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Determinants of non-compliant equity funds with EU portfolio concentration limits

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ABSTRACT

This study identifies the determinants of domestic equity funds that fail to comply with the portfolio concentration limits of the EU Directive 2009/65/EC. This study also determines the characteristics of the stocks subject to these non-compliant portfolios. The empirical application to a comprehensive sample of domestic equity funds registered in the Eurozone provides significant information that can help to improve market supervision in terms of investors' protection.

1. Introduction

During the past few decades, one of the most significant developments in financial intermediation has been the effective use of mutual funds as a vehicle to implement the preferred investment strategies of retail investors. European asset management has notably increased in recent decades, reaching EUR 17.7 trillion of total net assets (TNA) in 2019 (The European Fund and Asset Management Association EFAMA, 2020). Due to these funds' economic relevance, government policies in Europe have established a legal framework to provide transparency in open-end funds and higher levels of investor protection.

The Undertakings of Collective Investments in Transferable Securities (UCITS) Directives provide legislative uniformity throughout the European Union (EU) for these collective investment schemes. The significance of the UCITS directives is particularly important for the harmonization of the regulations concerning collective investment in the member states of the EU (Cumming et al., 2011). The UCITS directives can be considered a trend in EU regulation to reinforce market protection, increasing its transparency (Anderberg and Bolton, 2006).[1]

Mutual funds are structured to allow retail investors to access sophisticated active strategies that comply with liquidity and transparency restrictions protected by regulatory oversight. Their rules are based on certain levels of portfolio diversification with the aim of reducing their vulnerability to portfolio risk. This rationale is fully consistent with modern portfolio management. There is some evidence that greater portfolio diversification is associated with better performance (see Pollet and Wilson, 2008). Thus, EU regulation leads mutual fund managers to follow diversified portfolios.

Nevertheless, rising competition could affect active management strategies to bring profitable investment opportunities that could affect portfolio diversification (Cremers et al., 2019). Additionally, Kacperczyk et al. (2005) find that the level of portfolio

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[1] All UCITS directives have been transposed into the legal framework of each member state of the EU.

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concentration within certain industries tends to have better performance. Huij and Derwall (2011); Hiraki et al. (2015); Choi et al. (2017) and Fulkerson and Riley (2019) support the predictive power of portfolio concentration. Goldman et al. (2016) find that when managers include the largest market capitalization company within each industry sector, the performance is better. Thus, managers following concentrated portfolio strategies should be more likely to overweight positions against the UCITS regulation. In terms of investment constraints, the article 52 in force in UCITS IV presents the limits of portfolio concentration (UCITS, 2009). A UCITS shall invest no more than 10 % of its assets in transferable securities. In addition, the total value of the UCITS holdings with separate weights of more than 5% of its assets shall not exceed 40 % of the value of its assets (see more details in Appendix A).

Both the economic relevance and the very significant role of retail investors in the ownership structure of the European mutual fund industry (EFAMA, 2020) lead us to analyse how concentrated portfolios could involve conflicting patterns with the EU regulation that protects investors by setting portfolio concentration limits. Thus, our paper documents the controversy between the prevention of portfolio concentration by the UCITS directives and the evidence of domestic equity funds in the Eurozone that do not fulfil these portfolio concentration limits. Furthermore, our paper is the first to identify both the characteristics of mutual funds that are most likely to overweight their portfolio positions and the characteristics of these overweighted stocks in the current context of EU legal restrictions on portfolio concentration.

Among the different potential reasons for failing to fulfil the legal requirements, we first remark that the current financial markets are far different from the context of the original UCITS I (1985) and its portfolio concentration limits. This part of the EU regulation has not changed since 1985.[2] Rising competition in challenging financial markets could lead to the rationale that "one size fits all" approach is not useful in mutual fund industries where skilled fund managers applying their knowledge and expertise to form more concentrated portfolios to enhance their performance records.

Second, traditional portfolio management in the mutual fund industry uses a primary prospectus benchmark, which is the benchmark that best matches a fund's actual investment strategy (Cremers et al., 2021). According to Loban et al. (2020), the accumulated weight of equity benchmark constituents in domestic Eurozone markets is highly concentrated in fewer constituents than in US benchmarks. This benchmark concentration could be a problem to manage an appropriate diversification level for traditional portfolio management. That is, the high concentration level detected in the domestic Eurozone benchmarks conflicts with the 10 % concentration limit included in the EU regulation. This framework could conflict with traditional portfolio management in the mutual fund industry, and such characteristics could make managers likely to default. Therefore, EU concentration limits could conflict with fund management strategies focused on concentrated primary prospectus benchmarks.

The main objective of this paper is to contribute to an unexplored topic of the extensive literature on portfolio concentration. We study how concentrated strategies could lead to non-compliance with market UCITS such as EU Directives. Accordingly, the contributions of our paper are 1) to identify both market- and fund-specific characteristics that play a significant role in explaining the portfolio concentration default specified in the EU regulation and 2) to determine the main characteristics of the stocks subject to these defaults. Therefore, our paper deepens the analysis of the potential conflict between rising competition in the mutual fund industry (see Dyck et al., 2013; Cremers et al., 2016; Hoberg et al., 2018), portfolio concentration limits and concentrated primary prospectus benchmarks (see Loban et al., 2020).

This paper has important implications for market supervisors and policymakers in the mutual fund industries in the Eurozone. In the strongly regulated European markets (Benink and Schmidt, 2004), where policy implications are consistent with the importance of analysing factors that lead to the detection of market abuse as an important tool to protect investors (Cumming et al., 2018), our approach allows these market supervisors with limited resources to identify and control non-compliant domestic equity funds by monitoring only some fund-specific characteristics. The improvement of this monitoring process should contribute to the financial stability of the EU asset management industry in terms of investor protection and market transparency. That is, mutual fund unitholders should be completely sure that their money is allocated in portfolios fulfilling the concentration limits required by the EU.

Our paper also develops an assistance tool for EU market supervisors to identify some explanatory mechanisms in those stock weights that are over the EU concentration limits. Thus, our results may help supervisors identify what kind of domestic equity funds are more inclined to default and what kind of stocks are probably overweighted by these funds. Market supervisors could especially monitor these stocks to verify that domestic equity funds are fulfilling the concentration limits. Market supervisors should focus their limited resources on these types of stocks held by domestic equity funds in order to prevent portfolio concentration defaults. The examination of a whole list of disclosed portfolio holdings in each individual fund prospectus might not be an efficient tool to monitor the portfolio diversification defaults of a huge number of funds registered in the Eurozone mutual fund industry. Our results could lead to a more efficient supervision process by reducing the potential total number of the monitored stocks to those that show a high probability to be subject to defaults.

From our understanding, this multidimensional monitoring that is based on both fund and stock specific characteristics should be more efficient in terms of computational resources and costs than looking at each fund prospectus to see whether or not there is a violation of the directive. However, to estimate properly the gains in efficiency from the computational design of this monitoring process is beyond our knowledge and research objectives.

Finally, our approach should also help retail investors control their risk profiles in terms of exceeded limits of portfolio concentration. This application is in line with the reinforcement of investor protection against high levels of portfolio concentration. Investors should be sure that domestic equity funds fully follow the diversification requirements and market transparency provided by UCITS

[2] More recently, Directive 2014/91/EU governs depositary functions, remuneration policies and sanctions. UCITS V does not amend the portfolio concentration limits of the previous directives (UCITS V, 2014).

directives.

In this paper, we develop detailed hypotheses to test whether market-characteristics, fund-characteristics or stock-characteristics increase the probability of domestic equity funds to show levels of portfolio concentration higher than the limits defined by art 52 in UCITS IV. Our findings provide evidence that should lead market supervisors to pay attention to concentrated fund industries with concentrated domestic benchmarks to prevent defaults on EU concentration limits. In these markets, the most experienced funds that are solo-managed should be especially monitored to prevent portfolio weights over the 10 % limit. We also find that those overweighted stocks are liquid and large-cap stocks with low volatility.

The remainder of the paper is as follows. Section 2 identifies the fund and domestic market characteristics that are significant to explain portfolio holdings over the concentration limits. Section 3 evaluates the significant characteristics of these overweighted stocks. Section 4 collects robustness analyses. Finally, Section 5 concludes the paper.

2. Fund and market determinants in portfolio diversification default

In this section, we analyse a set of fund and market characteristics that may influence non-compliance with the EU legal restrictions on portfolio concentration. We first describe our sample of domestic equity funds registered in the Eurozone. Then, we describe the specific variables included in our logit panel data model. Finally, we present the results and identify the significant determinants of non-compliant domestic equity funds with EU portfolio concentration limits.

2.1. Sample description

Our comprehensive sample includes data on open-end mutual funds categorized as domestic equity funds by Morningstar. Our sample period is from 2002 to 2018.[3] Although the UCITS directives described in the previous section are applicable to the EU, we focus our study on European countries that share the Euro as a single currency (Eurozone fund industries).[4] The database is free from survivorship bias because it includes both active and terminated funds. We exclude offshore funds (e.g., funds domiciled in Luxembourg or Ireland), closed-index funds, index funds, Exchange-Traded Funds (ETF), enhanced index funds, funds of funds, international funds, industry sector funds, real estate funds, and other non-equity funds to avoid distorting the results of our analysis and to keep them in line with our objectives.[5] That is, our sample does not include domestic equity funds which, according to their mandates, follow indexed strategies. Our final sample includes 39,096 portfolios for 536 domestic equity funds. Morningstar provides 84.33 % of these portfolios on a monthly basis. The rest of the portfolios are also obtained from Morningstar using quarterly information according to the fiscal year definition of each fund.[6]

Table 1 presents information about the number of portfolios analysed, the average number of holdings by portfolio and the average fund size by each Eurozone market in our sample period. The most relevant mutual fund industries in the Eurozone, such as France, Germany, Italy and Spain, have a total of 28,480 portfolios and manage EUR16.06 billion on average. French funds represent 30 % of the sample in terms of the number of portfolios analysed, but on average, their fund size is smaller than those of other relevant fund industries. German funds represent 15 % of the sample in terms of the number of portfolios analysed with the highest average fund size. Other relevant fund industries with a large number of portfolios are Spain and Italy, which account for 18 % and 10 % of the total number of portfolios of our sample, respectively. Italian funds present, on average, the greatest number of holdings in each portfolio (71 holdings). In contrast, there are countries such as the Netherlands, Portugal, and Finland that show much more concentrated portfolios (28, 30, and 37 holdings, respectively). Thus, Table 1 shows various characteristics in terms of both economic relevance and portfolio concentration for the domestic equity funds registered in the Eurozone.

2.2. Model and variables

The objective of this analysis is to provide evidence of several market and fund characteristics that may influence the probability of a fund manager failing to fulfil the portfolio concentration limits. Three potential types of default can be determined according to the portfolio concentration limits presented in art 52 of UCITS IV. We define three excluding groups of portfolios. Default 1 includes portfolios with at least one holding with a portfolio weight higher than 10 %. Default 2 includes portfolios in which there are holdings with a weight within the range (5 %–10 %] and that jointly exceed 40 % of the total portfolio weight (i.e., the accumulated sum of the holdings weights higher than 5% and not higher than 10 % is over 40 %). Default 3 includes portfolios with holdings that incur both default 1 and default 2 at the same time.

For each country, Fig. 1 reports the distribution of portfolios by type of default. Domestic equity funds registered in the Eurozone

[3] Morningstar defines domestic equity funds as mutual funds that invest principally in domestic stocks.

[4] The countries analysed have been present in the constitution of the Eurozone. This area was created in 1999 by eleven founding states: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Spain and Portugal. In 2001, Greece joined the Eurozone. These industries represent 70% of the European mutual funds from 2002 to 2019 and at least 68% of domestic equity funds in the European mutual fund industry (Investment Company Institute, 2020).

[5] Luxembourg and Ireland are excluded from our sample because Morningstar does not provide a domestic equity category for these mutual fund industries.

[6] The weights of each portfolio constituent are computed from the portfolio holdings information provided by Morningstar.

Table 1
Summary statistics for domestic equity funds registered in the Eurozone (2002–2018).

	NETHERLANDS			GREECE			AUSTRIA			BELGIUM			FRANCE		
Year	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
2002	13	27	260.72	20	42	47.28	1	44	77.89	2	34	47.71	19	57	137.60
2003	77	26	276.94	20	43	48.47	2	43	39.72	4	37	50.09	156	57	135.83
2004	94	29	314.89	21	43	36.84	9	35	129.48	3	36	38.55	239	60	172.08
2005	91	27	323.28	54	41	28.37	18	37	96.42	9	44	47.33	201	57	136.78
2006	120	31	362.38	67	49	23.09	76	46	121.58	13	47	43.27	267	61	163.20
2007	137	26	412.23	85	50	79.44	86	50	134.17	11	42	31.65	413	58	298.33
2008	125	25	246.72	72	45	85.59	86	44	67.75	26	44	23.95	601	51	166.27
2009	118	27	211.62	75	42	56.92	132	40	64.05	26	51	16.30	946	53	139.68
2010	125	27	324.82	63	41	46.07	126	41	91.56	27	51	25.77	900	56	142.53
2011	136	28	348.52	63	35	30.35	129	41	121.57	13	44	51.88	961	55	112.21
2012	133	27	311.28	43	39	38.74	117	40	111.42	12	55	65.23	991	56	115.69
2013	136	27	304.19	44	36	48.36	136	35	143.05	13	53	69.40	984	61	132.27
2014	96	26	345.33	88	42	45.61	132	33	160.42	na	na	na	942	61	137.05
2015	70	29	251.15	83	41	31.56	144	34	155.23	na	na	na	930	61	131.66
2016	75	29	208.65	82	39	26.09	156	36	146.55	na	na	na	936	61	144.16
2017	80	29	197.66	79	31	32.19	107	34	184.07	na	na	na	1111	56	281.62
2018	72	30	210.60	78	32	39.15	107	46	220.87	na	na	na	1067	55	279.90
Average	100	28	288.88	61	41	43.77	92	40	121.52	13	45	42.59	686	57	166.29
Total	1698		4910.96	1037		744.12	1564		2065.79	159		511.12	11664		2826.87
	GERMANY			ITALY			SPAIN			FINLAND			PORTUGAL		
Year	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
2002	29	54	321.07	23	65	181.36	33	36	41.85	29	37	48.60	9	31	43.37
2003	321	51	322.03	143	68	191.43	289	39	50.08	90	39	54.94	19	32	45.53
2004	323	52	408.87	260	70	292.90	257	40	91.92	90	42	72.74	28	24	45.48
2005	313	51	404.69	302	69	268.26	275	42	109.25	108	40	98.89	55	26	41.06
2006	343	55	504.40	285	67	248.45	277	46	123.96	135	39	87.78	204	32	51.11
2007	413	56	458.07	276	81	191.38	301	45	118.87	188	38	103.33	211	34	69.97
2008	437	51	304.99	252	70	119.98	325	38	61.60	231	35	83.54	180	35	35.26
2009	461	52	259.56	293	66	87.01	310	38	44.99	237	36	94.09	198	34	24.95
2010	458	56	411.60	265	66	99.83	396	37	40.99	285	36	143.23	187	33	24.88
2011	430	58	528.49	260	68	79.82	416	36	39.51	315	34	122.30	182	31	17.17
2012	442	52	520.57	260	69	95.58	429	36	33.96	340	33	105.71	161	32	12.17
2013	387	48	642.36	195	73	117.07	480	38	56.30	383	34	127.99	155	31	17.39
2014	314	46	695.02	202	77	160.72	543	42	105.15	413	34	124.97	134	34	24.24
2015	297	47	821.92	207	80	181.16	578	41	110.75	366	33	143.21	118	31	22.08
2016	265	48	651.34	214	75	157.69	628	39	96.35	272	34	137.38	110	29	18.95
2017	389	48	877.43	330	76	183.14	585	36	111.49	327	38	159.04	85	20	27.56
2018	397	47	883.46	317	79	202.05	591	37	124.48	306	39	163.59	73	22	32.61
Average	354	51	530.35	240	72	168.11	395	39	80.09	242	37	110.08	124	30	32.57
Total	6019		9015.87	4084		2857.82	6713		1361.49	4115		1871.33	2109		553.77

This table shows (1) the total number of portfolios analysed, (2) the average number of holdings in each mutual fund portfolio, and (3) the average portfolio size in EUR millions. This information is reported for each country included in our sample from 2002 to 2018.

show on average 13.20 % of their portfolios with defaults, except for Dutch, Belgian and Spanish funds, which present a higher percentage.

We formulate several alternate hypotheses in our empirical analysis to test whether both market and fund characteristics and funds characteristics influence the probability that portfolios incur default 1, 2 or 3. To test the hypotheses, we compute model (1) using a logit panel data model (fixed effects).[7] The logistic probability function of a fund p incurring each default for period t is

$$\Pr(\text{Default 1, 2or3})_{\text{p}} = \frac{e^{\beta' X_p}}{1+e^{\beta' X_p}}, \quad \beta' X_p = \alpha_{p,0} + \beta_p X_{p,t} + \varepsilon_{p,t} \tag{1}$$

where $X_{p,t}$ is a vector of time-varying fund and market-specific variables.

We begin by testing whether market characteristics influence the probability that portfolios incur defaults. Regarding the justification of the market-specific variables to be included in the model, we find that the different domestic equity benchmarks in the Eurozone market tend to present excessive weights in some of their constituents (Loban et al., 2020). This conflicts with the limits of portfolio concentration specified by UCITS IV, and it could be a problem to appropriately manage portfolio diversification with active management strategies based on concentrated benchmarks. Formally, our first hypothesis is as follows:

H1. A high level of concentration in the domestic benchmark is positively related to the likelihood of incurring default 1, 2, or 3.

The level of concentration of the domestic benchmark of market m at the end of month t, $HHI_{m,t}$, is measured by the Herfindahl-Hirschman Index (HHI), which is a common indicator of the level of concentration within an industry, market, or sector. We adapt this concentration measure to obtain the monthly benchmark HHI as the sum of the squared weights of each benchmark constituent.[8] We include this variable in our model (1) to test whether the level of concentration in the benchmark could affect the probability of incurring the previously defined types of defaults because of the conflict between portfolio concentration limits and highly concentrated benchmarks.

Kacperczyk et al. (2014) find that the abilities of active management are not the same during a bearish market as those in a bullish market. Fund managers could develop different management strategies during an upward market trend and during a downward market trend. For that, our second hypothesis is as follows:

H2. The market state affects the likelihood of incurring default 1, 2, or 3.

We include $RB_{m,t-1}$ in model (1) as the average monthly return obtained by the domestic benchmark of market m during the previous 12-month period at the end of month t-1.

We also consider the level of concentration of each domestic fund industry as a potential factor to explain the different defaults. Dyck et al. (2013) find that in a competitive industry, hard competition with other funds should be a suitable environment for managers to feel pressure to perform better than others. Thus, the level of fund industry concentration as a proxy for fund competition could be considered as an explanatory variable to exceed the limits expressed in UCITS IV. The third hypothesis is as follows:

H3. A high level of concentration in the domestic fund industry is positively correlated with the likelihood of incurring default 1, 2, or 3.

In this paper, we follow Cremers et al. (2008) and Feldman et al. (2020) and use the normalised Herfindahl-Hirschman Index (NHHI) as the concentration of fund market m at the end of month t, $NHHI_{m,t}$.[9]

After the description of the market-specific variables in model (1), let us define the fund-specific factors. Firstly, we examine how the fund excess return over the benchmark could cause fund managers to incur default 1, 2, or 3. Positive and significant returns could increase the propensity to rely more on winner portfolio holdings irrespective of the limits of portfolio concentration. This propensity could be explained by overconfidence bias. Consistent with this possibility, Puetz and Ruenzi (2011) find evidence of self-serving attribution bias as a cause of overconfidence. Polkovnichenko (2005) shows that investors who appear confident with the positive outcome of their strategy tend to underdiversify their portfolios. Furthermore, Fuertes et al. (2014) conclude that overconfidence could explain poor diversification levels in portfolio holdings. Thus, overconfidence as a result of good excess return records could generate more concentrated portfolios and conflict with EU concentration limits. However, the literature has not resolved whether portfolio concentration clearly emerges from behavioural biases which may be consistent with this overconfidence approach. Further, Choi et al. (2017) find, in support of the information advantage theory, that concentrated portfolios in international markets from both rational and learned decision-making can be optimal in terms of risk-adjusted performance. Both motivations are robust for the inclusion of

[7] We use Hausman specification test to choose fixed or random effects following Hahn et al. (2011). We test whether the unique errors (ui) are correlated with the regressors. The results are available upon request.

[8] HHI is an index that originally measures the concentration of an industry and is calculated by squaring the market share of each firm competing in the industry and then summing the resulting numbers. The index ranges from 0 to 10,000. High values of the HHI indicate high levels of market concentration. Cremers et al. (2008) uses HHI as a proxy for the level of portfolio concentration.

[9] NHHI is a normalised version of HHI to measure fund market concentration, which is not related to the number of funds competing in an industry. NHHI takes a value near to zero for an industry in which all funds have equal market shares or near one in the opposite situation.

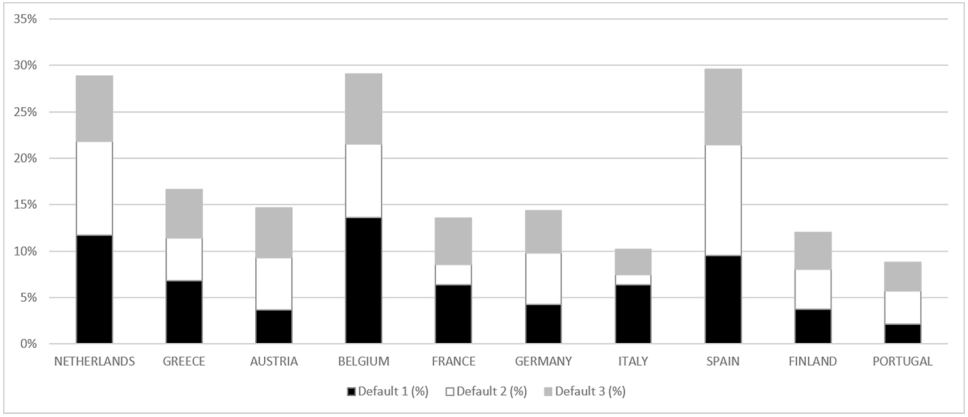

Fig. 1. Distribution of portfolios by default 1, 2 or 3.
For each country, this figure shows the excluding percentages of portfolios sorted by each type of default. The black bar chart indicates the percentage of those portfolios with at least one holding whose weight is higher than 10 % (default 1). The white bar chart shows the percentage of those portfolios with holdings whose weights are higher than 5% and whose accumulated sum is over 40 % (default 2). The grey bar chart indicates the percentage of those portfolios with holdings that incur both default 1 and default 2 at the same time (default 3).

lagged fund returns as an independent variable in our approach.[10] For that, our fourth hypothesis is as follows:

H4. The fund's excess returns over the benchmark affect lead to managers incurring default 1, 2, or 3.

We compute $ERB_{p,t-1}$ as the excess return of fund p during the previous 12-month period at the end of month *t-1* and include it in model (1).[11]

In addition, mutual fund size is one of the most controversial and studied variables in the mutual fund literature. Cremers and Petajisto (2009) find that small funds are more active than 80 % of large funds, which are similar to index funds. More recently, Ferreira et al. (2013) conclude that the positive effect of fund size on performance is pervasive around the world. While small funds can concentrate on a few investment positions, large funds could benefit from investment opportunities that are not available to smaller funds. This evidence leads us to suppose that small funds could present higher active share values (AS) than large ones as a result of having more concentrated portfolios (overweighting some holdings over the regulatory limits).[12] Our fifth hypothesis is as follows:

H5. A smaller domestic fund is positively related to the likelihood of incurring default 1, 2, or 3.

We test whether the size of fund p in month *t,* $TNA_{p,t}$, could increase the likelihood of incurring default 1, 2, or 3. To do so, we use the monthly total net assets (TNA) of all share classes as a measure of each fund size. This variable is normalised in model (1) for each domestic fund market to obtain comparable values within each market.

Continuing with fund-specific variables, Pollet and Wilson (2008) find that when the fund receives inflows, it tends to scale up its positions instead of diversifying into new holdings. Very important flows could lead to management decisions that could affect the portfolio concentration. For that, our sixth hypothesis is as follows:

H6. Large net flows are positively related to the likelihood of incurring default 1, 2, or 3.

According to Sirri and Tufano (1998), we compute $Flow_{p,t-1}$ as the percentage growth in total assets under the management of fund p between the beginning and the end of the previous 12-month period at the end of month *t-1* net of fund returns (assuming the reinvestment of dividends and distributions). This variable is normalised in model (1) for each domestic fund market to obtain comparable values within each market.

In addition to fund size and flows, fund age can have a significant impact on our model. Previous literature presents controversial findings about fund age and portfolio concentration. On the one hand, Kacperczyk et al. (2014) find that younger funds hold more concentrated portfolios and have better selection abilities. Recently, Hung et al. (2020) provide similar evidence for Taiwan's equity fund industry. Furthermore, Cremers et al. (2016) show that younger funds present higher levels of tracking error and active share, which are potentially consistent with higher levels of portfolio concentration. On the other hand, Amihud and Goyenko (2013) suggest that older funds are more active and more selective, which in turn enhances their performance and contributes to their longevity. Thus,

[10] The future performance implications of the highest concentrated positions in our sample is a noteworthy analysis. It could be a brilliant starting point for further research. However, the results of a preliminary analysis do not lead us to accept the hypothesis that stocks subject to defaults obtain a good subsequent performance in terms of alphas for the periods t+1, t+6 and t+12. Detailed results are available upon request.

[11] The use of a representative domestic benchmark for each industry avoids potential benchmark gaming to obtain excess fund returns (Sensoy, 2009).

[12] The active share measures the portfolio weights of a mutual fund that differ from its benchmark constituents' weights (Cremers and Petajisto, 2009).

the commitment to increase their idiosyncratic risk relative to their total risk levels could lead to more concentrated portfolios that could have significant effects on portfolio holdings and increase the likelihood of incurring default 1, 2, or 3. Our seventh hypothesis is as follows:

H7. The age of the domestic fund is positively related to the likelihood of incurring default 1, 2, or 3.

We define $Age_{p,t}$ as the number of months since the launch date of fund p at the end of month t. This variable is normalised in model (1) for each domestic fund market to obtain comparable values for each market.

Finally, we consider management structure as a potential determinant of incurring default 1, 2 or 3. The management team is defined when there is more than one person involved in fund management and they manage together (Karagiannidis, 2010). On the one hand, following Stein (2002), if a fund is managed by a team, managers may spend too much effort convincing others to implement their own ideas. On the other hand, while individual managers could be free from group difficulties, management teams develop connections that could help in making decisions about portfolio composition. Thus, portfolio decisions could be made consensually or unilaterally, depending on the management structure. Extensive literature has analysed the relationship between fund management structures with diverse findings. Chen et al. (2004) and Massa et al. (2010) find that the organizational structure influences the decision-making process of the fund, which may help to explain fund construction. In addition, Goldman et al. (2016) show that individual managers have much more concentrated portfolios than management teams. We analyse how management structure could increase the likelihood of incurring default 1, 2 or 3. Our eighth hypothesis is as follows:

H8. The management structure affects the likelihood of incurring default 1, 2, or 3.

We include $Man_{p,t}$ in the model (1) as a dummy variable that takes a value of one when fund p is managed by one person and zero otherwise at the end of month t.

Table 2 presents detailed definitions of the variables included in model (1).

Table 3 shows assorted market and fund characteristics across the Eurozone fund industries analysed. These differences between the domestic fund markets highlight the different scenarios in which the unique EU concentration limits are applied.

2.3. Empirical results

Table 4 reports the results of model (1). The regressions allow us to identify the market- and fund-specific characteristics that could be considered by policymakers and market supervisors when monitoring fund manager defaults on the limits of the portfolio concentration included in the EU regulations. We examine the odds ratios of the coefficients minus one to explain the variables in terms of the chance that the default will occur with a small change in the independent variable.

We find that the level of concentration of the domestic equity benchmarks significantly increases the probability of incurring default 1, 2 or 3. That is, the higher the level of concentration of the benchmark is, the greater the likelihood of finding non-compliant domestic equity funds. This positive significance is robust for the different model specifications and for the different types of defaults. Specifically, concentrated benchmarks would make the defaults almost twice as likely to occur. (i.e., if the level of concentration of domestic equity benchmark increases one log-unit, 1.81 will multiply the odds of incurring default 1. The same interpretation is valid for model specifications in terms of default 2 or 3).

Thus, market supervisors should especially monitor domestic equity funds domiciled in countries with highly concentrated domestic benchmarks.

The level of concentration of the domestic fund industry also has positive and significant effects on the likelihood of incurring default 1, 2 or 3. This evidence is consistent with previous findings in the literature that link competition with active management strategies such as concentrated portfolios. According to the different model specifications, defaults are around 12 %–17 % more likely to occur when the level of concentration of the domestic fund industry increases by one unit (this variable is normalised per industry). Therefore, the promotion of competition in mutual fund industries should reduce the likelihood of default on EU portfolio concentration limits. Market supervisors should especially monitor domestic equity funds registered in highlyconcentrated industries in which the market share of few large funds is significantly higher than the market share of the remaining small competitors. Consequently, there is evidence of a positive and robust relation between the level of concentration of the benchmark, the level of the concentration of the industry and the likelihood of portfolio weights over the EU concentration limits.

Considering the fund characteristics, we find that fund age has a positive and significant influence on the likelihood of default 1, 2, or 3. This positive significance is robust for the different model specifications and for the different types of defaults. That is, the probability of incurring defaults increases about 18 %–26 % when the fund age increases by one-month unit (this variable is normalised per industry). Thus, this evidence could be consistent with the previous literature that links older funds with higher levels of idiosyncratic risk as a consequence of more concentrated portfolios.

Finally, if we consider the management structure, we find both diverse and significant results. That is, the effects of the organisational structure on the decision-making process are different in terms of the different types of defaults. Market supervisors should monitor solo-managed funds in which decisions are made without team consensus to prevent portfolio weights over a 10 % limit. In contrast, when the defaults involve a higher number of portfolio holdings, i.e., default 2 or 3, team consensus plays a significant role. In terms of the interpretation of the results, the probability to incur default 1 increases approximately 3 % when funds are solo managed. On the other hand, the probability of incurring default 2 or 3 is reduced 7% and 3.5 % for solo managers, respectively. These potentially contradicting results may be explained by the fact that the types of defaults are different and require different decision-making processes.

Table 2
Variables' definitions.

Variable	Definition	Data source
$HHI_{m,\ t}$	Natural log of HHI, which measures the concentration of the market m at the end of the month t. $HHI_{m,t} = \sum_{i=1}^{n} W_i^2$, where W_i is the weight of each benchmark constituent, and n is the number of benchmark constituents at the end of month t.	(Datastream)
$RB_{m,\ t-1}$	Lagged return obtained by the domestic benchmark of market m during the previous 12-month period at the end of month $t-1$.	(Datastream)
$NHHI_{m,\ t}$	NHHI measures the concentration of the mutual fund industry as a normalised version of HHI by stock market capitalization of fund p at the end of month t. $NHHI_t = \frac{HHI_i - \frac{1}{m_t}}{1 - \frac{1}{m_t}}$ where HHI is the sum of the squared market share of each fund, and m_t is the number of funds at the end of month t.	(Datastream; Morningstar)
$ERB_{p,\ t-1}$	Lagged excess return of fund p during the previous 12-month period at the end of month $t-1$.	(Datastream; Morningstar)
$TNA_{p,\ t}$	Total net assets in EUR millions of fund p at the end of month t. This variable is normalised for each domestic fund market.	(Morningstar)
$Flow_{p,\ t-1}$	Lagged percentage growth of total net assets of fund p during the previous 12-month period at the end of month $t-1$. Following Sirri and Tufano (1998), this growth is net of fund returns (assuming reinvestment of dividends and distributions). This variable is normalised for each fund market.	(Datastream; Morningstar)
$Age_{p,\ t}$	Number of months of fund p since the launch date at the end of month t. This variable is normalised for each fund market.	(Morningstar)
$Man_{p,t}$	Dummy variable that equals one when the fund p is managed by one person and zero otherwise at the end of month t.	(Morningstar)

This table shows the definition of the time-varying fund- and market-specific variables that are included in the logit panel data model (1) to estimate the probability of incurring default 1, 2, or 3.

Table 3
Summary statistics of the variables.

	HHI(Log)			RB			NHHI			ERB		
Country	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
NETHERLANDS	2.92	2.92	0.03	0.07	0.01	0.05	0.13	0.12	0.10	0.00	0.00	0.06
GREECE	2.98	2.98	0.04	−0.07	−0.01	−0.01	0.17	0.16	0.21	0.06	0.00	0.12
AUSTRIA	2.98	2.98	0.04	0.05	0.01	0.01	0.04	0.12	0.27	−0.01	−0.01	0.07
BELGIUM	2.94	2.95	0.07	0.02	0.00	0.00	0.39	0.34	0.45	−0.06	0.01	0.06
FRANCE	2.68	2.69	0.04	0.06	−0.01	−0.01	0.02	0.02	0.05	0.01	0.00	0.05
GERMANY	2.76	2.75	0.07	0.09	0.03	−0.01	0.02	0.04	0.10	0.01	0.00	0.06
ITALY	2.87	2.88	0.06	0.03	−0.01	−0.01	0.01	0.05	0.07	0.00	−0.01	0.06
SPAIN	2.95	2.95	0.08	0.08	0.02	−0.01	0.02	0.03	0.03	−0.04	0.00	0.06
FINLAND	2.80	2.80	0.04	0.08	0.03	−0.01	0.01	0.04	0.12	0.00	−0.01	0.06
PORTUGAL	3.01	3.01	0.04	0.02	0.00	0.00	0.02	0.08	0.10	−0.01	0.00	0.07
	TNA			FLOW			AGE			MAN		
Country	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
NETHERLANDS	302.91	289.73	3.02	18.20	10.05	3.58	163	149	103	0.49	0.00	0.50
GREECE	83.65	44.21	40.91	5.09	−3.17	9.01	170	169	71	0.55	1.00	0.50
AUSTRIA	125.11	110.66	26.17	18.36	2.98	18.37	127	113	80	0.82	1.00	0.38
BELGIUM	55.00	42.49	4.46	13.32	3.25	11.33	148	117	102	0.00	0.00	0.06
FRANCE	172.31	152.77	13.03	59.40	30.10	21.09	171	160	100	0.67	1.00	0.47
GERMANY	513.08	463.51	66.28	22.46	13.24	12.66	283	226	196	0.51	1.00	0.50
ITALY	174.74	175.90	7.23	53.84	16.17	19.00	141	131	85	0.68	1.00	0.47
SPAIN	77.21	74.25	20.20	38.09	20.64	23.66	118	108	80	0.70	1.00	0.46
FINLAND	122.64	119.83	4.30	29.88	7.45	26.04	149	144	87	0.74	1.00	0.44
PORTUGAL	22.84	27.67	6.27	2.41	−1.98	7.01	199	200	46	0.63	1.00	0.48

This table presents (1) the mean values, (2) the median values and (3) the standard deviation values of all variables that are included in the logit panel data model (1) to estimate the probability of incurring default 1, 2, or 3. The variables TNA, Flow, and Age are included in the model in normalised terms, but this table provides additional information regarding EUR million and the number of months, respectively. This information is reported for each country included in our sample from 2002 to 2018. See Table 2 for more details about the definition of the variables.

Table 4
Results for domestic equity funds (2002-2018).

	Panel A			Panel B			Panel C		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	−0.0014***	−0.0283***	−0.0013***	−0.0019***	−0.0249***	−0.0016***	−0.0012***	−0.0292***	−0.0016***
	[−17.683]	[−23.427]	[−17.838]	[−16.053]	[−20.836]	[−16.934]	[−17.717]	[−23.577]	[−17.786]
HHI$_{m,t}$ (Log)	1.8100***		1.8089***	1.2466***		1.2542***	1.7207***		1.7616***
	[9.136]		[8.837]	[9.146]		[8.062]	[12.151]		[11.865]
RB$_{m,t-1}$	−0.3086**		−0.3127**	−0.0842**		−0.0825**	0.0660		0.0642
	[−4.027]		[−2.110]	[−3.336]		[−2.245]	[0.316]		[1.418]
NHHI$_{m,t}$	0.1459***		0.1351***	0.1194***		0.1196***	0.1678***		0.1577***
	[7.558]		[8.758]	[18.500]		[10.306]	[7.469]		[8.611]
ERB$_{p,t-1}$		−0.0155**	−0.0116**		−0.0673	−0.0516		−0.0151	−0.0166
		[−1.661]	[−1.130]		[−2.752]	[−1.378]		[−1.605]	[−1.917]
TNA$_{p,t}$		0.0074	0.0076		0.0098	0.0092		0.0007	0.0004
		[1.146]	[1.659]		[1.876]	[1.302]		[1.085]	[1.643]
Flow$_{p,t-1}$		0.0000	0.0000		0.0000	0.0000		0.0000	0.0000
		[0.274]	[0.324]		[0.534]	[0.421]		[0.057]	[0.080]
Age$_{p,t}$		0.2404***	0.2452***		0.2579***	0.2609***		0.1817***	0.1850***
		[8.300]	[9.112]		[3.322]	[3.937]		[7.006]	[8.975]
Man$_{p,t}$		0.0350***	0.0360***		−0.0744***	−0.0725***		−0.0350***	−0.0354***
		[1.540]	[2.253]		[−2.727]	[−4.058]		[−1.672]	[−2.346]
AIC	50440	54235	53601	67665	69509	674456	53473	54050	53426
Observations	53647	54239	54962	69518	69518	69518	54054	54058	54058
Wald Test X^2	9535	4675	5100	1640	2007	1264	9623	4723	5142
X^2(p-value)	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.1098	0.1737	0.1202	0.0267	0.0315	0.0299	0.1091	0.1400	0.1194
Pseudo R^2 (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results the results of several specifications for the logit panel data model (1) using fixed effects. In Panel A, Panel B and Panel C, the dependent variable is one when we detect default 1, 2 or 3, respectively, and zero otherwise. The odds ratios of the coefficients minus one are given for each model specification. Robust z-tests are in brackets underneath.*, **, and *** indicate significance at the 5 %, 1 % and 0.1 % levels, respectively.

To prevent defaults on EU portfolio concentration limits, the results of this section should lead market supervisors to pay more attention to concentrated fund industries with concentrated domestic equity benchmarks. The most experienced funds that are solo-managed should be especially monitored to prevent portfolio weights over a 10 % limit.

Since a large number of funds violate the UCITS directive, the analysis of the effects of these diversification defaults on mutual fund shareholders should be analysed to recommend the revision of these limits on portfolio concentration.[13]

3. Stock determinants of portfolio diversification default

The evidence provided in the previous section on the existence of domestic equity funds that fail to fulfil the EU regulation leads us to explore some features of this phenomenon in greater depth. Given these portfolio diversification defaults, this section identifies the stock characteristics that are especially subject to more concentrated strategies and, therefore, more vulnerable to mutual funds' investment policies. In this section, we test how stock characteristics influence the probability of the stock being subject to defaults.

Thus, we first describe our sample of stocks included in the portfolios of our set of domestic equity funds. Then, we describe the specific variables included in our multinomial logit panel data model. Finally, we contract the hypotheses and present the results and identify the characteristics of the portfolio holdings exceeding the EU concentration limits.

3.1. Sample description

Our data contain a comprehensive sample of stocks with a portfolio weight over 5% held by the domestic equity funds previously analysed in Section 2. Our initial sample includes more than 195,000 holdings of 6,306 stocks that are contained at least once in the portfolios of the 536 domestic equity funds analysed during our sample period (December 2002–December 2018). The final sample comprises 1,605 stocks with a portfolio weight over 5% that incur default 1, 2 or 3. The distribution by type of default is as follows: default 1 comprises 562 stocks, default 2 comprises 1,183 stocks and default 3 comprises 446 stocks. Detailed information is available upon request.

Table 5 presents the number of holdings with a portfolio weight over 5% in our fund sample. The most economically important mutual fund industries in the Eurozone, such as France, Germany, Italy and Spain, have a total of 134,086 holdings, representing 68.76 % of our sample. Table 5 also shows the number of stocks in which at least one fund on a concrete date has reported a portfolio weight greater than 5 %. French funds present more than 130 different stocks per year on average. In contrast, countries such as Belgium, Portugal, and Austria show fewer stocks with a portfolio weight over 5 %, likely due to the lower number of stocks listed in these domestic markets. In addition, Table 5 shows the average number of holdings with a portfolio weight over 5% per portfolio analysed. Excluding the information in 2002 which is affected by the number of months available in that year, all countries provide stable patterns in the average number of holdings with a portfolio weight over 5%.We calculate a variation of the HHI to detect the potential concentration of the default holdings of a small number of stocks. Fig. 2 shows the results of this measure for default 1 in each country.[14] Domestic equity funds registered in Italy concentrate their bets in fewer stocks than other domestic equity fund industries, such as Germany and the Netherlands. The descriptive evidence for our sample highlights the interest in the stock characteristics of the holdings exceeding the EU portfolio concentration limits.

3.2. Model and variables

In Table 4, we provided evidence that an increase in a log unit of the level of concentration of the domestic equity benchmarks almost duplicates the probability that domestic equity funds will incur default 1, 2, or 3. Accordingly, in this stock-based analysis, our hypothesis is that the characteristics of the constituents of domestic equity benchmarks may significantly influence the default probability.

We estimate the probability of the stocks that could be subject to default 1, 2, or 3 using a multinomial logit panel data model (fixed effects).[15] This model is a variation of the logit panel data in which the dependent variable k can take more than two values. The logistic probability function of a stock s to be subject to default k in period t is

$$\Pr(\text{Default 1, 2 or 3})_s = \frac{e^{\beta' x_s}}{1 + \sum_{k=1}^{K} e^{\beta' x_s}}, \quad \beta' X_s = \alpha_{s,0} + \beta_s X_{s,t} + \varepsilon_{s,t}; k = 1 \text{ to } K \tag{2}$$

where $X_{s,t}$ is a vector of time-varying stock-specific variables and K is the number of dependent variables.

The multinomial logistic regression allows us to avoid the duplication of the number of stocks included in each panel because it

[13] Although the potential revision of the limits on portfolio concentration is beyond the objectives of our research, we have preliminarily analysed the future performance implications of all the documented defaults. Our exploratory results support that the violation of the UCITS directive in our sample has no clear negative effects on mutual fund shareholders in terms of Jensen's alphas. Further research should contribute to these very first results. Details are available on request.

[14] Details for defaults 2 and 3 are available upon request.

[15] The results of Hausman test are available upon request.

Table 5
Number of holdings and stocks with a portfolio weight over 5 % (2002–2018).

	NETHERLANDS			GREECE			AUSTRIA			BELGIUM			FRANCE		
Year	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
2002	68	14	5.23	38	8	19.00	9	1	9.00	2	1	1.00	135	10	7.11
2003	395	30	5.13	137	14	6.85	21	3	10.50	17	4	4.25	477	47	3.06
2004	428	29	4.55	165	15	7.86	34	7	3.78	14	3	4.67	655	57	2.74
2005	532	36	5.85	221	21	4.09	78	16	4.33	19	9	2.11	592	62	2.95
2006	745	38	6.21	297	22	4.43	300	20	3.95	26	10	2.00	812	92	3.04
2007	819	45	5.98	408	31	4.80	357	20	4.15	21	10	1.91	934	90	2.26
2008	673	42	5.38	275	30	3.82	351	28	4.08	69	22	2.65	1692	170	2.82
2009	657	40	5.57	309	28	4.12	525	25	3.98	65	16	2.50	2816	185	2.98
2010	763	44	6.10	240	27	3.81	509	21	4.04	51	7	1.89	2279	175	2.53
2011	787	43	5.79	332	29	5.27	565	23	4.38	12	5	0.92	2157	145	2.24
2012	753	38	5.66	188	23	4.37	462	16	3.95	12	2	1.00	2859	164	2.88
2013	831	45	6.11	166	19	3.77	493	20	3.63	12	1	0.92	2826	169	2.87
2014	637	38	6.64	319	23	3.63	400	21	3.03	na	na	na	2562	206	2.72
2015	461	35	6.59	336	24	4.05	487	25	3.38	na	na	na	2396	170	2.58
2016	464	37	6.19	377	22	4.60	448	23	2.87	na	na	na	2492	175	2.66
2017	420	40	5.25	409	20	5.18	468	24	4.37	na	na	na	2798	178	2.52
2018	412	34	5.72	399	18	5.12	453	28	4.23	na	na	na	3222	164	3.02
Average	579	37	5.76	272	22	5.57	351	19	4.57	27	8	2.15	1865	133	3.00

	GERMANY			ITALY			SPAIN			FINLAND			PORTUGAL		
Year	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
2002	119	25	4.10	84	15	3.65	118	31	3.58	59	21	2.03	12	1	1.33
2003	1286	40	4.01	545	43	3.81	1002	49	3.47	323	29	3.59	85	5	4.47
2004	1328	38	4.11	976	39	3.75	870	27	3.39	377	28	4.19	137	9	4.89
2005	1263	33	4.04	1026	55	3.40	918	33	3.34	390	35	3.61	180	10	3.27
2006	1344	38	3.92	1015	69	3.56	1040	44	3.75	557	47	4.13	215	16	1.05
2007	1591	46	3.85	894	58	3.24	1112	45	3.69	720	48	3.83	922	25	4.37
2008	1785	63	4.08	783	45	3.11	1360	64	4.18	899	50	3.89	869	23	4.83
2009	1964	59	4.26	732	49	2.50	1147	67	3.70	977	46	4.12	781	23	3.94
2010	1802	48	3.93	801	42	3.02	1623	55	4.10	1296	44	4.55	786	21	4.20
2011	1545	38	3.59	684	32	2.63	1712	58	4.12	1450	52	4.60	813	20	4.47
2012	1508	41	3.41	655	28	2.52	1860	71	4.34	1637	48	4.81	807	19	5.01
2013	1487	47	3.84	522	24	2.68	2067	55	4.31	1698	53	4.43	701	19	4.52
2014	1247	51	3.97	539	20	2.67	1908	68	3.51	2028	62	4.91	692	19	5.16
2015	1368	48	4.61	593	33	2.86	2055	61	3.56	1777	52	4.86	590	19	5.00
2016	1322	41	4.99	550	29	2.57	2267	66	3.61	1658	51	6.10	527	17	4.79
2017	1296	59	3.33	594	38	1.80	2568	62	4.39	1698	49	5.19	641	20	7.54
2018	1301	51	3.28	681	36	2.15	2498	66	4.23	1553	51	5.08	668	19	9.15
Average	1386	45	3.96	687	39	2.94	1537	54	3.84	1123	45	4.35	554	17	4.59

This table shows (1) the number of holdings with a portfolio weight over 5%, (2) the number of stocks in which at least one fund on a given date has reported a portfolio weight greater than 5%, and (3) the average number of holdings with a portfolio weight over 5% per portfolio analysed. This information is reported for each country included in our sample from 2002 to 2018.

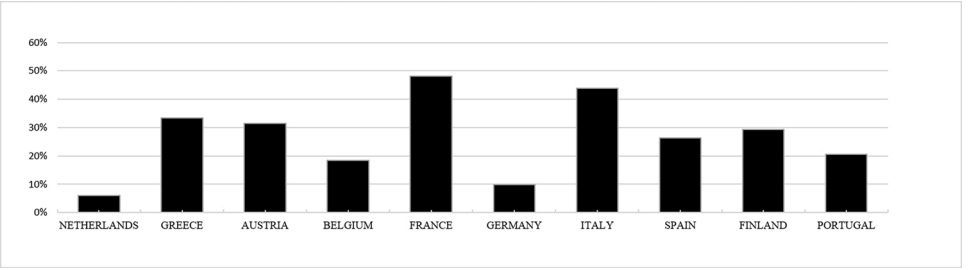

Fig. 2. Distribution of stocks by default 1.
This figure shows the level of concentration of stocks per country in default 1. This metric is based on a variation in HHI for each country during the period from 2002–2018. We adapt this concentration measure to obtain the HHI' as the proportion of the sum of the squared frequency of each stock with a portfolio weight higher than 10 % divided by the squared frequency of all portfolio positions incurring default 1.

categorises each stock by both the frequency and the type of default, if any. The multinomial logit model lets us evaluate the probability of incurring default 1, 2, or 3 at the same time by isolating the stock frequencies by type of default, that is, the multinomial logit model does not consider the frequency of stocks that incur in default 1 when analysing default 2 or 3.

We begin by testing whether benchmark-based stock characteristics increase the probability that stocks could be subject to default 1, 2, or 3.

Since the seminal work by Fama and French (1993, 1995), the size of stocks has been a key variable that influences portfolio composition and performance. The literature shows that mutual funds have a clear preference for large stocks (e.g., Chen et al., 2000; Gompers and Metrick, 2001). In the same manner, liquidity is another variable that influences portfolio composition. The literature argues that both institutional and retail investors prefer liquid assets over illiquid ones in their portfolios (e.g., Amihud and Mendelson, 1986; Gompers and Metrick, 2001). Additionally, Ding et al. (2016) find that stocks with a higher free-float capitalization have a higher level of liquidity. Loban et al. (2020) find that domestic equity benchmarks of the Eurozone present a high level of concentration in some of their large free-float capitalization constituents. Thus, stocks with larger weights in the corresponding domestic equity benchmark could be more likely to be overweighted in the portfolios of domestic funds that follow this benchmark. Formally, our ninth hypothesis is as follows:

H9. A larger weight in domestic benchmark is positively related to the likelihood of incurring default 1, 2, or 3.

This fact could subsequently imply a failure to fulfil the EU portfolio concentration limits. Traditionally, market capitalization is a common measure to compute stock size. However, we measure the size of stock *s* relative to its domestic equity benchmark at the end of month *t*, $WSize_{s,t}$, as the monthly weight of stock *s* in its domestic equity benchmark. We include this variable in our model (2) to test whether the free-float market capitalization as a proxy of size and liquidity could affect the probability of incurring the previously defined types of defaults.

In addition to stock size, Bae et al. (2008) argue that the importance of local advantage is inversely related to the quality of the information provided by firms. Ding et al. (2016) find that firms included in free-float benchmarks can alleviate information asymmetry problems. Furthermore, Kacperczyk and Seru (2007) show how analyst recommendations proxied by public information tend to affect portfolio holdings. Busse et al. (2007) use holdings information to consider fund managers' willingness to take big bets out-benchmark in a relatively small number of stocks, resulting in more concentrated portfolios. More recently, Reibnitz (2017) finds that firm-specific information influences fund performance more than market conditions, especially with regard to small companies with a relatively less rich information environment. These information asymmetries could affect the probability of incurring defaults on EU portfolio concentration limits. Our tenth hypothesis is as follows:

H10. The number of months that stock is in the benchmark is positively related to incurring default 1, 2, or 3.

We use the recent permanency of the stocks in the domestic equity benchmark as a proxy for this information coverage. We include $Benchmark_{s,t}$ in model (2) as the proportion of months that stock *s* in month *t* has remained in the benchmark out of the last 24 months.

We also consider the accumulated weight of each industry in the benchmark as a potential factor to explain the different defaults. Fulkerson (2013) finds that fund managers tend to select majority stocks within economically relevant industries. More recently, Narayan et al. (2017) show that the same sectors that dominate returns from dynamic trading strategies are included in portfolios, regardless of the different portfolio constraints. Cremers and Petajisto (2009) show that managers may take large stock-specific positions if they simultaneously diversify their active positions across all industries, producing a low tracking error and a high active share. In addition, we find that domestic equity benchmarks present high return correlation levels within stocks included in each industry.[16] Thus, this evidence of correlation could be considered managers' incentive to diversify that overweighted stocks in the same industry exceed the EU portfolio concentration limits. Our eleventh hypothesis is as follows:

H11. A higher accumulated industry weight in domestic benchmark is positively related to the likelihood of incurring default 1, 2, or 3.

We include $WIndustry_{I,\ t}$ in model (2) as the accumulated weight of the stocks in industry *I* at the end of month *t*.

Previous findings support that mutual fund holdings exhibit a distinct preference for growth stocks (e.g., Carhart, 1997; Wermers, 1999; Chen et al., 2000; Kacperczyk et al., 2005; Frazzini and Lamont, 2008). Furthermore, Brands et al. (2005) find that more concentrated funds tend to be those that implement growth styles. Thus, growth strategies could generate more concentrated portfolios and imply conflicts with EU concentration limits. Our twelfth hypothesis is as follows:

H12. The growth stock strategies are positively related to the likelihood of incurring default 1, 2, or 3.

We compute $MB_{s,t}$ in model (2) as the monthly ratio between the stock market price and the value of each stock according to the book value of firm *s* at month *t*.

Traditionally, stock performance is a widely used variable. In our analysis, we include return and risk separately to capture the specific information provided by each performance factor. We examine how stock return records may influence the probability of that stock being subject to default 1, 2 or 3 by domestic equity funds. Jegadeesh and Titman (1993) show how stocks that have performed

[16] We obtain the correlation matrix of the returns between stocks belonging to the same industry. The industry classification is provided by Datastream, i.e., Basic Materials, Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Real Estate, Technology, Telecommunications, and Utilities. Details are available upon request.

relatively well in the past have a subsequent positive return. Grinblatt et al. (1995) find that the tendency to include stocks based on their past return could be common among managers. Furthermore, Carhart (1997) finds persistent abnormal returns in portfolio management strategies based on the continuance of market trends, i.e., momentum strategies. Additionally, Wermers (1999) provides additional evidence that momentum is not a statistical fluke. Chen et al. (2000) show that fund managers prefer to hold past winners. Thus, a positive and significant previous return as a consequence of momentum strategies could increase the propensity to rely more on winner stocks regardless of the limits of portfolio concentration. Further, a merely mechanical explanation also complements momentum explanation. High past return stocks grow larger and increase naturally as a share of the portfolio. Both explanations are consistent with lagged stock return as an independent variable in our model. Our thirteenth hypothesis H13 is as follows:

H13. Previous stock return is positively correlated with the likelihood of incurring default 1, 2, or 3.

In model (2), we define $Return_{s,t-1}$ as the excess return of stock *s* during the previous 12-month period at the end of month *t-1*.

Finally, we evaluate the level of risk as a potential factor to explain the probability of a stock being subject to default 1, 2 or 3. The relationship between both the return on the stock and its risk is an important topic in financial research. There are important papers that find a significant and positive relation between different specifications of stock returns and risk (e.g., Merton, 1980; French et al., 1987; Chou et al., 1992). However, there are also relevant findings in that question (e.g., Black, 1976; Cox and Ross, 1976; Bekaert and Wu, 2000; Li et al., 2005). Thus, we analyse how risk could affect the probability of being subject to EU regulation defaults by domestic equity funds. Falkenstein (1996) documents that mutual fund managers prefer stocks with high volatility. More recently, Huang et al. (2011) show that mutual funds can shift risk by changing their exposure to systematic risk (e.g., by switching between low-beta stocks and high-beta stocks). This commitment to managing risk could affect the probability of incurring defaults on EU portfolio concentration limits because domestic equity funds could also follow risk-shifting strategies by changing their exposure to idiosyncratic risk with more concentrated portfolios. Thus, risk may have a significant impact on our model (2). Our fourteenth hypothesis H14 is as follows:

H14. Risk-shifting strategies are positively correlated with the likelihood of incurring default 1, 2, or 3.

We define $Volatility_{s,t-1}$ as the variance of excess return of stock *s* during the previous 12-month period at the end of month *t-1*.

Table 6 presents a detailed definition of the time-varying stock-specific variables included in model (2).

Table 7 reports summary statistics of the previously defined variables. Both significant differences in the weights of the benchmark constituents and the accumulated industry weights of these constituents highlight the differences in our sample where the unique EU concentration limits are applied.

3.3. Empirical results

Table 8 reports the results for model (2). The regressions allow us to identify the stock-specific characteristics that could be subject to portfolio holdings not fulfilling the EU portfolio concentration limits. These specific characteristics should be monitored by market supervisors to identify the stocks that are subject to the default of domestic equity funds. Consistent with the interpretation of the results in model (1), we also analyse the odds ratios of the coefficients minus one to explain the significance of the variables in terms of the probability that the default will occur with a small change in the independent variable.

Considering the stock characteristics in relation to their benchmarks, we find a positive and significant relation between the weight of stocks in their domestic benchmarks and the probability of a stock being subject to default by domestic equity funds. This positive significance is robust to different model specifications and to different types of defaults. The results show how the probability of a stock to be subject to default is around 8 %–25 % higher when the stock weight in the domestic benchmark increases by one unit (in percentage terms). Thus, market supervisors should monitor stocks with large weights in domestic equity benchmarks.

The recent permanency of stocks in their domestic equity benchmarks also has a positive significant effect around 13 %–24 % on the likelihood of stock being subject to defaults 1 and 3 (Panel A and Panel C) per each increase by one unit (in percentage terms). Thus, this result is consistent with previous literature that argues for the local advantage to reduce the information asymmetry problems. Therefore, supervisors should particularly monitor fund markets with a stable list of benchmark constituents. In contrast, this variable presents a negative effect on the likelihood of a stock being subject to default 2. The definition of default 2 implies that the accumulated

Table 6
Variables' definitions.

Variable	Definition	Data source
$\boldsymbol{WSize_{s,\,t}}$	The weight of stock *s* in its domestic equity benchmark at the end of month *t*.	(Datastream)
$\boldsymbol{Benchmark_{s,\,t}}$	Proportion of months in which stock *s* is included in its domestic equity benchmark in the previous 24-month period at the end of month *t-1*. This variable is obtained with a rolling-window method from November 2000 to December 2018.	(Datastream)
$\boldsymbol{WIndustry_{I,\,t}}$	Accumulated weight of the domestic equity benchmark of the stocks included in the same industry at the end of month *t*. This industry classification is obtained following Global Industry Classification Standard criteria.	(Datastream)
$\boldsymbol{MB_{s,\,t}}$	Monthly ratio between the stock market price and the book value of each stock *s* at the end of month *t*.	(Datastream)
$\boldsymbol{Return_{s,\,t-1}}$	Lagged excess return of stock *s* during the previous 12-month period at the end of month *t-1*.	(Datastream)
$\boldsymbol{Volatility_{s,\,t-1}}$	Variance of monthly return of stock *s* over the prior 12 months at the end of month *t-1*.	(Datastream)

This table shows the definition of the time-varying stock-specific variables included in the multinomial logit panel data model (2) to estimate the probability of incurring default 1, 2, or 3.

Table 7
Summary statistics of the variables.

	WSize			Benchmark			WIndustry		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
NETHERLANDS	13.95	12.74	4.41	0.58	0.98	0.46	13.98	11.34	9.94
GREECE	15.77	12.95	2.68	0.80	0.77	0.33	31.46	26.11	14.40
AUSTRIA	11.30	13.22	4.74	0.80	0.91	0.29	22.60	17.88	9.46
BELGIUM	10.49	7.52	5.29	0.66	0.59	0.41	14.80	11.41	8.24
FRANCE	6.01	5.94	2.31	0.58	0.55	0.47	14.55	10.33	3.26
GERMANY	7.46	7.94	1.64	0.89	0.78	0.31	16.01	15.02	3.44
ITALY	9.64	10.01	2.01	0.79	0.80	0.38	23.60	20.20	7.21
SPAIN	14.20	15.50	4.35	0.82	0.91	0.33	26.97	24.98	4.61
FINLAND	6.03	6.01	1.04	0.79	0.76	0.35	15.14	13.64	3.26
PORTUGAL	8.95	7.64	4.01	0.81	0.88	0.29	16.40	15.39	4.92
	MB			Return			Volatility		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
NETHERLANDS	1.96	1.77	2.00	−0.01	0.01	0.00	0.04	0.01	0.25
GREECE	2.17	1.73	2.33	0.02	0.01	0.04	0.15	0.03	0.81
AUSTRIA	1.67	1.23	1.39	−0.01	0.00	0.06	0.11	0.03	0.59
BELGIUM	1.95	1.31	1.29	0.00	0.00	0.03	0.07	0.01	0.24
FRANCE	2.07	1.59	1.71	0.01	0.00	0.07	0.04	0.01	0.20
GERMANY	2.26	1.89	1.60	0.00	0.00	0.00	0.04	0.02	0.12
ITALY	1.66	1.24	1.23	0.00	0.00	0.00	0.04	0.04	0.04
SPAIN	2.41	1.61	2.43	0.00	0.00	0.01	0.03	0.02	0.07
FINLAND	2.50	1.94	2.04	0.00	0.00	0.00	0.06	0.02	0.18
PORTUGAL	2.44	1.45	2.60	−0.01	0.00	0.02	0.06	0.03	0.08

This table presents (1) the mean values, (2) the median values and (3) the standard deviation values of all variables that are included in the multinomial logit panel data model (2) to estimate the probability of incurring default 1, 2, or 3. This information is reported for each country included in our sample from 2002 to 2018. See Table 6 for more details about the definition of the variables.

weight of several stocks over 5% must be higher than 40 %, which could lug this result. Thus, the need for a higher number of stocks to incur this default leads us to hypothesize that the managers may not only analyse the stocks included in their benchmarks in this type of default.

Finally, we also find that risk has a negative and significant effect on the likelihood of stocks being subject to default 1, 2, or 3. This significance is robust to the different model specifications and to the different types of defaults. The results confirm that the probability of a stock to be subject to default is around 19 %–27 % lower when the stock volatility increases by one unit (in standard deviation terms). The commitment to controlled risk strategies could be consistent with the idea that domestic equity funds tend to hold low-volatility stocks.

To identify stocks subject to default on EU portfolio concentration limits, the results of this section should encourage market supervisors to pay more attention to liquid, domestic and large-cap stocks with low volatility records. Furthermore, market supervisors should especially monitor these types of stocks held by domestic equity funds in order to prevent portfolio concentration defaults.

4. Robustness

We provide several robustness checks for our main findings in models (1) and (2).[17] Firstly, the current situation in financial markets is different from the situation when the Directive 2009/65/EC was first established. Fund managers might show different non-compliant practices with the legal requirements depending on the market environment. We wonder whether the portfolio concentration limits should be revised and adjusted for different market scenarios. We run a Chow test to check for any structural change in default 1, 2, or 3 that non-comply with the limits of portfolio concentration included in the EU Directives. We consider the period of the Euro Sovereign Debt crisis as the most striking scenario affecting the financial markets of the European Union in the recent decade. However, the results show no evidence of structural changes in the patterns of default 1, 2, or 3 for the following crisis phases defined by Lane (2012): pre-crisis (before January 2010), the most critical phase of the sovereign debt storm (January 2010-June 2012), and after the Draghi effect on the financial markets (from July 2012 onward).[18] That is, we find that there are no structural breaks in the defaults series to justify a revision of the portfolio concentration limits depending on significantly different market scenarios.

Secondly, the three types of defaults are not homogeneously distributed across our country sample. In order to control for this country-level variation, we run a new specification of model (1) with only fund-level variables and a control variable $Countrydefaults_{m,t-1}$ which is defined as the percentage of defaults incurred per country-year at the end of month *t-1*. The new results are robust with the

[17] Detailed results of all robustness analyses are available upon request.

[18] From Mario Draghi's speech on July 26, 2012 at the U.K. Trade and Investment Global Investment Conference: "The European Central Bank is ready to do whatever it takes to preserve the Euro, and believe me, it will be enough."

Table 8
Results for domestic stocks (2002-2018).

	Panel A			Panel B			Panel C		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	−0.0012***	−0.0019	−0.0013***	−0.0004***	−0.0004	−0.000***5	−0.0013***	−0.0019***	−0.0013***
	[−73.900]	[−73.416]	[−74.614]	[−27.781]	[−33.041]	[−28.115]	[−73.920]	[−73.400]	[−74.623]
WSize$_{s,\ t}$	0.1952***		0.2504***	0.0812***		0.0877***	0.2494***		0.2503***
	[47.555]		[43.162]	[27.844]		[23.060]	[43.940]		[43.148]
Benchmark$_{s,\ t}$	0.2472***		0.2440***	−0.1246***		−0.1219***	0.1336***		0.1342***
	[54.410]		[47.700]	[−8.943]		[−9.129]	[54.455]		[46.577]
WIndustry$_{s,\ t}$	−0.0172*		−0.0173*	−0.0309*		−0.0304*	−0.0094*		−0.0097*
	[−9.566]		[−10.144]	[−3.038]		[−3.019]	[−10.571]		[−10.150]
MB$_{s,\ t}$		−0.0010	−0.0012		−0.0048	−0.0047		−0.0010	−0.0012
		[−1.126]	[−1.257]		[−2.218]	[−2.646]		[−1.124]	[−1.614]
Return$_{s,\ t-1}$		0.0114	0.0116		0.0012	0.0019		0.0116	0.0118
		[0.517]	[2.345]		[1.450]	[1.765]		[0.516]	[2.353]
Volatility$_{s,\ t-1}$		−0.2115***	−0.2047***		−0.2736***	−0.2644***		−0.1913***	−0.2147***
		[−4.036]	[−3.011]		[−0.408]	[−0.775]		[−4.038]	[−3.009]
AIC	25057	27772	24871	110250	117070	109710	24710	21712	24870
Observations	31427	31427	31427	131788	131788	131788	27423	27423	27423
Wald Test X^2	4405	5663	5722	15374	33676	28581	4466	5870	5727
X^2(p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.1343	0.0147	0.1711	0.0645	0.0633	0.0742	0.1344	0.0144	0.1544
Pseudo R^2 (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results of specifications for default 1, 2, or 3 in the multinomial logit panel data model (2) using fixed effects. In Panel A, Panel B and Panel C, the dependent variable is one when we detect default 1, 2 or 3, respectively, and zero otherwise. The odds ratios of the coefficients minus one are given for each model specification. Robust z-tests are in brackets underneath. *, **, and *** indicate significance at the 5 %, 1 % and 0.1 % levels, respectively.

previous findings provided in Table 4 and show why some funds are more likely to incur legal defaults, while controlling for the overall likelihood of a default in a country.

Then, we check the robustness of our findings using an alternative definition of default. In our primary specifications, we define three types of default according to the limits of portfolio concentration presented in art 52 of UCITS IV. We consider a more restrictive definition of default 1 to determine if the previous results are not biased by minor 10 % overweights, which could be classified as non-intentional defaults due to the increase in the stock's market price and/or sales of other portfolio positions. First, we organize the holdings with weights over 10 % into quartiles.[19] Second, we exclude holdings included in q1. Finally, we run both models (1) and (2). Further, we also run a similar analysis for those holdings included only in q4. All these new results are in accordance with the previous findings in both models, regardless of the definition of default 1. That is, our findings are not significantly biased by unconscious defaults on the legal requirements.

The evidence of assorted characteristics of the Eurozone fund industries leads us to check the robustness of our results to alternative sample clusters based on homogeneous sets of mutual fund industries. We divide the sample into two alternative clusters based on the mean level of the previously defined *NHHI* as a proxy for the market concentration of each domestic fund industry. This choice is justified by the significance of this country-level variable in the likelihood of non-compliance with the EU portfolio concentration limits. We also obtain very similar clusters and results when these homogeneous groups of countries are based on the concentration of each domestic equity benchmark, *HHI*. We find that the results are consistent with the previous findings reported in Tables 4 and 8.

Finally, we check the robustness of our results to alternative specifications of our lagged variables. Initially, we run model (1) including market and fund returns using four different performance and lag periods (the 3-month period at the end of month t-1, the 6-month period at the end of month t-1, the 12-month period at the end of month t-2, and the 12-month period at the end of month t-3). The results are consistent with previous findings using the entire sample of logit panel data. Our main findings also remain mostly unchanged when we run model (2) using the same periods defined in model (1) for both stock return and volatility variables.

5. Conclusions

This study is the first to investigate how some market and fund characteristics play a crucial role in explaining the portfolio concentration default on EU Directive 2009/65/EC (UCITS IV). Our findings should help market regulators and supervisors to improve the monitoring process of defaults by domestic equity funds in the Eurozone mutual fund industry.

Using a large sample of open-end domestic equity funds in 10 Eurozone countries over the 2002–2018 period, we find that both the level of domestic benchmark concentration and the level of the concentration of the domestic fund industry significantly increase the likelihood of non-compliance with the EU portfolio concentration limits.

In line with fund characteristics, we show that fund age has a positive and significant effect on portfolio concentration defaults. Additionally, our findings are consistent with the influence of management structures on portfolio concentration strategies.

Focusing on some stock-specific characteristics that influence the likelihood of stocks being subject to noncompliance with the EU legal restrictions, we find that 1) the weight of the stocks in their benchmarks has a positive and significant effect on the EU portfolio concentration defaults, 2) the stocks which are more permanently listed in domestic benchmarks are likely to be subject to concentration defaults, and 3) the stocks that present low volatility have a greater likelihood of being subject to noncompliance with the EU portfolio concentration limits. Therefore, market supervisors should pay more attention to these stock characteristics to monitor those stocks which are more frequently overweighted over the EU concentration limits.

Finally, these documented diversification defaults should highlight the interest for further research on the possible changes in the UCITS directive. Both return and risk consequences of these defaults should be thoroughly analysed to determine the potential negative effects on mutual fund shareholders and to propose potential revisions of the limits to portfolio concentration.

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[19] The quartile breakpoints are 10.67%, 11.58% and 13.74%, for q2, q3 and q4, respectively.

Appendix A. Investment constraints in EU Directives

The seminal UCITS Directive was established in 1985 by Council Directive 85/611/EEC of December 20, 1985, (UCITS I) to create a single regulatory framework for mutual funds as a major financial industry of Europe. For the first time, Section V (article 22) showed the obligations concerning the investment policies which are mandatory compliance.

The currently Directive 2009/65/EC (UCITS IV) in force specifies in article 52.1 as "A UCITS shall invest no more than 5% of its assets in transferable securities or money market instruments issued by the same body; or 20 % of its assets in deposits made with the same body". According to article 52.2, "Member States may raise the 5% limit laid down in paragraph 1 to a maximum of 10 %. If they do so, however, the total value of the transferable securities and the money market instruments held by the UCITS in the issuing bodies in each of which it invests more than 5% of its assets shall not exceed 40 % of the value of its assets. That limitation shall not apply to deposits or OTC derivative transactions made with financial institutions subject to prudential supervision".

In terms of investment constraints, article 52 in the Directive 2009/65/EC is similar to article 22 in the seminal Directive 85/611/EEC.

In addition to the previously identified limitations, article 57.1 included in UCITS IV specifies, "Member States may allow recently authorized UCITS to derogate from articles 52 for six months following the date of their authorization". However, there is not a precise time limit to correct exceeded portfolio weights in most of the European legal framework. We analysed the national transpositions of UCITS IV by Belgium, Germany, Greece, Spain, France, Italy, the Netherlands, Austria, Portugal and Finland. Only article 65 of Greek law 4009/2012 gives a specific period (Law, 2012).

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