stat	1.27	0.25	0.69	−0.15	−3.82	−3.19	−3.93	−2.48
Observation Period: 6 months								
Alpha	0.116	−0.202	−0.050	−0.040	−0.798***	−0.600***	−0.858***	−0.627***
t-stat	0.51	−0.91	−0.25	−0.19	−3.27	−2.48	−3.51	−2.76
Observation Period: 6 months								
Alpha	0.211	0.214	0.031	0.243	−0.724***	−0.796***	−0.671***	−0.7851***
t-stat	0.89	0.99	0.14	1.15	−2.82	−3.10	−2.72	−3.0675
Observation Period: 6 months								
Alpha	0.020	0.039	0.147	−0.006	−0.726***	−0.461**	−0.514**	−0.551**
t-stat	0.10	0.19	0.67	−0.03	−2.76	−1.80	−2.00	−2.27

Obs.: the momentum strategy builds portfolios based on the stock's performance over the previous *J* months (observation period) and held during *k* months (holding period). In the first row and column, the *J* and *K* values for the various techniques are indicated. The stocks were ordered in ascending order at the end of each month based on their performance over the previous *J* months. Subsequently, the stocks were divided into 10 equally weighted deciles, each decile corresponding to a portfolio of stocks. The portfolio of the first decile (worst performance) is designated as the loser, while the portfolio of the last decile (best performance) is indicated by the winner. Finally, stocks are held during *K* months. This table shows the abnormal returns for the WmL (winners minus losers) portfolios built using all stocks listed in Euronext Lisbon between January 1991 and December 2016 (300 months). t-stat refers to Student's *t*-test for the null hypothesis of average equal zero.
*Statistical significance at 10%,
**Statistical significance at 5%,
***Statistical significance at 1%.

When using just surviving stocks, the null hypothesis of average returns being equal was only rejected once, and only for a significance level of 10%. This phenomenon occurred when the observation period was 6 months and the holding period was 3 months. In all other cases, we obtained equality for the average return before and after the crisis for the momentum strategy return.

When considering the winner portfolios, the null hypothesis was sometimes rejected, leading to the conclusion that the average profitability was superior before the crisis. This phenomenon was documented for 7 of the 24 winner portfolios when all stocks were combined (panel I) and in 6 of the 24 winner portfolios when only surviving stocks were used (panel II).

This phenomenon was particularly evident for holding periods of 3 months, in which three of the four portfolios rejected the null hypothesis. Thus, there was evidence that the average returns of winners were slightly higher before the crisis compared to after the crisis, when considering a holding period of 3 months and observation periods of 3, 6, or 9 months. Otherwise, the cases for which the null hypothesis was rejected were sporadic.

For the loser portfolios, the null hypothesis was rejected very sporadically (four in panel I and three in panel II) when compared to the winner portfolios. Thus, there was no clear pattern for the two samples.

Finally, the regressions presented in **Table 2** were repeated, adding a dummy to the equation that assumed a value of zero for 1991–2007 and a value of 1 for 2008–2016. All regressions

TABLE 4 | Monthly average returns of momentum strategy portfolios before the crisis minus after the crisis.

	Holding Period: 3 months			Holding Period: 6 months			Holding Period: 9 months			Holding Period: 9 months		
	Winners	Losers	Momentum	Winners	Losers	Momentum	Winners	Losers	Momentum	Winners	Losers	Momentum
Panel I - All Stocks Sample												
Observation Period: 3 months												
Average Difference	0,009*	0,003	0,005	0,010**	0,007	0,003	0,008**	0,007	0,001	0,006	0,007	0,000
t Stat	1,578	0,512	0,638	1,844	1,078	0,375	1,700	1,150	0,147	1,089	1,016	-0,031
Observation Period: 6 months												
Average Difference	0,011**	0,003	0,008	0,007*	0,009*	-0,001	0,002	0,010**	-0,008	0,005	0,005	0,001
t Stat	2,099	0,481	1,028	1,587	1,289	-0,172	0,493	1,801	-1,191	1,156	0,700	0,113
Observation Period: 9 months												
Average Difference	0,009**	0,010**	-0,002	0,004	0,009*	-0,005	0,003	0,007	-0,004	0,002	0,006	-0,004
t Stat	1,871	1,678	-0,243	0,783	1,355	-0,705	0,510	1,005	-0,523	0,394	0,972	-0,594
Observation Period: 12 months												
Average Difference	0,003	0,004	0,000	0,003	0,001	0,002	0,000	0,003	-0,003	0,006*	-0,002	0,009
t Stat	0,663	0,605	-0,064	0,544	0,146	0,232	0,043	0,444	-0,363	1,291	-0,355	1,054
Panel II -Survivors Stocks Sample												
Observation Period: 3 months												
Average Difference	0,009**	0,005	0,004	0,012***	0,010**	0,002	0,007**	0,004	0,002	0,006	0,002	0,004
t Stat	1,901	0,996	0,703	2,586	2,036	0,342	1,648	0,913	0,447	1,230	0,427	0,701
Observation Period: 6 months												
Average Difference	0,009**	0,000	0,009*	0,009**	0,003	0,006	0,003	0,003	0,000	0,006	0,004	0,002
t Stat	1,762	-0,005	1,338	1,831	0,619	0,875	0,758	0,501	0,073	1,262	0,818	0,305
Observation Period: 9 months												
Average Difference	0,011**	0,004	0,007	0,006	0,004	0,002	0,005	0,008*	-0,003	0,002	0,004	-0,002
t Stat	2,055	0,660	0,960	1,262	0,655	0,318	1,108	1,481	-0,483	0,525	0,679	-0,249
Observation Period: 12 months												
Average Difference	0,000	0,003	-0,003	0,003	0,000	0,003	-0,001	-0,002	0,000	0,002	0,000	0,002
t Stat	-0,026	0,535	-0,508	0,686	0,025	0,483	-0,288	-0,278	0,036	0,352	-0,007	0,259

Obs.: portfolios of the momentum strategy are formed based on the stock's performance of the last *J* months (observation period) and held during *K* months (holding period). In the first row and column, the *J* and *K* values for the various techniques are indicated. The stocks were sorted in ascending order at the end of each month based on their performance over the previous *J* months. Subsequently, the stocks were divided into 10 equally weighted deciles, each decile corresponding to a portfolio of stocks. The portfolio of the first decile (worst performance) is designated as the loser, while the portfolio of the last decile (best performance) is indicated by the winner. Finally, stocks are held during *K* months. This table shows the difference of the average returns for the winners, losers, and WmL (winners minus losers) for the period from January 1991 to the end of 2007 (before the crisis) and for the period from January 2008 to the end of 2016 (after the crisis). Panel I refers to portfolios built using all stocks listed in Euronext Lisbon between January 1991 and December 2016 (all stocks sample). Panel II refers to portfolios built using only the stocks listed in Euronext Lisbon between January 1991 and December 2016 (300 months) that stay listed (survivors stock sample). t-stat refers to Student's *t*-test for the null hypothesis of average equal zero.
*Statistical significance at 10%,
**Statistical significance at 5%,
***Statistical significance at 1%.

had statistically relevant values for this variable, supporting Fama and French (5) model, with no changes before to after the crisis for the momentum strategy or for the winner versus loser portfolios.

4. Conclusion

This study evaluated anomalies in momentum to understand its impact on the Portuguese stocks market. When considering all stocks combined for certain time periods, the momentum effect was not detected in the Portuguese market. This phenomenon was largely due to winner portfolios, which obtained a negative performance

during holding periods. These results were consistent with those of Hwang and Rubesam (12) and Daniel and Moskowitz (13), who detected the disappearance of the momentum effect.

When only using surviving stocks, we obtained positive returns for all 16 momentum strategies that were analyzed. For 81.3% of these strategies, the returns were statistically relevant. Thus, the performance of loser portfolios contributed more to the good results of the momentum strategy.

When applying Fama and French (5) three-factor approach, we only obtained evidence of positive abnormal returns for the momentum strategy for the surviving stocks. When using all stocks, we obtained negative returns for

the momentum strategy. The momentum effect reported for surviving stocks was primarily attributed to the negative abnormal returns of the loser portfolios.

This study found no evidence that the profitability patterns of the momentum strategy were impacted by the recent financial crisis in Portugal. However, this study did demonstrate that, for shorter holding periods, winner portfolios had higher returns on average before the crisis compared to after the crisis.

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