“Valuation discrepancies in money market funds during market disruptions: evidence from Egypt”

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VALUATION DISCREPANCIES IN MONEY MARKET FUNDS DURING MARKET DISRUPTIONS: EVIDENCE FROM EGYPT

Abstract

Money market funds (MMFs) are generally considered safe investment vehicles, but the 2008 global financial crisis showed their vulnerability during market disruptions resulting in increased regulatory oversight across developed markets to protect investors. This paper examines the effect of MMF accounting regulation on investors in an emerging market context. It hypothesizes that the continued use of amortized cost methods to account for MMFs' Net Asset Value (NAV) during market disruptions can result in unfair treatment of investors. The Egyptian money market provided a unique laboratory to test this hypothesis over a prominent economic crisis that combined high levels of interest rate volatility with a redemption-only structure for MMFs. A model that measures the discrepancies between the amortized and floating market NAVs per certificate for various money market portfolios (MMPs) simulating MMFs of different durations is tested using the Egyptian data. A sharp rise in interest rates is found to lead to significant discrepancies between the amortized NAV per certificate relative to their floating value. Serial investor redemptions of the certificates compound the discrepancies, but only certificate holders remaining in the funds bear the accumulated losses, which are augmented for portfolios with higher durations. The results suggest that emerging market regulators consider introducing the rules that switch to floating NAV calculations for MMFs during such periods to promote equality across all investors.

Keywords emerging markets, money market funds, net asset values, regulation, treasury yields

JEL Classification G01, G14, G15, G18

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INTRODUCTION

Money market funds (MMFs) are considered one of the most accessible savings mechanisms for retail investors (Rosen & Katz, 1983), globally reaching approximately USD 6 trillion in assets under management by the first quarter of 2018 (Investment Company Fact Book, 2018). One main reason for the growth stems from the ability of MMFs to preserve their Net Asset Value (NAV) per certificate, which is possible because MMFs invest in high quality, liquid, and short-term fixed-income securities, allowing fund managers to calculate each fund's NAV per certificate at the amortized (book) value rather than at the floating (market) value of the underlying investments[1]. In stable market conditions, this accounting treatment is reasonable, but during times of market disruption and friction, it can result in losses to investors who remain in the funds.

MMFs in developed markets, like the USA, require fund managers to calculate a daily shadow floating NAV per certificate, compare it to that of the amortized NAV, and switch to the floating NAV when the two values significantly deviate. Such rules are considered a protection mechanism for investors from early runs on funds and are usually only triggered by market disruptions that would impact the NAV. This

1 In this paper, the terms 'amortized/book' and 'floating/market' will be used interchangeably.

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study is the first to focus on the valuation issue arising from MMF accounting in an emerging market context and hypothesizes that the lack of a similar rule results in large discrepancies between the amortized and floating NAV leading to the unfair treatment of investors who remain in the fund during times of crisis.

The Egyptian money market presented an ideal laboratory to test this hypothesis during a prominent economic crisis. Egyptian MMF certificates, a popular investment and cash management tool, follow a similar accounting treatment to the amortized NAV method used in the USA and other developed markets but have no rules requiring fund managers to switch to floating NAV calculations during market disruptions. Between January 2014 and December 2017, the Central Bank of Egypt (CBE) rapidly increased interest rates to manage a severe economic crisis. To limit investor demand on high-yielding MMFs, which were predominately invested in treasury bills (*T*-bills), the CBE also enforced a rule that limited subscriptions in MMFs and only allowed redemptions. Those conditions allowed the isolation and testing of two main research questions. First, whether significant discrepancies appear between the amortized and floating NAV per certificate result from a sudden increase in interest rates combined with serial certificate redemptions; and second, whether such discrepancies result in losses to MMF investors that remain in the funds.

1. LITERATURE REVIEW

MMFs originally came into existence when the US Federal Reserve in 1933 set interest rate limits on bank deposit savings to regulate bank competition. They increased in popularity in the 1970s, when interest rates on bank deposits hit this limit, with investors finding them to be a safe option that offers the liquidity, stability, and competitive returns (Peirce & Greene, 2014). The safety of MMFs was due to their nature of holding short-term, high-quality securities and providing cash on demand for investors and therefore viewed as interchangeable with bank deposits. Evidence of how investors perceived MMFs to be safe investments was supported by the large inflows they receive following increased instances of financial market volatility (Miles, 2001). This perceived safety resulted in policymakers and academic studies largely ignoring the possible risk of runs on MMFs (Bengtsson, 2013), with only a few earlier studies warning of this possibility during times of uncertain valuations (Lyon, 1984; Shleifer & Vishny, 1997). This valuation issue, which is the subject of this present research, only attracted the attention from researchers and policymakers, whether in the US or other global markets, when this safety was threatened during the 2008 global financial crisis as investors realized the risk associated with MMFs, given that unlike banks, they are not protected by federal insurance.

USD MMFs in the USA dominate over half the global market for these funds. An amortized NAV treatment is used for their certificate values. However, they are closely governed by the Securities and Exchange Commission (SEC) under Rule 2a-7 of the Investment Company Act of 1940, which forces US MMF managers to calculate a daily shadow floating NAV per certificate[2], compare it to that of the amortized NAV, and switch to the floating NAV when the two values deviate by ±0.5%. Because US MMFs constantly distribute returns, the amortized NAV treatment allows them to keep the NAV per certificate fixed at USD 1. Historically, only three MMFs have been forced to break this value[3]. The most recent incident occurred in 2008 to the Reserve Primary Fund after the failure of Lehman Brothers, which was among the assets in which the MMF held investments (Peirce & Greene, 2014). Even though the fund's investments in Lehman Brothers were not unusually high – only 1% – the bank's bankruptcy led to a huge run on MMFs by risk-fleeing investors. This 'first mover advantage' resulted in the draining of the fund's liquidity of its high-quality

2 An MMF certificate valued at a floating NAV derives its value from the value of its underlying assets. It is bought and redeemed at its market value – 'that is, shares are valued at a purchase price of securities minus computed premium or discount, amortized over the securities' remaining life' (Schmidt, Timmermann, & Wermers, 2016).

3 This is often referred to as 'breaking the buck'.

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assets, while leaving troubled instruments in the fund (Brunnermeier, 2009), essentially causing early redeemers to pass on the losses to the remaining investors in the fund (McCabe, 2010) and revealing the susceptibility of MMFs to managers' risk-taking incentives (Kacperczyk & Schnabl, 2013). Consequently, investments in institutional prime funds dropped from USD 1.3 trillion to almost USD 900 billion in the few days following the crisis (Duygan-Bump, Parkinson, Rosengren, Suarez, & Willen, 2013).

These events resulted in a series of reforms to amend Rule 2a-7 to make MMFs more resilient to financial and economic crises by setting tighter governance regulations and reducing information asymmetry around the value of their underlying investments, to ensure an efficient and fair market for all investors (Cipriani & La Spada, 2018). The reforms instituted in 2010 included the imposing of restrictions on the investments' liquidity, credit quality, and maturity, and on enhanced disclosures (Peirce & Greene, 2014). In July 2014, the restrictions were expanded to include a requirement for a floating NAV for institutional prime MMFs and the imposing of redemption fees, to limit run risk in times of economic pressure (Fisch, 2014, p. 31). MMF reforms following the global financial crisis extended to Europe, where the market was also suffering from asset price drops and enormous investor redemptions (Bengtsson, 2013), resulting in the EU's 2017 'Regulation on Money Market Funds'[4], which imposed new rules to guard investors against liquidity and redemption risks. Despite such efforts, scholars continue to question whether the money market reforms around the developed world are sufficient to protect MMFs from market disruptions and shield investors from liquidity shocks and valuation distortions (Nijs, 2020).

Understanding the interplay between fund liquidity and valuation, especially during market disruptions, is important to guide future reforms. Parlatore (2016) presents a model showing that the value of MMFs decreases with increased liquidation, which further aggravates asset prices resulting in even more liquidations and possible fund runs. Witmer (2019) provides empirical evidence that liquidity management in MMFs is crucial to protect funds against investor runs, especially given their use of fixed valuation methods. Such issues are important to explore in emerging market settings, yet the academic literature is scant about empirical studies examining the effect of market disruptions on the valuation of MMFs in such markets. This is particularly critical since investor protection regulations governing MMFs are sometimes missing there. This motivated the present study to fill this gap in the literature by focusing on the valuation issue arising from MMF accounting in emerging markets that lack rules equivalent to Rule 2a-7 and to examine its effect on investor performance.

2. METHODS

2.1. Data

Egyptian MMFs present an ideal setting to examine this study's objectives. Although MMFs are a popular investment and cash management tool in Egypt, MMFs are valued using amortized cost methods, and Egypt has no equivalent rule to Rule 2a-7 requiring fund managers to switch to floating (market) value during the crisis. Therefore, this study selects a prominent and extended period of market disruption in Egypt as its sample to examine the research questions.

MMFs in Egypt are jointly regulated by the Egyptian Financial Regulatory Authority (FRA) under Capital Markets Law no. 95/1992 (HSBC, 2016) and the Central Bank of Egypt (CBE). By the end of the sample period, 27 active MMFs operated in Egypt, with assets under management of 32.8 billion Egyptian pounds (EGP)[5], comprising 82% of the total value of all assets managed by various types of funds (Oxford Business Group, 2017).

The testing period runs from the first week of January 2014 to the last week of December 2017. This testing period is chosen for two reasons. First, it coincides with the restriction that the CBE imposed on investors entering MMFs. In May 2013,

4 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1131&from=EN

5 The exchange rate at the end of the sample period was USD 1 = EGP 17.8.

the CBE capped investment in MMFs at 2% of a bank's capital, down from the previously allowed 5% (Werr, 2013). Money market funds reached the cap by the end of 2013; therefore, January 2014 was chosen as a starting date to reflect the period in which new subscriptions were banned, and only redemptions were allowed. This limit was further restricted in January 2016 when the size of MMFs was capped at 2.5% of a bank's deposits in local currency (Noueihed, 2016). This restriction further amplified the redemptions, resulting in net outflows from MMFs of around EGP 8 billion over the sample period. Figure 1 presents the annual number of outstanding MMF certificates for all MMFs in Egypt obtained from one of the largest money market asset managers – Beltone Financial – at the beginning of each year from 2014 to 2019. Only redemptions were allowed over the sample period, decreasing the overall number of outstanding MMF certificates. By 2018, subscriptions were being allowed; therefore, the sample is limited to the end of 2017 to benefit from the natural asymmetric structure, making this testing period ideal for the research objective.

A second valuable feature justifies the chosen sample period: Because the CBE had imposed several interest rate hikes to manage the severe economic and political crisis that the country faced following the Arab Spring movement in January 2011, the period was characterized by a high level of interest rate volatility. The crisis resulted in hard currency shortages and tough monetary policy actions by the CBE to limit dollarization and strengthen the EGP (Bassiouny & Tooma, 2019).

The empirical data employed in this study over the sample period are as follows. Coinciding with the weekly CBE issuances of *T*-bills, weekly data on Egyptian *T*-bills, the main component of MMFs in Egypt, were retrieved for their different maturities: 91, 182, 173, and 364 days. The data were retrieved using the Refinitiv Eikon database, which included the *T*-bill type, auction date (issuance date), maturity date, and weekly yield. Interest rates on weekly time deposits (TDs), the other main component of Egyptian MMFs, were also obtained. Yields jumped over the testing period from approximately 10% at the beginning of 2014 to a high of approximately 22% in mid-July 2017.

2.2. Methodology

2.2.1. *NAV discrepancies under different accounting treatments*

The first research question around the differences in NAVs of MMFs under the amortized vs. floating accounting treatments was examined by simulating the NAV discrepancy per certificate for four types of Money Market Portfolios (MMPs), each one modeling an MMF that exclusively invests in one type of *T*-bills (91, 182, 273, or 364 days). Although Egyptian MMFs invest in a mix of *T*-bills with different durations, this separation allows the control for each portfolio's riskiness with the prediction that investors in higher-duration funds would be most affected by the amortized NAV accounting treatment.

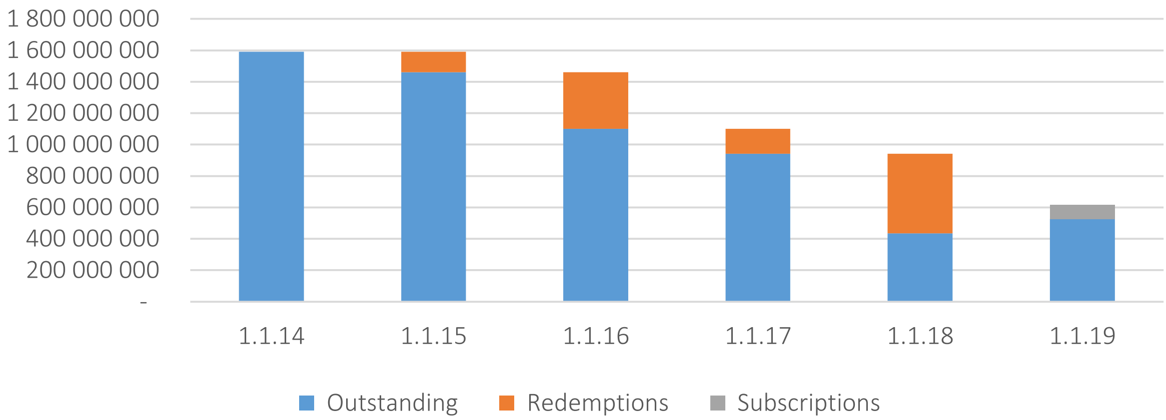

Figure 1. Egyptian MMFs' annual outstanding certificates, redemptions, and subscriptions from 2014 to 2018

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First, four simulated portfolios, MMP_i, are defined where $i=1$ to 4 and denotes a portfolio invested in only one of the four types of *T*-bills. For each portfolio, target duration $\left(D_{i,t}^{p}\right)$ was defined and achieved through a mix of one type of *T*-bill and weekly time deposits (TDs) – the other main component of MMFs in Egypt. $D_{i,t}^{p}$ is therefore a weighted average duration of both *T*-bills and TDs, which were set at durations lower than the maturity of the *T*-bills that each MMP_i invested in, and were calculated as:

$$D_{i,t}^{p}=\left(W_{i,t}^{TD}\cdot D^{TD}\right)+\left(W_{i,t}^{TB}\cdot D_{i,t}^{TB}\right), \tag{1}$$

where D^{TD} is the TD's duration, which is fixed at 7 days. $D_{i,t}^{TB}$ is the *T*-bills' duration for each portfolio i. $W_{i,t}^{TD}$ and $W_{i,t}^{TB}$ are the weights of TDs and *T*-bills in each MMP_i, respectively. The mix of $W_{i,t}^{TD}$ and $W_{i,t}^{TB}$ in each MMP_i was calculated to keep the target durations constant throughout the testing period. Because of the higher liquidity of TDs, if a lesser duration is desired, $W_{i,t}^{TD}$ would go up and $W_{i,t}^{TB}$ would go down.

The MMP mix was combined with the return on each asset to determine the NAV per certificate. Throughout this research, a distinction was made between two yields – amortized yield $\left(Y_{i,t}^{A}\right)$ and floating yield $\left(Y_{i,t}^{F}\right)$:

- $Y_{i,t}^{A}$ is the weighted average yield of all corresponding outstanding *T*-bills at the time of their issuance. This is the proxy for amortized (book) yield and was used to determine the amortized NAV per certificate.
- $Y_{i,t}^{F}$ is the weekly actual yield quoted when new *T*-bills were issued. This is the proxy for market yield and was used to determine the floating (market) NAV per certificate.

To assess the effect of using $Y_{i,t}^{A}$ rather than $Y_{i,t}^{F}$ to reach the value at which a certificate is redeemed for the remaining investors in each MMP_i, an accumulated amortized NAV $\left(NAV_{i,t}^{A}\right)$ and an accumulated floating NAV $\left(NAV_{i,t}^{F}\right)$ were calculated.

$NAV_{i,t}^{A}$ was calculated by adding compounded accumulated weekly returns to the initial value of each certificate; EGP 100:

$$NAV_{i,t}^{A}=100\prod_{t=1}^{N}\left(1+Y_{i,t}^{A}\right), \tag{2}$$

where t = week 1 to week N in the sample, and $Y_{i,t}^{A}$ is weekly yield from $t=1$ to N.

$NAV_{i,t}^{F}$, on the other hand, was calculated by adding $NAV_{i,t}^{A}$ to the difference between the present value of the *T*-bills discounted at $Y_{i,t}^{F}$ and $Y_{i,t}^{A}$:

$$NAV_{i,t}^{F}=NAV_{i,t}^{A}+\frac{F}{\left(1+Y_{i,t}^{F}\right)^{D_{i,t}^{TB}}}-\frac{F}{\left(1+Y_{i,t}^{A}\right)^{D_{i,t}^{TB}}}, \tag{3}$$

where F is the face value per certificate in MMP_i.

Because *T*-bills are discounted at the floating yield $Y_{i,t}^{F}$, to obtain their market value when interest rates are increasing, their present value is lower than their book value, which is calculated using $Y_{i,t}^{A}$. Equations (2) and (3) are, therefore, used as the basis for measuring the NAV discrepancy per certificate in EGP, $NAV_{i,t}^{D1}$:

$$NAV_{i,t}^{D1}=NAV_{i,t}^{F}-NAV_{i,t}^{A}, \tag{4a}$$

or in relative logarithmic form as:

$$RNAV_{i,t}^{D1}=\ln\left(\frac{NAV_{i,t}^{F}}{NAV_{i,t}^{A}}\right). \tag{4b}$$

2.2.2. *Investor profits and losses from MMF accounting*

This subsection presents the methodology used to examine the second question about the impact of the asymmetric (redemption-only) structure on investors remaining in the fund. The total NAV discrepancies for all certificates redeemed are divided by the number of certificates remaining in the fund. Because the remaining investors in each portfolio bore investors that exited early redeemed their certificates at the amortized value in addition to the accumulated returns rather than at the market value, losses resulting from the sale of *T*-bills MMP_i. This asymmetric structure was accounted for by measuring the aggregated profit or loss per certificate in EGPs remaining in each MMP_i for every week *t* in the sample through the variable, $PL_{i,t}$:

$$PL_{i,t}=\frac{\sum_{t=1}^{N}R_t^{7}NAV_{i,t}^{D1}}{Q_t^{7}}, \tag{5a}$$

where Q_t^7 is the number of outstanding certificates in MMP_i at time t and is reduced every week by R_t^7, the number of weekly certificate redemptions[6]. A relative measure of the profits/losses is constructed as:

$$RLP_{i,t} = \frac{PL_{i,t}}{NAV_{i,t}^{F^0}}, \tag{5b}$$

where the denominator, $NAV_{i,t}^{F^0}$, represents the floating NAV per certificate in EGPs after incorporating the redemptions. Redemptions are measured as:

$$NAV_{i,t}^{F^0} = NAV_{i,t}^{F} - PL_{i,t}, \tag{6}$$

and used to measure the discrepancy per certificate in EGP following redemptions denoted as $NAV_{i,t}^{D2}$ and measured as:

$$NAV_{i,t}^{D2} = NAV_{i,t}^{F^0} - NAV_{i,t}^{A}. \tag{7a}$$

Or, in relative logarithmic form:

$$RNAV_{i,t}^{D2} = \ln\left(\frac{NAV_{i,t}^{F^0}}{NAV_{i,t}^{A}}\right). \tag{7b}$$

3. RESULTS

3.1. Size of NAV discrepancies under different accounting treatments

Table 1 summarizes the descriptive statistics for the main variables over the sample period. Panel A shows the results of the weekly floating yields of *T*-bills, $Y_{i,t}^F$, for different maturities (91, 182, 273, and 364 days). Each *T*-bill was combined with time deposits to construct the four simulated MMPs: MMP_i. The target durations for each MMP_i are also shown in the same table. The *T*-bill yields were extremely volatile over the sample period, reflecting the CBE's tight monetary policy to control inflation and currency value deterioration. For example, the average yield on the 91 *T*-bills was 13.928%, with the range of yields between 10.151% and 22.523%. This volatility is also consistent for the *T*-bills with the other durations and impacted the portfolios' simulated market values, resulting in significant discrepancies in the NAV per certificate.

Panel B of Table 1 presents the relative NAV discrepancy's descriptive statistics, $RNAV_{i,t}^{D1}$, from equation (4b). NAV discrepancy results are compared relative to the ±0.5% threshold used in the US Rule 2a-7. In the case of the portfolio with the shortest target duration, MMP_1, the average discrepancy was –0.025%, with a minimum of –0.303%. Although the average is significantly different from zero, the overall range of discrepancies for this portfolio is relatively low, and within a ±0.5% threshold that would have triggered the switch to the floating NAV if Egypt were to have had a similar rule. This picture differs if the portfolio with the highest duration MMP_4 is evaluated. The average discrepancy for this portfolio was –0.351%, and the minimum reached a discrepancy as low as –1.6% – more than three times the lower boundary of the selected relative threshold. The discrepancy arising from the accounting treatment is further augmented across the various portfolios by serial redemptions, as observed in Panel C of the relative NAV discrepancy per certificate $RNAV_{i,t}^{D2}$ from equation (7b). The results show that all minimum levels of discrepancies for three of the four portfolios exceeded the lower threshold. The average discrepancy for the highest-duration portfolio is approximately equal to the minimal threshold at –0.5%.

The results are also graphically presented for the two simulated portfolios with the highest durations, MMP_3 and MMP_4, in Panels I and II of Figure 2, which track the weekly evolution of $RNAV_{i,t}^{D1}$ and $RNAV_{i,t}^{D2}$ against the yield plotted on the secondary axis over the sample[7]. It is notable that as the asymmetric redemption-only structure continued, the discrepancies were further aggravated over time, especially in the second half of the sample period between 2016 and 2017, when additional restrictions were imposed on money market funds in early 2016. Therefore, for robust-

6 The data include only the total annual number of MMF certificates and their net annual redemptions/subscriptions. This information is used to calculate an equal weekly certificate redemptions rate, R_t^7, for each year in the sample.

7 The study's focus is on the simulated portfolios with the highest durations, as they match the actual portfolio durations of MMFs in Egypt. Following the discussions with various asset managers of the 27 active MMFs, it was found that their duration ranges from 4 to 6 months.

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Table 1. Summary statistics of simulated money market portfolio

MMP$_i$	*T*-bill Type	MMP_i duration $\left(D_{i,t}^p\right)$	Mean (%)	Standard deviation (%)	Minimum (%)	Maximum (%)	Count	t-statistic
Panel A. Summary statistics for weekly floating yields of treasury bills $Y_{i,t}^F$								
MMP$_1$	91	45	13.928	3.542	10.151	22.523	208	–
MMP$_2$	182	91	14.284	3.513	10.551	22.278	208	–
MMP$_3$	273	136	14.395	3.387	10.691	22.444	208	–
MMP$_4$	364	182	14.383	3.362	10.737	21.706	208	–
Panel B. Summary statistics for relative NAV discrepancy $RNAV_{i,t}^{D1}$								
MMP$_1$	91	45	–0.025	0.066	–0.303	0.136	208	–5.463**
MMP$_2$	182	91	–0.093	0.17	–0.553	0.225	208	–7.890**
MMP$_3$	273	136	–0.201	0.315	–0.998	0.383	208	–9.203**
MMP$_4$	364	182	–0.351	0.495	–1.616	0.461	208	–10.227**
Panel C. Summary statistics for relative NAV discrepancy after redemptions $RNAV_{i,t}^{D2}$								
MMP$_1$	91	45	–0.033	0.067	–0.31	0.118	208	–7.103**
MMP$_2$	182	91	–0.129	0.172	–0.593	0.073	208	–10.817**
MMP$_3$	273	136	–0.282	0.324	–1.073	0.101	208	–12.553**
MMP$_4$	364	182	–0.498	0.532	–1.749	0.186	208	–13.500**

Notes: Table 1 presents the summary statistics for the main variables over the sample period 2014–2017. Panel A shows the descriptive statistics of the weekly floating yields of *T*-bills of different maturities (91,182, 273, and 364 days), which are used to construct four simulated money market portfolios, MMP_i, with different target durations, $D_{i,t}^p$ (45, 91, 136, 182 days). Panel B presents the descriptive statistics of the relative NAV discrepancy $RNAV_{i,t}^{D1}$ in % from equation (4b) and Panel C presents the descriptive statistics of the relative NAV discrepancy following redemptions $RNAV_{i,t}^{D2}$ in % from equation (7b). Panels B and C also show the t-statistic of a statistically significant *t*-test from zero for the NAV discrepancy measures. ** = significant at 1%

ness, the sample is divided into two sub-periods[8]: period 1 which extends from 2014 to 2015 and period 2 from 2016 to 2017. Those periods' choice is justified by the increased volatility of yields and the larger redemptions observed in the last two years of the sample. This analysis confirms that discrepancies were higher in the second period when yields were more volatile and redemptions more pronounced further supporting the results, thereby incentivizing the second question: How was investors' performance remaining in the fund impacted?

8 The results of robustness over the two sub-periods are available upon request.

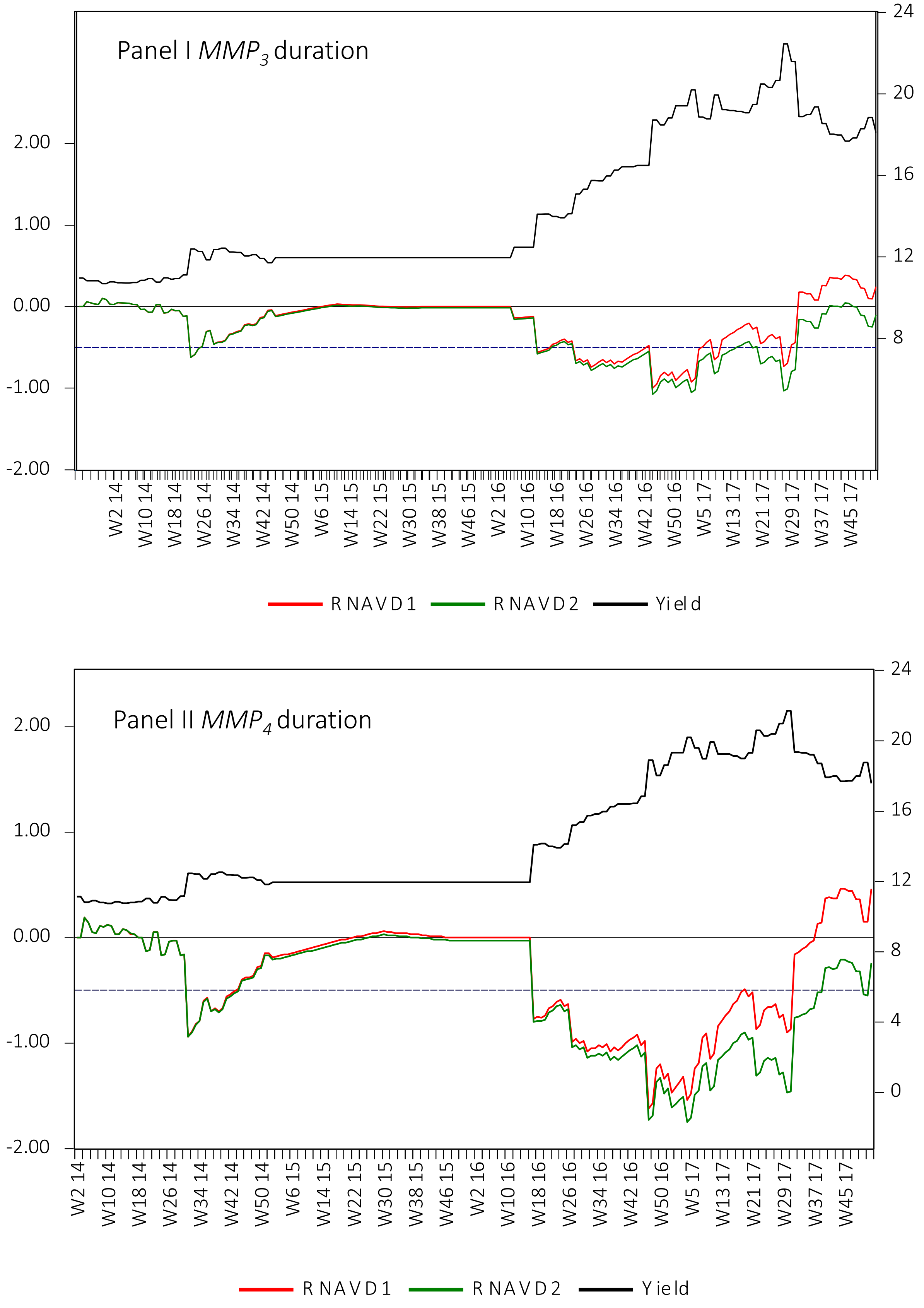

Figure 2. Treasury yields (%) and NAV discrepancies (%) for selected simulated MMPi

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3.2. How much do investors lose from MMF accounting during the crisis?

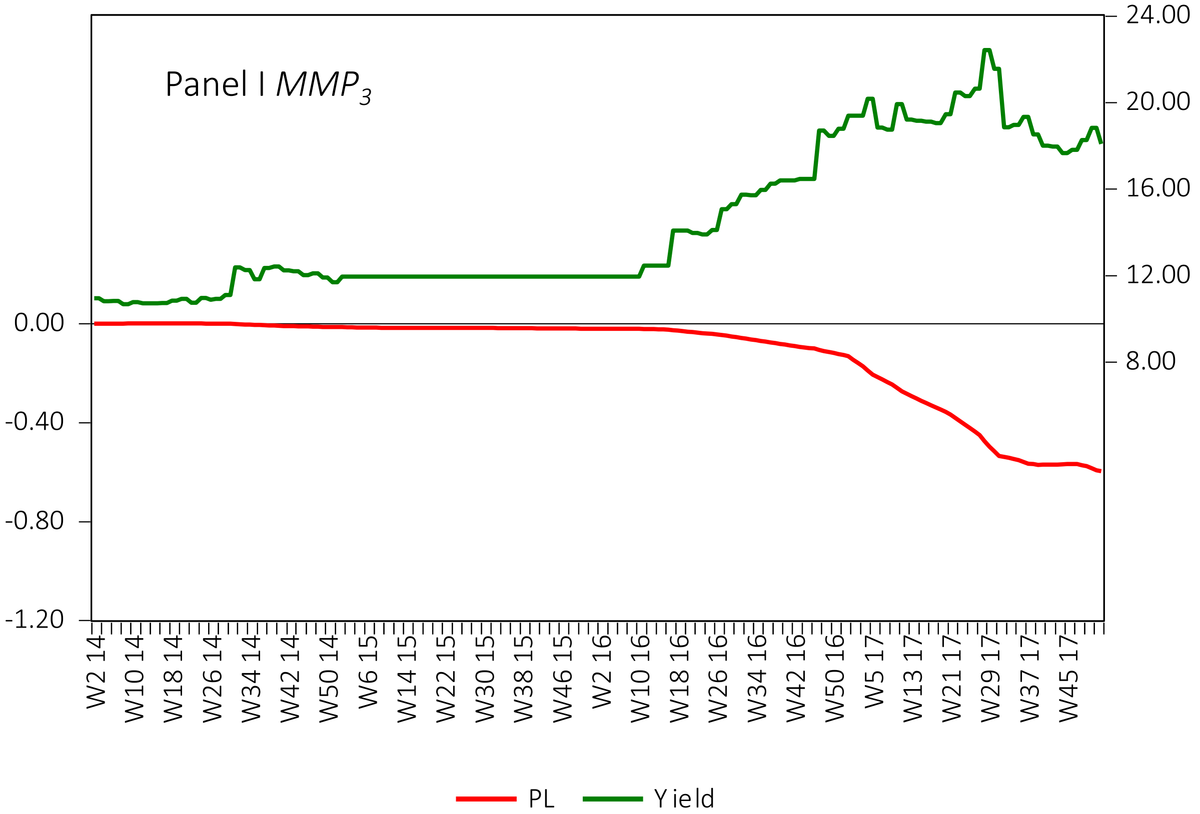
Table 2 presents the descriptive statistics of the relative profit/loss, $RPL_{i,t}$, from equation (5b), which shows that investors remaining in each portfolio suffered losses, especially in the portfolios with higher durations.

Given the rising yields over the sample, there were rarely any profits (all maximum values approximately at 0%), but the average weekly loss for investors was as low as –0.705 % for the portfolio with the six-month target duration. Table 2 presents the aggregated profit/loss statistics per certificate for investors remaining in each portfolio at the end of the sample period in 2017. It is obvious that the higher the duration of the portfolio, the more losses realized by investors, which go as high as EGP 1.2 per certificate or 0.7% for MMP_4. Panels I and II of Figure 3 present these data graphically for two simulated portfolios with the highest durations – MMP_3 and MMP_4 – over the sample period and show that the lack of adjustment to market value accounting during crisis times of rising yields and serial redemptions (whether structurally or through runs) is translated into losses for investors remaining in the fund.

Table 2. Weekly profit/loss statistics per certificate for investors remaining in the portfolio

MMP_i	*T*-bill type	MMP_i duration $\left(D^p_{i,t}\right)$	Mean (%)	Standard deviation (%)	Minimum (%)	Maximum (%)	Last	Count	t-statistic
Panel A. Summary statistics for profit/loss per certificate in EGP $PL_{i,t}$									
MMP_1	91	45	–0.013	0.019	–0.065	0.000	–0.056	208	–9.788**
MMP_2	182	91	–0.056	0.085	–0.256	0.001	–0.256	208	–9.509**
MMP_3	273	136	–0.125	0.188	–0.595	0.001	–0.595	208	–9.574**
MMP_4	364	182	–0.225	0.352	–1.195	0.002	–1.195	208	–9.217**
Panel B. Summary statistics for relative profit/loss per certificate in % $RPL_{i,t}$									
MMP_1	91	45	–0.008	0.012	–0.041	0.000	–0.033	208	–9.615**
MMP_2	182	91	–0.036	0.052	–0.154	0.001	–0.148	208	–9.985**
MMP_3	273	136	–0.082	0.116	–0.348	0.001	–0.347	208	–10.195**
MMP_4	364	182	–0.148	0.218	–0.705	0.002	–0.705	208	–9.791**

Notes: Table 2 reports the losses to investors remaining in the various simulated money market portfolios investing exclusively in different *T*-bill types and for various durations $D^p_{i,t}$. Panel A presents profit/loss per certificate measured using $PL_{i,t}$ from equation (5a), which measures the aggregated profit/loss at the end of each week in the sample in EGP, with the *Last* summary statistics showing losses per certificate for investors remaining in the portfolios at the end of the sample period in 2017. Panel B presents relative profit/loss per certificate using relative $RPL_{i,t}$ from equation (5b) and measures the aggregated profit/loss at the end of each week in the sample in EGP, with the *Last* summary statistics showing the aggregated relative profit/loss per certificate for investors remaining in the portfolios at the end of the sample period in 2017. Panels A and B also show the t-statistic of a statistically significant *t*-test from zero for the profit/loss measures. ** = significant at 1%.



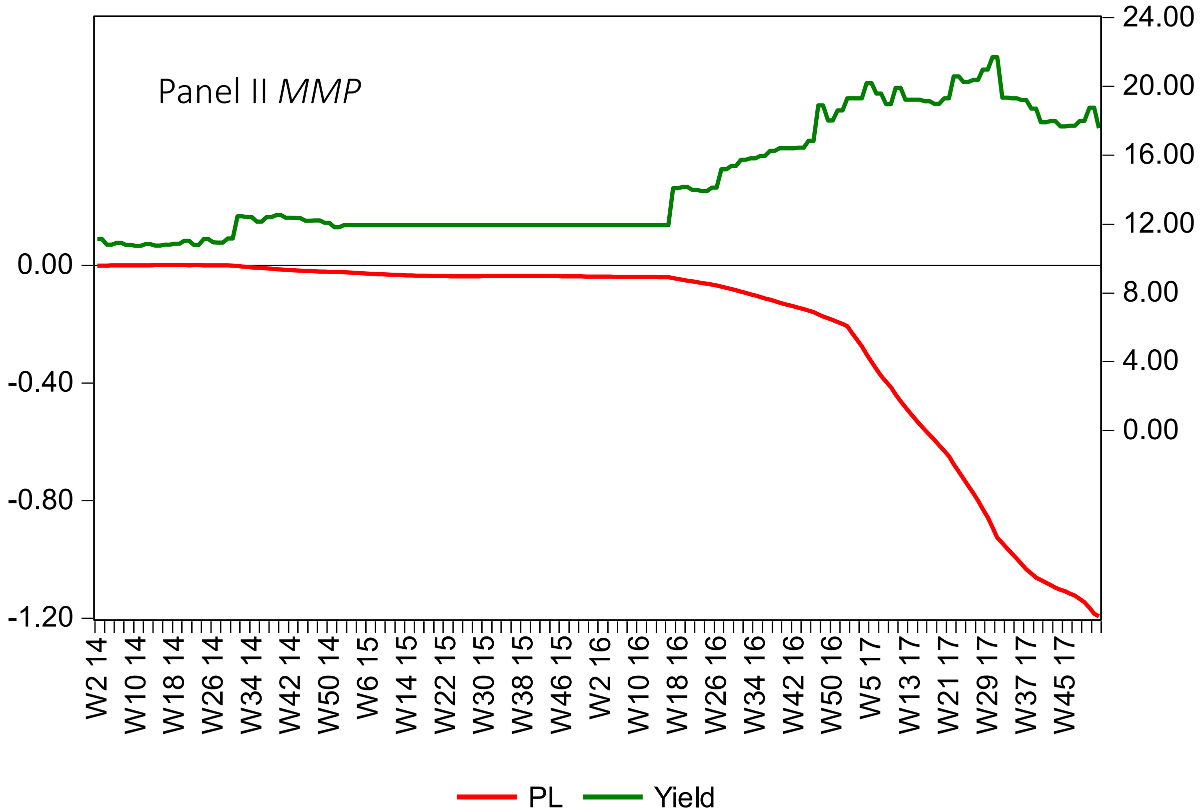


Figure 3. Floating yields $Y_{i,t}^{F}$ (%) and profits/losses $PL_{i,t}$ (EGP) for selected simulated portfolios MMPi

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3.3. Impact of MMF accounting and policy recommendations

Finally, to guide regulators and provide quantifiable policy recommendations around the effect of the absence of rules governing the accounting treatment of MMF NAV calculations, three multivariate fixed-effects panel regression models were estimated.

The first model relates to the results described in subsection 3.1. It isolated the effect of changes in the yields on the NAV discrepancy per certificate, $RNAV_{i,t}^{D1}$, under the two accounting treatments:

$$RNAV_{i,t}^{D1} = \alpha + \beta_1 Y_{i,t}^{F} + \varepsilon, \qquad (8a)$$

where the weekly yields $Y_{i,t}^{F}$ was used as the explanatory variable. The results presented in Table 3 show that every 1% weekly increase in yields results in a significant difference of –0.033% between floating and amortized NAV per certificate. Thus, a reduction of 0.5% in the shadow NAV on an equally weighted fund of the four MMPs occurred when interest rates increased by more than 15%; other things kept constant.

The second model isolated the effect of changes in the redemptions on the NAV discrepancy per certificate, following redemptions $RNAV_{i,t}^{D2}$ under the two accounting treatments:

$$RNAV_{i,t}^{D2} = \alpha + \beta_1 \Delta R_t^{7} + \varepsilon, \qquad (8b)$$

where the weekly change redemptions ΔR_t^{7} was used as the explanatory variable. The results presented in Table 3 show that every 1% increase in redemptions per week results in a significant drop of –0.174% between floating and amortized NAV per certificate after serial redemptions. This effect implies that redemptions have a larger effect on the discrepancy than yields do and that a reduction of 0.5% in the shadow NAV on an equally weighted fund of the four MMPs occurs when redemptions increase by 2.87% every week; other things kept constant. The results of both models demonstrate that, in isolation, interest rates hikes and serial redemptions both result in significant NAV discrepancies.

Although the level of the discrepancy may seem minor, in aggregation over extended periods of interest rate hikes and redemptions, this small discrepancy can result in economically significant differences. So finally, the third model is estimated, which quantifies the results of the analysis in subsection 3.2 around the effect of changes in the yields and serial asymmetric redemptions on investors who remain in MMFs using a relative profit/loss measure per certificate NAV discrepancy per certificate, $RPL_{i,t}$:

$$RPL_{i,t} = \alpha + \beta_1 Y_{i,t}^{F} + \beta_2 \Delta R_t^{7} + \varepsilon. \qquad (8c)$$

The results are also presented in Table 3, with significantly different negative coefficients on both variables. Every week, investors remain in the fund; they lose approximately 0.02% for every 1% increase in yields and 0.20% for every 1% increase in redemptions. These results demonstrate that the lack of fair accounting treatment methods results in a significant and unfair impact on investors remaining in the fund, especially over long, sustained periods of crisis.

Table 3. Multivariate panel regression models explaining NAV discrepancies and profits/losses per certificate

Variable	Model 1	Model 2	Model 3
Intercept	0.003**	–0.002**	0.002**
$Y_{i,t}^{F}$	–0.033**		–0.017**
ΔR_t^{7}	–	–0.174**	–0.196**
Cross-sections included	4	4	4
Total panel observations	832	832	832
R-squared (%)	25.867%	23.471%	54.804%

Notes: Table 3 reports the results of two multivariate panel regression models. Model 1 isolates the effect of the weekly floating yields $Y_{i,t}^{F}$ on the relative NAV discrepancy $RNAV_{i,t}^{D1}$ from equation (4b). Model 2 isolates the effect of the weekly change in redemptions ΔR_t^{7} on the relative NAV discrepancy after redemptions $RNAV_{i,t}^{D2}$ from equation (7b). Model 3 quantifies the effect of the weekly floating yields $Y_{i,t}^{F}$ and weekly change in redemptions ΔR_t^{7} on losses to investors remaining in the various $RS_{i,t}$. * = significant at 1%.

4. DISCUSSION

This study investigated the implication of early redemptions on hold-to-maturity investors in a market with volatile interest rates – specifically Egypt. Other studies cited in this paper and served as a reference point were mainly from the USA and Europe and focused primarily on a discussion of the nature of MMFs and how they were affected during the global financial crisis. Although other researchers have studied and evaluated the post-crisis reforms, the focus in this present study is on examining a market in which no regulation regarding the accounting treatment of NAV exists during crisis times. The study concentrated on the effect of amortized NAV on certificate holders, and the fact that this effect suggests that the implementation of an accumulated floating NAV is a fair method of accounting for MMFs in Egypt during and after economic disruptions.

The proposal of shifting to a floating NAV has been subject to particularly fierce debate. There are strong advantages to shifting to a floating NAV. It can eliminate investors' motives to redeem early during adverse events – a situation that causes a run on MMFs. A floating NAV would eliminate the first-mover advantage and eliminate the perception that MMFs are as safe as bank deposits. On the other hand, critics of this proposal believe that it would not eliminate a run, as it would not mitigate the real trigger behind a run: the risk, liquidity, and solvency of the underlying asset. Shifting to a floating NAV would require funds to incur the high costs of tax, accounting, and recordkeeping, which would outweigh the benefit, even as it demotivated investors (Peirce & Greene, 2014). Moreover, Beresford (2012) argues that because the deviation between the amortized and floating NAV is minor, there is no need to switch to a floating NAV. Beresford's debate would make sense in developed markets where interest rate volatility is usually low and runs are rare – a situation that would only incentivize a shift to market value accounting during crises. However, this shift is critical in emerging markets because they go through a more frequent series of political, economic, and financial crises.

The results of this study's simulations show that sharp rises in interest rates lead to large discrepancies between MMF certificate values and their market values. This situation is further compounded by serial net redemptions, further decreasing the market value per certificate; but only investors who remain in the fund bear the accumulated losses. The discrepancies and losses are augmented for funds with higher durations, pointing to conservative portfolio risk management's importance as a protection mechanism for MMF investors during volatile times.

CONCLUSION

The past several decades have seen phenomenal growth in MMFs worldwide. Investors seek such funds for their safe and predictable returns. Recent studies from developed markets suggest the susceptibility of MMFs to market disruptions and recommend regulatory reforms to reduce investment risks. One issue that has not received proper attention is the accounting of the NAV of such funds' certificates during the crisis in emerging markets. This study examines this issue in the Egyptian money markets. It shows that during a period of particularly volatile interest rates combined with limitations on fund subscriptions, that the use of cost amortization methods resulted in large significant deviations between amortized vs. floating NAV per certificate which translates to losses that are borne by investors remaining in the funds. The findings suggest that MMF managers continuously calculate and monitor the shadow floating NAV and compare it to the amortized NAV to evaluate their funds' risk, given their vulnerability to yield changes and redemptions. It invites regulators and policymakers in emerging markets to consider policy discussions around the accounting and regulatory framework of MMFs in Egypt and other emerging markets that lack such rules. This study is significant, given that no prior studies examined the effect of accounting treatment on MMFs during times of crises in an emerging market setting and recommends future research in other markets.

AUTHOR CONTRIBUTIONS

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Software: Kariman Kordy.
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Validation: Eskandar Tooma, Kariman Kordy.
Visualization: Kariman Kordy.
Writing – original draft: Aliaa Bassiouny, Kariman Kordy.
Writing – review & editing: Aliaa Bassiouny.

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