MFSA MALTA FINANCIAL SERVICES AUTHORITY

Liquidity Stress Testing for Maltese Retail Investment Funds: 2021 Update

by

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Abbreviations

AIF	Alternative Investment Fund
CFI	Classification of Financial Instruments
ESMA	European Securities and Markets Authority
GPD	Generalised Pareto Distribution
HQLA	High Quality Liquid Assets
IMF	International Monetary Fund
MFSA	Malta Financial Services Authority
NAV	Net Asset Value
OLS	Ordinary Least Squares
STIFF	Stress Testing for Investment Funds Framework
UCITS	Undertakings for the Collective Investment in Transferable Securities

Abstract

The main purpose of this report is to provide an update, at a micro level, of the liquidity stress testing of investment funds carried out for the first time by the Authority in 2020. While most of the methodology remains unchanged, some modifications were applied to overcome certain shortcomings that emerged from the previous framework. Overall, we find that the liquidity risk in the Maltese retail investment fund industry remains contained, with most of the funds capable of withstanding extreme redemption requests. Moreover, the COVID-19 pandemic provided a perfect opportunity to test the validity of the model calibrated in 2020. We find that the extreme redemptions calibrated in the previous stress testing exercise provided a reliable estimate of the redemption magnitudes which a fund manager could expect during turbulent years such as 2020.

JEL Classification: C15, C58, G17, G23

Keywords: Investment funds, liquidity risk, stress testing, COVID-19

Introduction

Liquidity risk in investment funds has been central in the agenda of international regulators for the last few years. In particular, several isolated events such as liquidity shortages in large retail investment funds and unforeseen events such as the COVID-19 global pandemic, which translated into market stress, brought increased attention to this matter.

In 2020, the Financial Stability function within the Malta Financial Services Authority (MFSA) developed and adopted its first stress testing for investment funds framework (STIFF)[1]. The purpose of this framework is to assess the resilience of the retail investment funds licensed in Malta – both from a micro and a macro perspective – to severe but plausible weekly redemption shocks. This report provides an update of the STIFF framework developed in 2020 both in terms of the methodology as well as the quantitative analysis, which both focus only on the micro-level stress testing[2]. We implemented changes to two of the four steps of the methodology used in the 2020 STIFF. First, we revised the method of one of the liquidation approaches which a fund manager would use to liquidate a fund's portfolio – namely the slicing approach – to align it with the approach being adopted by ESMA and IMF. Specifically, cash is not used as a first means to meet the redemption requests but rather it is sliced in a similar manner to the investment fund's portfolio of assets. Secondly, we applied a Bayesian approach to estimate the second-round effects. Several funds started operating only recently and therefore it is difficult to prove the well-known, positive relationship between performance and net flows using the classical frequentist econometric tools. Through a Bayesian approach, it is possible to introduce this a priori belief to better estimate the effect of a shock on the expected future net flows of the Maltese retail investment funds.

In this report, we also evaluate the effectiveness of the 2020 stress testing framework in flagging the distress that Maltese retail investment funds experienced during the first months of the COVID pandemic, which brought large market corrections due to economic uncertainty. The results of the 2020 liquidity stress test overall gave a good indication of the extreme liquidity scenario which funds were expected to meet during stressed market conditions.

The updated methodology of the STIFF using data up to end 2020 shows that the liquidity risk profile of Maltese retail investment funds remained aligned with the previous stress test results obtained in 2020. On one hand, more funds would need to liquidate part of their portfolio in case of an extreme scenario due to a lower cash buffer. This lower level of cash holding could be due to the investment opportunities which materialised in the financial markets as a consequence of the stimulus packages issued by governments and central banks in response to the COVID-19 pandemic (ESMA, 2020). On the other hand, an improvement in the liquidity risk is observed since fewer funds than what was observed during the previous liquidity stress testing exercise would face difficulties in meeting redemption requests, with these falling under the 1% worst case scenario.

The report is structured as follows. First, we present an overview of the sample of investment funds used for the stress testing exercise. Then we provide an overview of the STIFF framework, focusing on the new updates which we introduce to the 2020 STIFF. Next, we

[1] Meglioli and Gauci, (2020). Report available here.
[2] The micro level stress test assesses the resilience of the individual investment funds to extreme but plausible weekly redemption shocks.

analyse the effectiveness of the 2020 STIFF at the onset of the COVID-19 pandemic. Finally, we present the results obtained from the updated micro-level STIFF 2021.

Funds Sample Composition

The sample consists of 64 retail investment funds licensed in Malta covering a total net asset value of €2.67 billion or 88% of the total NAV of the Maltese retail funds as at end 2020. Out of this sample, 59 (85% of sample NAV) are UCITS and five (15% of sample NAV) are AIFs targeting retail investors. Only investment funds which have been in operation for at least two years are included in the sample.

In terms of investment fund strategy, bond funds occupy the largest share (57%) of the sample NAV, followed by diversified funds[3] (15%), equity funds (14%), mixed funds[4] (10%) and other funds (4%).

Table 1: NAV and number of funds in the sample[5]

Type of fund	NAV (€ bn)	% share	Number of funds	% share
Bond	1.52	57%	22	34%
Diversified	0.39	15%	11	17%
Equity	0.38	14%	16	25%
Mixed	0.26	10%	9	14%
Other	0.12	4%	6	9%
Total	**2.67**	**100%**	**64**	**100%**

The number of weekly redemption observations for the selected funds varies between 105 and 731. The average weekly redemption varies between 0.01% of NAV and 1.53% of NAV, and the mean average weekly redemption is 0.36% of NAV. Table A.1 in the appendix summarises various statistics for the weekly redemptions and weekly net flows of the funds in our sample.

STIFF 2021 – Updates to the asset liquidation approach and modelling of second round effects

The methodology of the micro-level stress test consists of four steps, which are the same as the steps followed in the 2020 STIFF, namely:
Step 1: defining the redemption shock;
Step 2: calculating the liquidity of a fund's portfolio;
Step 3: applying different liquidation approaches to simulate the managers' strategies to satisfy the investors' redemption requests; and
Step 4: incorporating second round effects.

[3] Diversified funds invest in a broad set of assets.
[4] Mixed funds invest in bonds and equities.
[5] Due to rounding, % share may not add up to 100%.

Enhancements to the STIFF methodology carried out in this report relate to revisions in steps three and four.

In the first step, we use the historical approach where the shock is estimated based on historical redemptions and calibrated using the Generalised Pareto distribution (GPD). Three different levels of extreme redemptions, namely the 10%, 5% and 1% worst redemptions, are calibrated[6].

In the second step, cash and deposits maturing within one year are considered to be highly liquid assets. The remaining investment portfolio is split by the Classification of Financial Instruments (CFI) code and the liquidity weights are assigned based on the adjusted high quality liquid assets (HQLA) approach.

Table 2: Liquidity weights based on an adjusted HQLA approach

	Credit Rating			
	CQS1 (AAA, AA+, AA, AA-)	**CQS2 (A+, A, A-)**	**CQS3 (BBB+, BBB, BBB-)**	**<CQS3 (BB+ and lower)**
Government bonds	(G1) 100	(G2) 85	(G3) 50	(G4) 0
Corporate bonds	(C1) 85	(C2) 50	(C3) 50	(C4) 0

	Market Capitalisation / Total NAV		
	>1BIL	**1BIL > 500MIL**	**< 500 MIL**
Equities	(S1) 75	(S2) 50	(S3) 25
ETF	(E1) 75	(E2) 50	(E3) 25
Other Instruments	(O) 0	(O) 0	(O) 0

In step three, the waterfall and the slicing approaches are the methods used for the liquidation of assets within a portfolio to service redemptions. The waterfall approach is kept unchanged by using a hierarchical liquidation routine based on the liquidity weights of the assets as defined in Table 2. On the other hand, we amended the slicing approach to reflect the findings of a study carried out by ESMA on the behaviour of fund managers during the COVID-19 crisis (ESMA, 2020). From data collected by ESMA, it emerged that during the peak of the COVID-19 crisis, fund managers tried to maintain a proportional composition of the portfolio. Therefore, unlike what we did in the 2020 STIFF – where it was assumed that a fund manager would first liquidate the highly liquid assets (cash and deposits up to one year) and then liquidate proportionately the remaining assets in the portfolio of the fund – we update the slicing approach so that cash is also sliced proportionately at the outset. Only in the case where the fund manager could not recover enough cash from the liquidation of assets within the portfolio (possibly under fire sale conditions), would additional cash be used, apart from that already sliced.

In step four, we adopt a Bayesian approach to measure the second-round effects. In particular, the expected effect of lagged returns and lagged net flows on current net flows is estimated using the following equation:

$$Y_{i,t} = \alpha + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t-1} + \epsilon_{i,t} \quad i = 1,2,\dots,64 \tag{1}$$

$$\beta_1 \sim N\left(E\left(\hat{\beta}^{OLS}_{1,strat(i)}\right), var\left(\hat{\beta}^{OLS}_{1,strat(i)}\right)\right) \text{ and } \beta_2 \sim N\left(E\left(\hat{\beta}^{OLS}_{2,strat(i)}\right), var\left(\hat{\beta}^{OLS}_{2,strat(i)}\right)\right)$$

[6] Further details on the calibration of the extreme redemptions can be found in the 2020 STIFF report.

where $Y_{i,t}$ refers to the weekly net flows, $Y_{i,t-1}$ are the lagged weekly net flows, and $X_{i,t-1}$ are the lagged returns. Moreover, we assume that the coefficients β_1 and β_2 are normally distributed with mean equal to the average of the estimates of β_1 and β_2 respectively when applying a simple OLS on funds belonging to the same strategy[7] of fund i. Similarly, the variance of the prior distributions of the coefficients is based on the variance of the estimates of β_1 and β_2 for funds belonging to the same strategy. Finally, similar to the 2020 STIFF, we analyse the effects of the second-round redemptions using the expected net flows estimated with equation (1).

Effectiveness of the 2020 STIFF during the COVID-19 Pandemic

In this section we analyse the effectiveness of the stress testing framework developed in 2020 by studying the performance of a sample of investment funds during the COVID-19 stress scenario. For comparison purposes, the selected sample consists of investment funds which have been selected for both the 2020 and 2021 liquidity stress testing exercises.

Initially, we analyse the validity of the 90th percentile threshold estimated in the 2020 STIFF during the COVID-19 stress scenario. For each fund in the sample, we count the number of redemption observations in 2020 which exceeded this threshold. Such threshold is considered appropriate if the number of redemption exceedances is around five or six (due to having 52 weeks in a year).

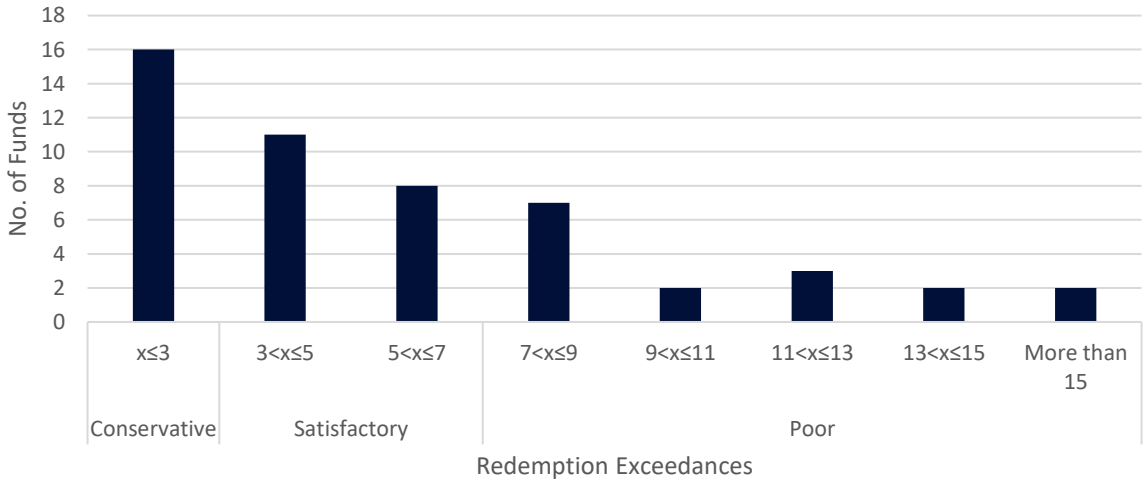

Figure 1: Redemption observations during 2020 that exceeded the threshold parameter estimated in 2020 STIFF

From Figure 1, we can observe that 16 funds out of 51[8] (or 31%) had more than seven redemption observations which exceeded the 2020 STIFF threshold. Therefore, for these 16 funds, the threshold applied in the STIFF 2020 exercise gave a poor estimation of the worst 10% scenario since it was a too low extreme redemption. For another 16 funds, the threshold estimated last year was a conservative one as it was exceeded only between zero and three

[7] The strategies used are equity, bond, mixed and other, with the strategy other combining diversified and other together. The strategy of fund i is denoted by $strat(i)$.

[8] Here we are referring to 51 funds and not the total of 64 funds because there were some funds which had a threshold of zero last year, while there were some new funds which were included in STIFF 2021 but not in STIFF 2020.

times. Finally, for 19 funds (or 37%) the threshold was exceeded between three and seven times, which is considered to be a satisfactory frequency.

Next, we compare the estimated 5% and 10% worst case scenarios[9] as calibrated in the 2020 STIFF with the actual averages of the 5% and 10% redemptions experienced during 2020 (empirical 5% and 10% worst case scenarios). From Figure 2, we observe that for the majority of the funds, the empirical 5% and 10% worst case scenarios were below the estimated 5% and 10% worst case scenarios. Moreover, for 17 out of 23 funds which had an empirical worst 10% redemption higher than the estimated 10% worst case scenario (and 13 out of 21 for the 5% worst case scenario), the empirical worst case was less than 1 percentage point greater than the estimated one. In general, STIFF 2020 performed relatively well in estimating the worst-case scenario since for both the 5% and 10% redemptions, the overall majority of funds had an empirical worst-case scenario within 1 percentage point from that estimated.

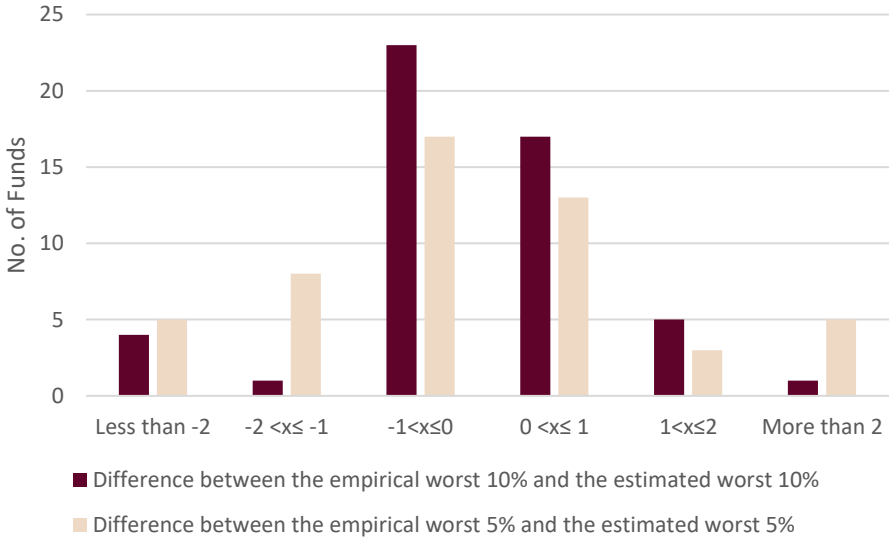

Figure 2: Difference between the empirical worst redemptions during 2020 and the estimated worst redemptions

Finally, we analyse how many times the 1% worst case scenario estimated in the 2020 STIFF was exceeded during the year. Overall, only 13 funds experienced a redemption greater than the estimated 1% worst case scenario. In particular, two funds received two weekly redemption requests exceeding the estimated 1% worst case scenario. We further study whether the COVID-19 turmoil was the main contributor to such large redemption requests, and we find that for seven funds these redemption requests occurred in the period February 2020 to end June 2020, this being considered as the main critical period of the COVID-19 crisis within the analysed timeframe.

[9] The 5% and 10% worst case scenarios are defined as the expected redemption requests when the redemption exceeds the 95th and the 90th percentile respectively.

Re-calibration of the STIFF

Calibration of the Extreme Redemption Curve

We start the analysis by computing the threshold parameter μ for each fund within the sample, that is the 90th percentile of the funds' weekly redemption observations. In this way, the parameters of the GPD curve are estimated for the observations exceeding the threshold μ. Similar to what we found in the STIFF 2020 report, only 14 funds (or 22%) have a μ parameter, and therefore a 90th percentile, equal to or higher than 1%. This is considered as a good indicator that the redemption requests received by most of the Maltese retail funds are generally low compared to their NAV.

A test is also conducted on the shape parameter ξ of the GPD to identify whether it is statistically lower than one and therefore whether the first moment of the distribution is finite. This test shows that 37 funds have an estimated shape parameter that is statistically lower than one. Thus, for the remaining funds the estimated worst 10% redemption is calculated using the composite trapezoidal rule. Table A.2 in the appendix presents the estimated GPD parameters for each of the sampled funds.

From Figure 3, one observes that most of the funds would only suffer redemption requests lower than 5% of their NAV for both the 10% worst case scenario (58 funds or 91%) and the 5% worst case scenario (53 funds or 83%). Conversely, for the 1% worst case scenario, 31 funds (or 48%) would receive a redemption request lower than 5% of their NAV while five funds (or 8%) would expect redemption requests higher than 20% of their NAV. The maximum redemption for the 1% worst case scenario is of 41%. For the worst 10% and 5% redemption scenarios the maximum redemption requests are much more contained. In fact, no funds would experience any outflows higher than 10% for the former scenario while only one fund would experience a redemption request of up to 15% for the latter scenario.

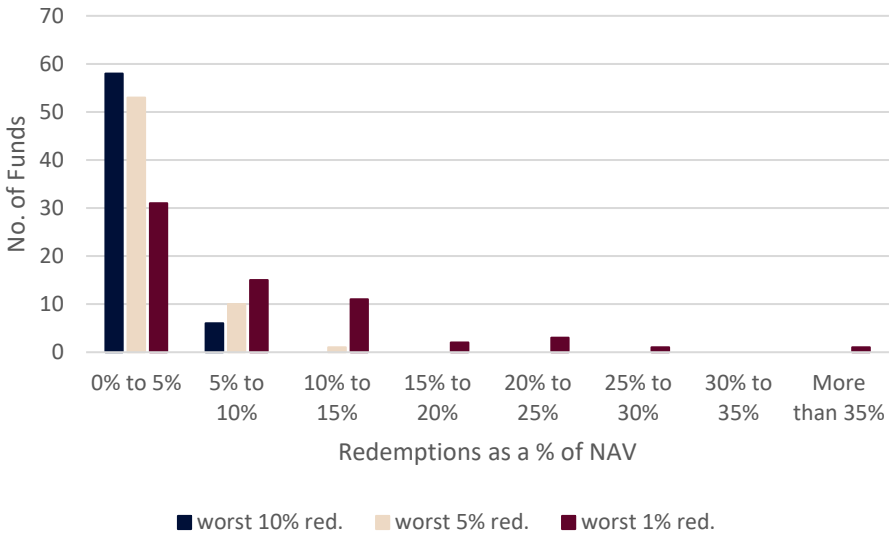

Figure 3: Extreme redemption shocks at the 10%, 5% and 1% level as a % of NAV

At a fund strategy level, although 64% of the bond funds would experience an expected 1% worst redemption in the range of 0% to 5% (only funds classified in the 'other' category have a higher percentage of funds which would experience a 1% worst case redemption in the range

of 0% to 5%, at 67%), the distribution of the 1% worst case redemption appears to be the most skewed. In fact, this is the only category that has two funds which would experience a 1% worst case redemption higher than 25%. Similar to bond and other funds, the majority of funds categorised as 'diversified' (55%) would suffer a 1% worst case redemption in the range of 0% to 5%. When looking at equity funds, 50% would experience a 1% worst case redemption between 5% and 10%. Additionally, equity funds have the second highest average 1% worst redemption (at 8.2%), with only mixed funds performing worse at 8.3%.

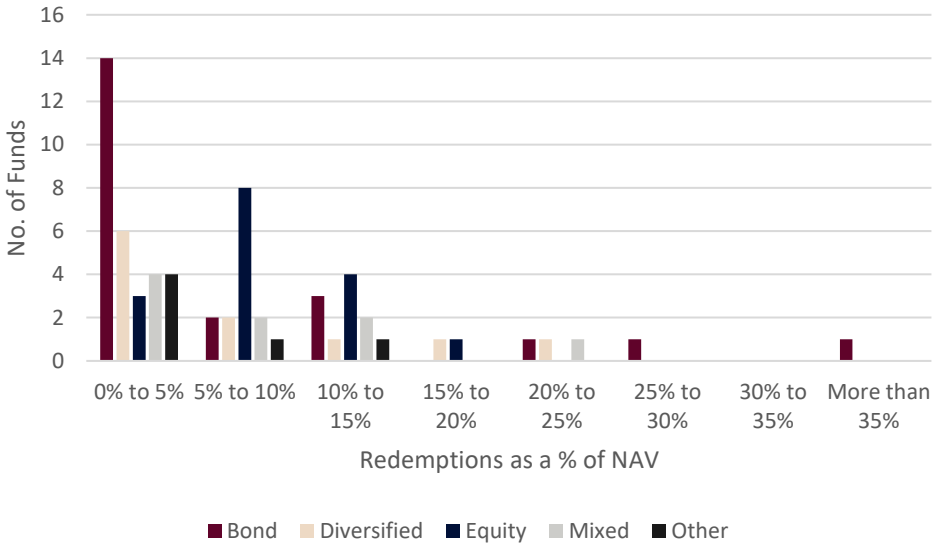

Figure 4: Extreme redemption shock at the 1% level by strategy

Asset Liquidation

Under the waterfall approach, nine funds (or 14% of the sample) would experience a liquidity shortfall for the 10% worst case scenario, while 13 funds (or 20% of the sample) would record a liquidity shortfall for the 5% worst case scenario. For the 1% worst expected redemption, 31 funds (almost 50% of the sample) would experience a liquidity shortfall and would be expected to liquidate part of their portfolio of assets to be able to meet the redemption requests. The liquidity shortfall is calculated as the difference between the expected redemptions for the three different scenarios and the percentage of highly liquid assets (cash and short-term deposits). The full results for the liquidity shortfall are presented in Table A.3 in the appendix.

The waterfall and slicing approaches give differing results in terms of losses incurred due to liquidation of assets within the investment portfolio. This contrasts with what we obtained in the first stress testing study in 2020, where the two approaches gave almost the same results in terms of losses incurred due to liquidation. The main reason behind this is that under the slicing approach, cash is considered as part of the portfolio of assets. Hence it is treated in the same manner as the other assets in the portfolio during the redemption process, unlike the waterfall approach where cash is first used to meet the redemption requests. Therefore, when adopting the slicing approach for liquidation, a larger number of funds are required to liquidate part of their portfolio of assets due to not being able to use all the cash available first. Indeed, for the slicing approach only one fund (namely Fund 57) does not incur any liquidation losses, as shown in Figure 6. This is a diversified fund whose portfolio is classified as completely illiquid under the adjusted HQLA approach and thus it cannot readily liquidate its investment to service redemptions. On the other hand, under the waterfall approach, only

funds experiencing a liquidity shortfall are susceptible to incur liquidation losses as long as they do not hold government bonds which have a liquidity weight of 100%. In fact, 89% of the funds with a liquidity shortfall under the 10% worst case scenario, 92% of the funds with a liquidity shortfall under the 5% worst case scenario and 87% of the funds with a liquidity shortfall under the 1% worst case scenario would incur liquidity losses.

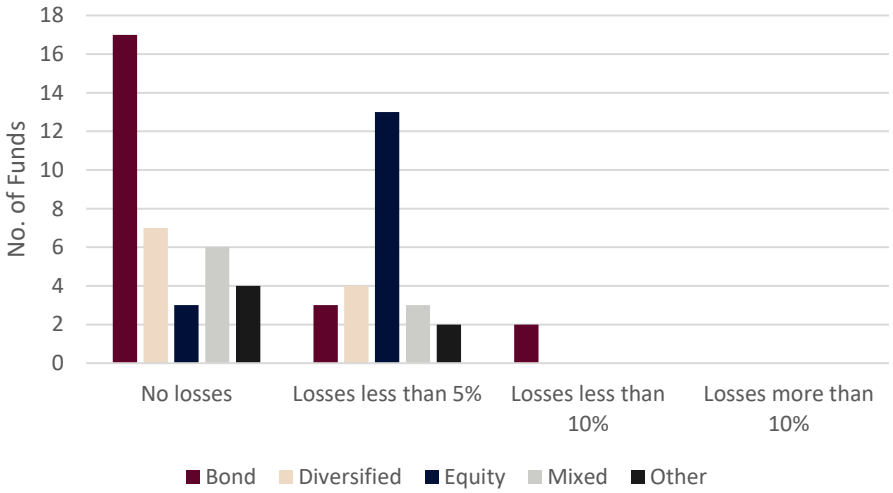

Figure 5: Losses suffered to meet the 1% worst redemption using the Waterfall approach

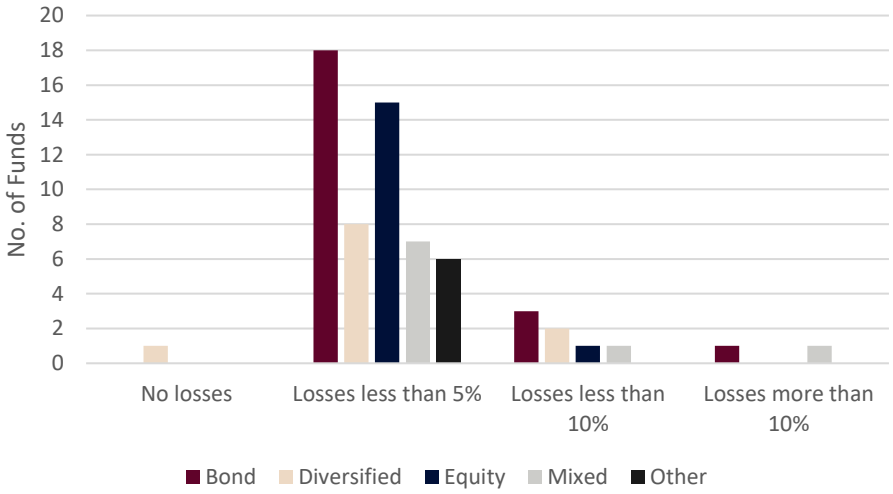

Figure 6: Losses suffered to meet the 1% worst redemption using the Slicing approach

For those funds which are not able to meet the redemption requests after having liquidated their portfolio of assets, both the waterfall and the slicing approaches give the same results. Only two funds would not be able to meet the redemption requests under the 1% worst case scenario. One of these funds, fund 57, would only experience a liquidity shortfall for the 1% worst case scenario. This fund's portfolio is classified as completely illiquid under the adjusted HQLA approach and thus it cannot expeditiously liquidate its assets to meet the 1% worst case redemption requests. In the STIFF 2020 report, this fund was not able to meet redemption requests under any of the three scenarios and not just the 1% worst case scenario. The other fund is fund 34, which is classified as a bond fund, and in the STIFF 2020 report was also not able to meet the redemption requests for the 1% worst case scenario. This is shown in both Figures 7 and 8.

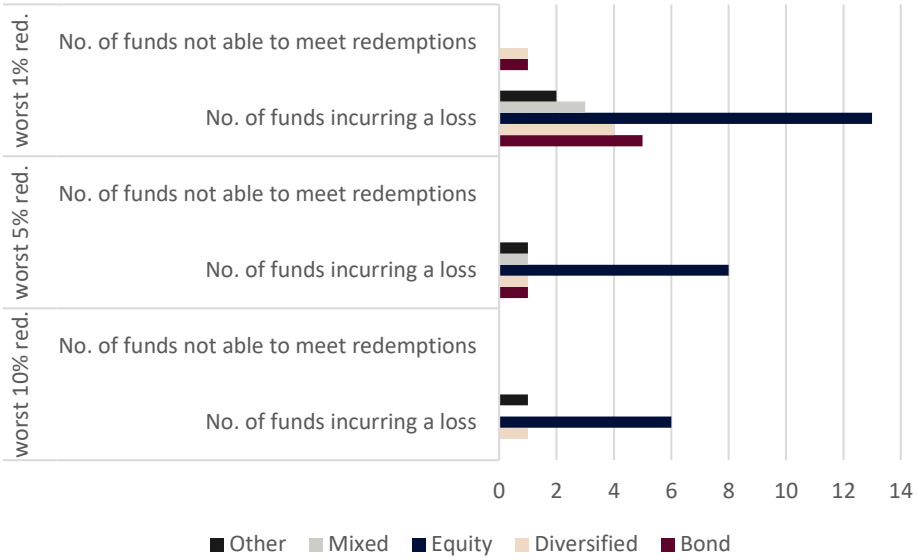

Figure 7: Liquidation of assets using the Waterfall approach

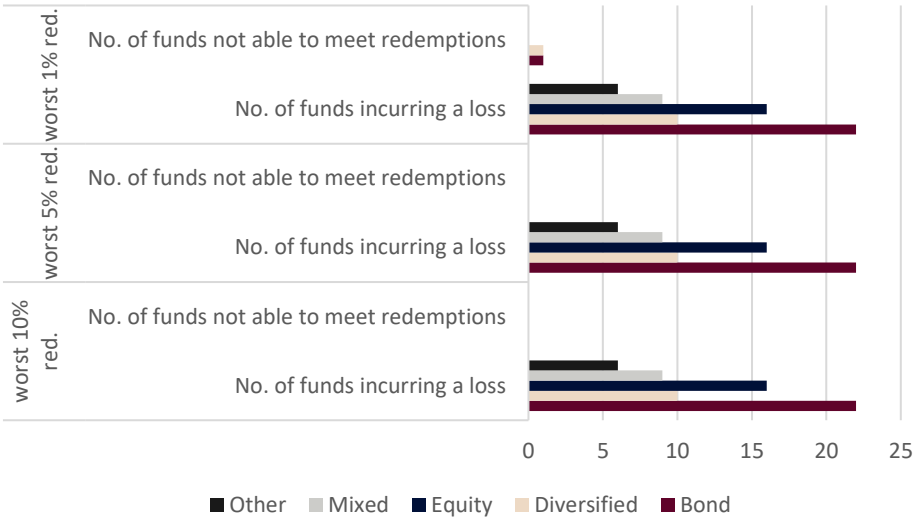

Figure 8: Liquidation of assets using the Slicing approach

Figure 9 shows that at a strategy level, consistent with the results obtained in the STIFF 2020 exercise, equity funds suffer the most in all the three worst redemption scenarios. In particular, if the 1% worst redemption request were to occur simultaneously in all of the equity funds, the total NAV of equity funds would shrink by 8.5%. Liquidation losses under the waterfall approach would further shrink the NAV by 1.4%, while under the slicing approach the NAV would decline by 1.1%.

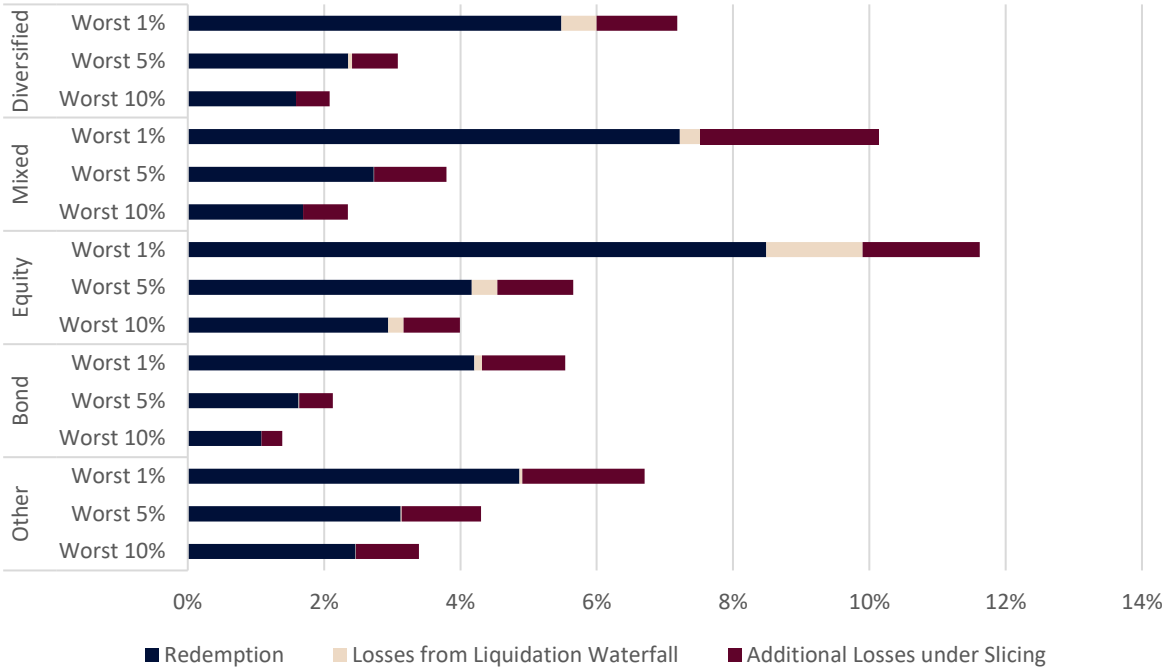

Figure 9: Impact of extreme redemptions on the strategy NAV

Second-round Effects

The losses suffered by the funds in liquidating their portfolio to meet the extreme redemption requests might spearhead other investors to redeem their shares in the fund. In turn, the fund manager would need to further liquidate its assets, thus causing additional liquidation losses.

In this section, we model the flow-return relationship to deduce the size of the second-round redemptions resulting from the first round of outflows and losses due to liquidation. As a first step, we run an OLS regression of lagged net flows and lagged returns on current net flows. We then calculate the average and standard deviation of the estimated coefficients grouped by strategy[10] to be used as inputs in the prior distributions for the Bayesian regression. The positive values obtained for the average of β_1, as shown in Table 3, show that strong net inflows in a fund are usually followed by further inflows in the future, highlighting a momentum effect. The positive averages obtained for β_2 instead confirm that investors penalise funds which underperform and reward funds which have a better performance.

Table 3: Bayesian coefficients' prior distribution parameters

	Mean			**Standard Deviation**		
	α	β_1	β_2	α	β_1	β_2
Bond	0.06734	0.06515	0.01851	0.29711	0.15179	0.08651
Equity	0.17269	0.10714	0.01473	0.52312	0.15013	0.06606
Mixed	-0.1574	0.01338	0.04724	0.1465	0.06886	0.06324
Other	0.0831	0.04592	0.01928	0.46601	0.0626	0.15969

[10] The category 'other' is grouped with the category 'diversified' given the small number of funds in the former category.

Once we fit a Bayesian model for each fund, the first-round redemptions and liquidation losses are plugged into the regression equation to forecast the expected second-round redemptions. We only present the chart for the waterfall approach (Figure 10) since the expected second-round redemptions following the first round of liquidation under both the waterfall and slicing approaches are very similar. The expected second-round redemptions would mostly be below 2% in all the three worst redemption scenarios, with only one fund expected to experience a second-round redemption of around 2.8% of NAV. Due to the low amplitude of the second-round redemptions, even losses suffered by the manager to meet this further round of redemptions would be contained. The only two funds which will not be able to meet the second-round redemptions under the 1% worst case scenario are the same two funds that were not able to meet the first round of 1% extreme redemptions[11].

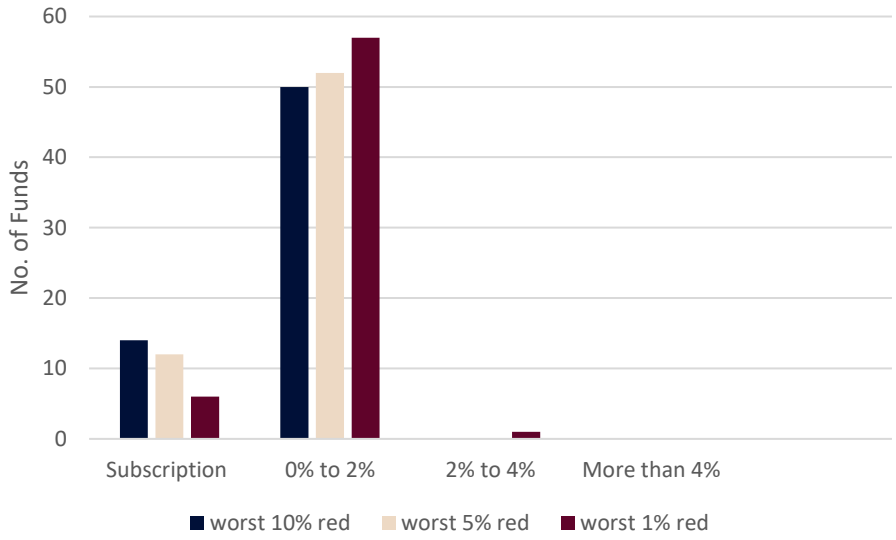

Figure 10: Second-round redemptions following liquidation under the waterfall approach

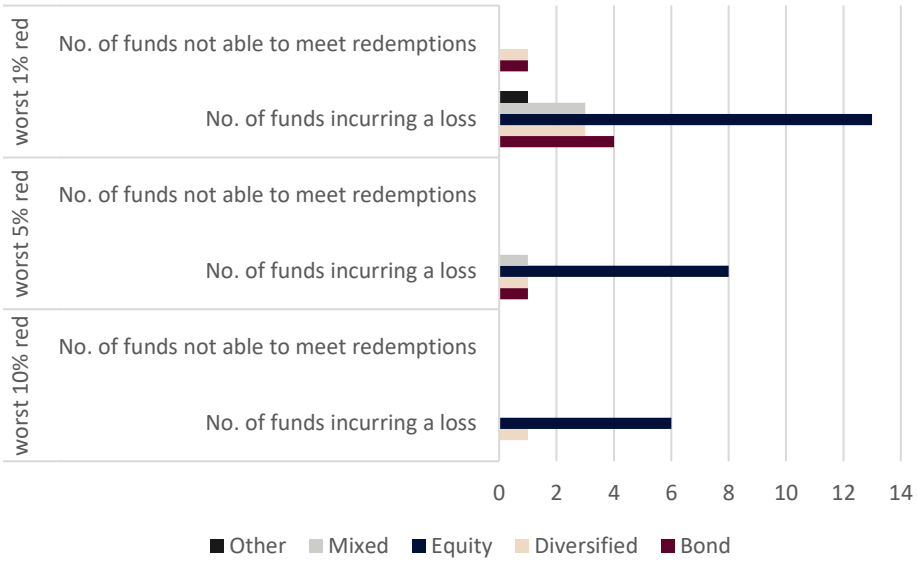

Figure 11: Liquidation of assets due to second-round redemptions under the Waterfall approach

[11] Fund 34 and Fund 57.

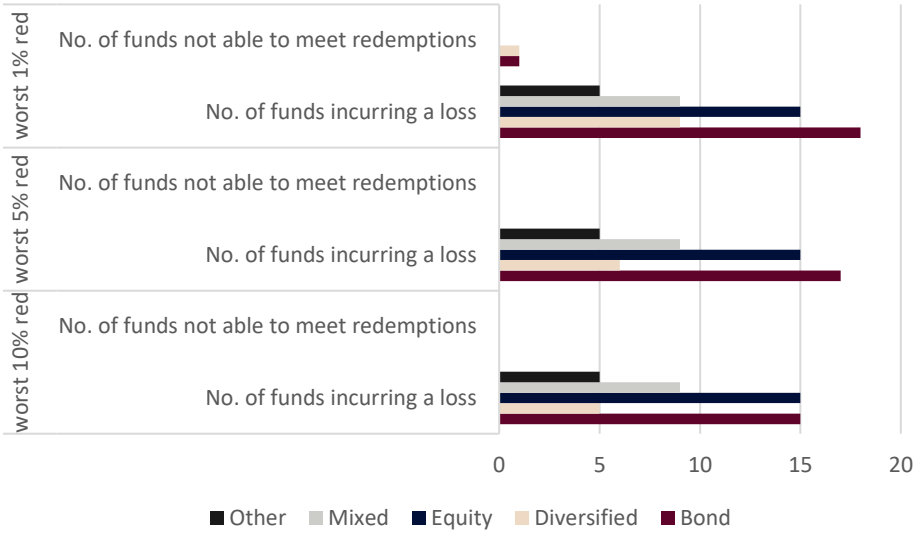

Figure 12: Liquidation of assets due to second-round redemptions under the Slicing approach

The type of funds that are mostly influenced by the second-round redemptions are equity funds. In particular, in the 1% worst case scenario it is the only fund strategy which would see the total NAV reduce by more than 1%. Most of the decline in NAV would be attributable to the second-round redemptions, which would be higher than 0.8% both under the slicing and the waterfall approaches. A further decline in NAV would be due to liquidation losses, which would vary from 0.28% to 0.39% depending on which liquidation approach is followed.

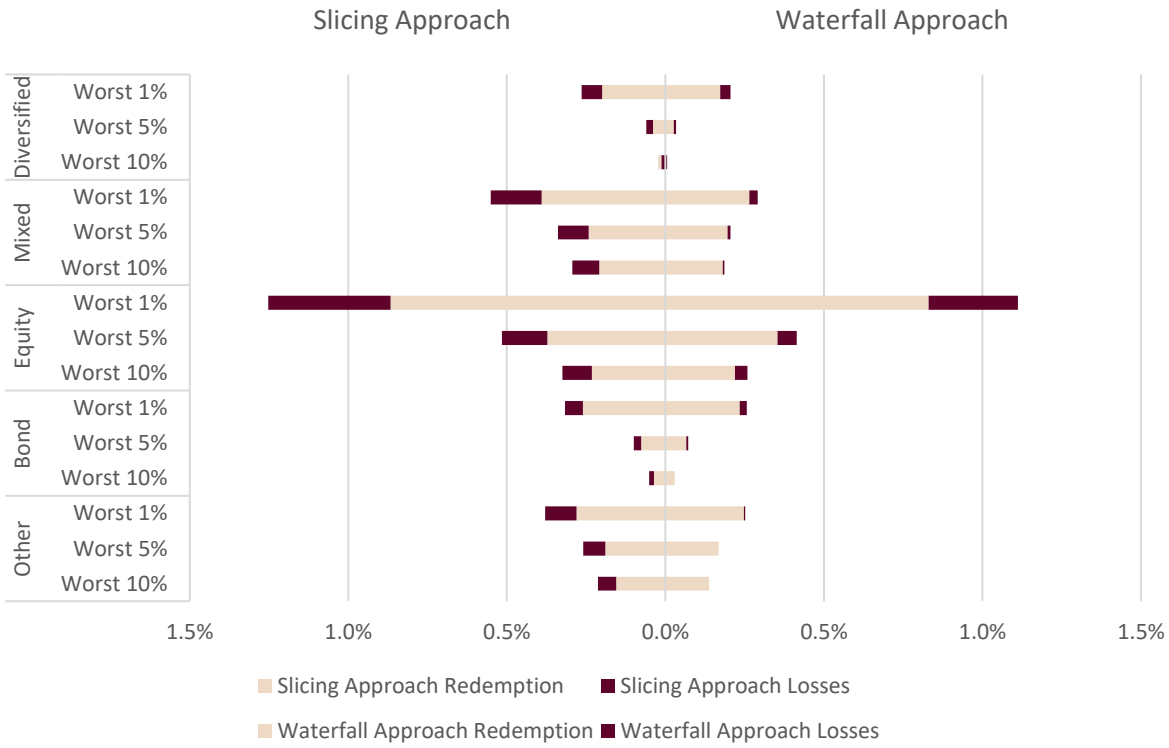

Figure 13: Impact of the second-round extreme redemptions on the strategy NAV

Conclusion

This study presents an updated methodology of the stress testing framework, which was developed in 2020, focusing on the micro-level aspect. The updated framework was then applied to Maltese retail investment funds covering data up to end 2020.

We provide an update to two of the four steps within the methodology. We updated the slicing approach where cash is also considered as part of the portfolio of assets to be sliced by the fund manager while trying to meet the redemption requests. Moreover, we introduced Bayesian econometrics to improve the estimation of the second-round effects.

We analysed the effectiveness of our first stress testing framework during COVID-19 and our findings show that it performed relatively well during this extreme stress scenario. Only 13 funds experienced redemption requests greater than the estimated 1% worst case scenario in 2020, seven of which experienced such severe redemptions during the first months of the COVID-19 crisis.

Our results show that only two funds would face liquidity strains in meeting redemption requests, specifically under the 1% worst case scenario. This is an improvement compared to what was observed from the first stress testing exercise carried out in 2020, where three funds were identified as not being able to meet the extreme redemptions, with one of these funds not able to meet the extreme redemptions for any of the three stress scenarios. Furthermore, we also found that the expected second-round effects remain contained both in terms of redemptions and magnitude of liquidation.

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Appendix

Table A.1: Summary statistics

		% of NAV				
Fund	**No. of Weekly Obs.**	**Average Red.**	**Average Net Flow**	**Max Red.**	**Max Net Outflow**	**Max Net Inflow**
Fund 1	211	0.29	-0.17	11.19	11.19	5.94
Fund 2	283	0.37	0.57	18.54	18.54	104.33
Fund 3	166	0.01	49.60	0.52	0.50	8099.22
Fund 4	442	0.05	0.31	1.95	1.90	7.00
Fund 5	664	0.07	6.35	2.22	1.54	3930.82
Fund 6	221	0.08	1.29	3.48	3.48	221.60
Fund 7	208	0.43	0.51	8.19	7.99	39.53
Fund 8	292	0.25	0.40	9.15	3.81	26.94
Fund 9	254	0.19	1.47	8.93	8.92	121.33
Fund 10	248	0.22	0.50	12.76	7.86	80.39
Fund 11	105	1.20	2.48	11.31	11.09	27.04
Fund 12	108	1.21	0.64	11.63	7.46	12.40
Fund 13	165	0.58	0.99	5.48	4.28	39.74
Fund 14	203	0.27	1.33	1.98	1.43	54.50
Fund 15	203	0.21	1.81	1.41	1.16	99.62
Fund 16	203	0.23	1.91	3.30	2.56	120.80
Fund 17	488	0.16	0.85	9.22	1.06	77.00
Fund 18	488	0.16	0.58	11.73	2.52	41.71
Fund 19	376	0.51	0.63	15.92	5.98	105.07
Fund 20	166	0.33	1.48	13.45	4.52	110.72
Fund 21	279	0.28	0.23	2.76	2.24	6.07
Fund 22	193	0.16	2.96	12.07	11.08	100.00
Fund 23	143	0.15	1.87	3.03	2.68	18.44
Fund 24	255	0.78	0.54	7.96	7.96	16.00
Fund 25	255	0.89	-0.32	20.64	20.47	3.96
Fund 26	255	0.82	0.43	20.32	15.14	19.88
Fund 27	183	0.89	1.00	34.87	11.06	29.99
Fund 28	119	0.42	1.93	7.91	7.91	100.00
Fund 29	731	0.19	0.11	4.50	4.34	56.40
Fund 30	731	0.22	0.12	4.63	4.60	53.02
Fund 31	731	0.24	-0.12	3.93	3.68	1.77
Fund 32	731	0.26	-0.10	5.27	5.22	0.68
Fund 33	731	0.32	-0.20	5.61	5.51	0.66
Fund 34	479	1.20	1.94	66.86	66.86	477.81
Fund 35	217	0.22	1.09	3.45	2.67	37.45
Fund 36	328	0.17	0.74	5.61	2.30	13.06
Fund 37	393	0.17	0.87	3.33	2.25	13.32
Fund 38	233	0.04	0.17	3.62	3.62	33.33
Fund 39	196	0.08	0.65	1.47	1.27	22.90
Fund 40	196	0.10	0.88	1.65	1.34	18.65
Fund 41	255	0.05	0.29	3.41	3.31	5.90
Fund 42	175	0.77	1.26	15.46	15.46	56.81
Fund 43	303	0.47	-0.18	16.27	16.27	7.56

Fund 44	305	0.29	-0.10	23.84	23.84	9.76
Fund 45	155	0.65	-0.26	21.83	21.83	5.88
Fund 46	479	0.33	0.15	18.00	17.99	35.95
Fund 47	479	0.31	0.31	32.55	29.50	35.91
Fund 48	681	0.20	0.13	5.75	5.75	116.40
Fund 49	684	0.38	0.07	20.28	20.25	68.65
Fund 50	667	0.37	-0.09	14.63	14.07	4.76
Fund 51	667	0.17	0.27	3.45	3.43	2.84
Fund 52	596	1.53	-0.32	21.99	21.99	22.16
Fund 53	596	0.24	0.13	3.09	2.79	7.68
Fund 54	596	0.23	-0.10	10.27	10.24	1.95
Fund 55	596	0.30	-0.11	11.68	11.68	3.05
Fund 56	596	0.13	0.08	0.89	0.80	3.03
Fund 57	395	0.22	0.14	6.78	6.33	11.55
Fund 58	667	0.43	0.08	11.83	10.88	35.88
Fund 59	355	0.24	0.60	2.61	2.59	17.81
Fund 60	596	0.25	0.07	4.35	4.07	2.40
Fund 61	596	0.24	0.19	2.03	1.51	2.82
Fund 62	596	0.33	0.06	12.29	11.78	23.34
Fund 63	596	0.29	-0.06	11.23	11.10	11.88
Fund 64	258	0.13	0.05	5.24	5.24	5.17

Table A.2: GPD parameter estimates

Fund	**μ**	**σ**	**ξ**	**Fund**	**μ**	**σ**	**ξ**
Fund 1	0.30	1.61	0.30	**Fund 33**	0.67	0.34	0.42
Fund 2	0.42	1.11	0.90	**Fund 34**	2.08	2.59	0.88
Fund 3	0.02	0.02	0.97	**Fund 35**	0.53	0.96	-0.15
Fund 4	0.14	0.07	0.78	**Fund 36**	0.50	0.17	0.94
Fund 5	0.15	0.06	0.87	**Fund 37**	0.39	0.29	0.43
Fund 6	0.00	2.12	-0.54	**Fund 38**	0.04	2.23	-0.52
Fund 7	1.15	1.58	0.27	**Fund 39**	0.21	0.50	-0.22
Fund 8	0.64	0.92	0.43	**Fund 40**	0.29	0.22	0.31
Fund 9	0.21	1.04	0.37	**Fund 41**	0.11	0.12	0.59
Fund 10	0.19	0.78	0.75	**Fund 42**	2.40	3.55	0.04
Fund 11	2.77	5.58	-0.59	**Fund 43**	1.31	1.02	0.40
Fund 12	3.51	2.62	-0.09	**Fund 44**	0.53	0.39	0.73
Fund 13	1.69	1.63	-0.29	**Fund 45**	1.26	0.99	0.84
Fund 14	0.97	0.47	-0.34	**Fund 46**	0.85	1.09	0.38
Fund 15	0.68	0.12	0.37	**Fund 47**	0.69	0.84	0.49
Fund 16	0.72	0.48	0.23	**Fund 48**	0.43	0.46	0.63
Fund 17	0.33	0.18	0.59	**Fund 49**	0.95	0.79	0.60
Fund 18	0.39	0.33	0.56	**Fund 50**	0.82	0.43	0.58
Fund 19	1.19	0.63	0.48	**Fund 51**	0.31	0.26	0.29
Fund 20	0.58	0.49	0.82	**Fund 52**	3.24	2.19	0.08
Fund 21	0.95	0.77	-0.29	**Fund 53**	0.43	0.30	0.27
Fund 22	0.00	0.03	2.81	**Fund 54**	0.36	0.19	1.02
Fund 23	0.37	0.33	0.52	**Fund 55**	0.55	0.16	0.72

Fund 24	2.01	1.82	-0.06	**Fund 56**	0.28	0.14	0.01
Fund 25	1.66	0.76	0.85	**Fund 57**	0.51	0.22	0.61
Fund 26	2.27	1.42	0.51	**Fund 58**	0.83	0.37	0.46
Fund 27	2.38	2.40	0.44	**Fund 59**	0.45	0.18	0.28
Fund 28	0.90	1.39	0.48	**Fund 60**	0.44	0.14	0.86
Fund 29	0.39	0.33	0.69	**Fund 61**	0.44	0.20	0.30
Fund 30	0.54	0.25	0.50	**Fund 62**	0.59	0.25	0.95
Fund 31	0.49	0.18	0.38	**Fund 63**	0.44	0.36	0.90
Fund 32	0.50	0.23	0.67	**Fund 64**	0.12	0.93	0.19

Table A.3: Simulated worst redemptions at the 10%, 5% and 1% levels[12]

Fund	Worst 10% Red.	Worst 5% Red.	Worst 1% Red.	Liquid Assets	Shortfall Worst 10%	Shortfall Worst 5%	Shortfall Worst 1%
Fund 1	2.59	4.34	10.08	20.44	-17.85	-16.10	-10.35
Fund 2	3.95	7.18	23.30	8.31	-4.35	-1.13	14.99
Fund 3	0.19	0.31	1.14	8.15	-7.96	-7.84	-7.00
Fund 4	0.41	0.62	1.84	7.78	-7.37	-7.16	-5.94
Fund 5	0.49	0.74	2.32	6.25	-5.76	-5.51	-3.93
Fund 6	1.37	2.16	3.17	10.04	-8.67	-7.88	-6.87
Fund 7	3.33	4.98	10.29	16.19	-12.87	-11.21	-5.90
Fund 8	2.26	3.52	8.43	17.29	-15.03	-13.77	-8.86
Fund 9	1.86	3.15	7.76	8.47	-6.60	-5.32	-0.70
Fund 10	2.41	4.36	13.82	14.88	-12.47	-10.52	-1.06
Fund 11	6.29	8.29	10.72	1.73	4.55	6.55	8.98
Fund 12	5.91	7.52	10.90	2.55	3.36	4.97	8.35
Fund 13	2.95	3.74	5.06	7.30	-4.35	-3.56	-2.25
Fund 14	1.33	1.54	1.89	1.85	-0.52	-0.31	0.04
Fund 15	0.92	1.06	1.58	13.99	-13.07	-12.93	-12.41
Fund 16	1.35	1.82	3.26	1.09	0.25	0.73	2.17
Fund 17	0.78	1.14	2.85	8.24	-7.46	-7.09	-5.39
Fund 18	1.15	1.74	4.47	4.35	-3.20	-2.61	0.11
Fund 19	2.40	3.36	7.31	3.18	-0.78	0.17	4.13
Fund 20	2.23	3.71	11.39	12.97	-10.75	-9.26	-1.58
Fund 21	1.54	1.92	2.54	4.51	-2.96	-2.59	-1.96
Fund 22	2.09	4.51	28.16	24.48	-22.39	-19.96	3.69
Fund 23	1.04	1.61	3.99	4.62	-3.57	-3.01	-0.62
Fund 24	3.73	4.91	7.46	6.56	-2.83	-1.66	0.90
Fund 25	4.12	6.34	17.58	4.00	0.12	2.34	13.57
Fund 26	4.97	7.20	16.10	8.37	-3.40	-1.18	7.72
Fund 27	6.69	9.74	21.87	22.69	-16.00	-12.95	-0.82
Fund 28	3.46	5.54	13.73	13.61	-10.15	-8.07	0.12
Fund 29	1.33	2.15	6.21	11.74	-10.41	-9.59	-5.53
Fund 30	1.04	1.44	3.15	13.09	-12.05	-11.64	-9.94
Fund 31	0.78	1.02	1.87	5.19	-4.41	-4.17	-3.32
Fund 32	1.19	1.68	4.37	7.91	-6.71	-6.22	-3.54
Fund 33	1.25	1.72	3.51	7.87	-6.61	-6.14	-4.35
Fund 34	8.54	14.54	41.31	9.22	-0.69	5.32	32.09

[12] Red figures indicate a liquidity shortfall.

Fund 35	1.36	1.91	2.98	9.92	-8.55	-8.01	-6.93
Fund 36	1.35	2.10	6.56	2.43	-1.08	-0.33	4.13
Fund 37	0.91	1.33	2.92	5.38	-4.47	-4.05	-2.45
Fund 38	1.51	2.36	3.47	6.07	-4.57	-3.72	-2.61
Fund 39	0.63	0.89	1.37	4.46	-3.83	-3.57	-3.09
Fund 40	0.62	0.87	1.72	1.67	-1.06	-0.81	0.04
Fund 41	0.39	0.64	1.75	0.69	-0.30	-0.05	1.06
Fund 42	6.09	8.68	14.98	22.01	-15.92	-13.33	-7.03
Fund 43	3.01	4.34	9.25	0.79	2.22	3.54	8.46
Fund 44	1.67	2.68	7.72	8.30	-6.63	-5.62	-0.58
Fund 45	4.31	7.05	20.56	9.56	-5.25	-2.51	11.00
Fund 46	2.61	3.98	8.99	5.40	-2.79	-1.42	3.59
Fund 47	2.35	3.62	8.99	0.91	1.44	2.72	8.08
Fund 48	1.67	2.53	7.01	4.88	-3.21	-2.34	2.13
Fund 49	2.91	4.25	10.91	7.57	-4.66	-3.32	3.34
Fund 50	1.85	2.64	6.35	2.20	-0.35	0.43	4.14
Fund 51	0.67	0.95	1.86	3.74	-3.07	-2.79	-1.88
Fund 52	5.62	7.32	11.64	58.91	-53.29	-51.59	-47.27
Fund 53	0.84	1.16	2.18	3.78	-2.94	-2.62	-1.60
Fund 54	1.39	2.34	8.08	2.09	-0.70	0.25	5.99
Fund 55	1.07	1.50	3.77	0.92	0.15	0.58	2.85
Fund 56	0.42	0.53	0.76	0.74	-0.33	-0.22	0.02
Fund 57	1.07	1.51	3.64	1.94	-0.87	-0.43	1.70
Fund 58	1.51	2.05	4.22	0.83	0.68	1.22	3.39
Fund 59	0.70	0.90	1.51	3.48	-2.77	-2.58	-1.96
Fund 60	1.07	1.60	4.73	1.87	-0.81	-0.27	2.86
Fund 61	0.73	0.95	1.68	10.75	-10.03	-9.80	-9.08
Fund 62	1.74	2.80	8.89	1.67	0.07	1.12	7.22
Fund 63	1.86	3.15	10.25	3.89	-2.03	-0.73	6.37
Fund 64	1.27	2.12	4.58	11.95	-10.69	-9.84	-7.37

Table A.4: Expected second-round redemptions

	2nd Round Redemptions - Waterfall Approach			2nd Round Redemptions - Slicing Approach		
Fund	**Worst 10% Red.**	**Worst 5% Red.**	**Worst 1% Red.**	**Worst 10% Red.**	**Worst 5% Red.**	**Worst 1% Red.**
Fund 1	0.20	0.22	0.30	0.24	0.30	0.48
Fund 2	0.21	0.25	0.61	0.29	0.40	0.99
Fund 3	-0.11	-0.10	-0.03	-0.11	-0.10	-0.02
Fund 4	-0.06	-0.05	0.01	-0.05	-0.04	0.04
Fund 5	-0.04	-0.03	0.09	-0.04	-0.02	0.11
Fund 6	0.17	0.18	0.20	0.20	0.23	0.27
Fund 7	0.20	0.23	0.30	0.25	0.29	0.44
Fund 8	0.09	0.17	0.48	0.10	0.18	0.52
Fund 9	0.05	0.12	0.40	0.07	0.16	0.48
Fund 10	0.09	0.21	0.78	0.10	0.24	0.86
Fund 11	0.35	0.59	0.89	0.36	0.60	0.89
Fund 12	0.37	0.56	0.96	0.38	0.57	0.97
Fund 13	0.46	0.50	0.56	0.47	0.51	0.57
Fund 14	0.06	0.07	0.09	0.07	0.08	0.10
Fund 15	0.06	0.07	0.10	0.07	0.07	0.10
Fund 16	-0.13	-0.11	-0.04	-0.13	-0.10	-0.03
Fund 17	0.12	0.15	0.26	0.12	0.15	0.26
Fund 18	0.11	0.15	0.31	0.12	0.16	0.35
Fund 19	0.27	0.36	0.77	0.28	0.38	0.79
Fund 20	0.05	0.16	0.73	0.06	0.18	0.81
Fund 21	0.18	0.18	0.19	0.20	0.21	0.23
Fund 22	-0.02	0.12	1.47	-0.01	0.14	1.57
Fund 23	-0.26	-0.22	-0.06	-0.25	-0.20	0.07
Fund 24	0.27	0.40	0.69	0.29	0.42	0.72
Fund 25	0.23	0.35	0.94	0.26	0.37	0.96
Fund 26	0.04	0.28	1.30	0.06	0.32	1.33
Fund 27	0.11	0.25	0.81	0.14	0.30	0.92
Fund 28	0.04	0.25	1.06	0.06	0.27	1.12
Fund 29	0.17	0.25	0.67	0.17	0.26	0.69
Fund 30	0.03	0.05	0.14	0.03	0.05	0.15
Fund 31	-0.03	-0.02	0.02	0.00	0.01	0.08
Fund 32	0.06	0.10	0.34	0.07	0.11	0.35
Fund 33	0.18	0.21	0.34	0.18	0.22	0.36
Fund 34	0.55	0.98	2.84	0.61	1.06	2.84
Fund 35	0.08	0.14	0.25	0.08	0.14	0.26
Fund 36	-0.06	-0.02	0.20	-0.05	-0.01	0.21
Fund 37	-0.07	-0.05	0.02	-0.07	-0.05	0.02
Fund 38	0.12	0.16	0.21	0.13	0.17	0.23
Fund 39	-0.21	-0.18	-0.13	-0.21	-0.18	-0.12
Fund 40	-0.05	-0.03	0.03	-0.05	-0.03	0.05
Fund 41	-0.12	-0.11	-0.06	-0.12	-0.11	-0.05
Fund 42	0.18	0.30	0.59	0.21	0.34	0.66
Fund 43	0.67	0.82	1.41	0.67	0.83	1.41
Fund 44	0.20	0.21	0.28	0.22	0.25	0.38
Fund 45	0.26	0.44	1.39	0.32	0.52	1.59

Fund 46	0.13	0.19	0.43	0.13	0.20	0.44
Fund 47	0.24	0.37	0.93	0.24	0.37	0.94
Fund 48	0.35	0.46	1.02	0.36	0.47	1.05
Fund 49	0.27	0.35	0.76	0.27	0.36	0.78
Fund 50	0.27	0.36	0.77	0.28	0.37	0.78
Fund 51	-0.11	-0.09	-0.04	-0.11	-0.09	-0.03
Fund 52	0.27	0.35	0.55	0.31	0.40	0.63
Fund 53	0.05	0.07	0.13	0.05	0.08	0.14
Fund 54	0.17	0.19	0.31	0.22	0.27	0.56
Fund 55	0.11	0.14	0.27	0.12	0.14	0.29
Fund 56	0.05	0.06	0.07	0.05	0.06	0.07
Fund 57	0.21	0.23	0.33	0.21	0.23	0.33
Fund 58	0.21	0.27	0.51	0.22	0.28	0.52
Fund 59	0.19	0.20	0.23	0.20	0.21	0.25
Fund 60	0.15	0.16	0.22	0.18	0.20	0.33
Fund 61	-0.01	0.01	0.06	-0.01	0.01	0.06
Fund 62	0.33	0.44	1.08	0.34	0.45	1.09
Fund 63	0.16	0.29	1.04	0.18	0.33	1.16
Fund 64	0.14	0.16	0.19	0.16	0.18	0.23

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