# Mutual Fund Flows and Government Bond Returns

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**Abstract**

We investigate daily flows to Israeli government bonds mutual funds, which are held primarily by retail investors. We divide the bonds into six categories: nominal/CPI-linked; short-term, intermediate-term, and long-term maturity. We find that daily net flows are contemporaneously correlated with price changes of all categories. These price changes are significant and they subsequently reverse fully or mostly within 10 trading days. The price reversal indicates that the initial price changes are due to "noise." We find that these price distortions affect break-even inflation—a measure of inflation expectations. Our findings indicate that even government bonds are affected by retail sentiment.

Keywords: Investor sentiment, government bonds, mutual fund flows, break-even inflation

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## 1. Introduction

Government bonds are traded mainly by institutional and professional investors. Therefore, intuitively, their prices are less likely to be distorted by retail investors. In this paper, we show, using Israeli data, that contrary to this intuition, retail investors distort government bond prices through their flows in and out of mutual funds. This finding is in line with the numerous papers investigating the effect of investor sentiment on stock prices.[1] We find that daily net mutual fund flows to a bond category (nominal/CPI-linked; short-term, intermediate-term, and long-term maturity) are contemporaneously positively correlated with their price level. These price changes are subsequently reversed, indicating that mutual fund flows—which are translated to mutual funds transactions—induce mispricing or "noise" (as in Ben-Rephael, Kandel, and Wohl, 2011, who examined the effect of flows on stock prices). Since mutual funds are held mostly by retail investors, our findings show that these investors distort, through their flows, the prices of government bonds. In addition, we find that these flows distort the break-even inflation (i.e., the spread between the nominal yield and the real yield of a comparable maturity)—a measure that is monitored by economists, central banks, and governments.[2] Beyond the direct importance of mispricing of government bonds and expected inflation, government bond yields are used as the baseline for discount rates of corporate bonds and equities. Therefore, mispricing of government bonds has important implications for other asset classes and investment decisions.[3]

Mutual funds' government bond holdings in Israel are of the same order of magnitude as those of other developed countries. For example, during 2019, Israeli mutual funds held about 10% of the government bond market, compared with 9.3% in the UK and 13% in the US.[4] In Israel, bonds are traded on the Tel Aviv Stock Exchange (TASE) by a limit order book as stocks. We

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[1] For a survey, see Baker and Wurgler (2007).
[2] A recent example appears in the minutes of the December 2020 Federal Open Market Committee (FOMC) meeting, which includes the following sentences: "The rise in longer term Treasury yields was concentrated in inflation compensation. The 5-year and 5-to-10-year measures of inflation compensation based on Treasury Inflation Protected Securities rose above their pre-pandemic levels." In addition, the minutes of the November 2020 Bank of Israel meeting include the following sentence: "Inflation expectations for the coming year from all sources remained below the lower bound of the target range, but expectations derived from the capital market increased. Forward inflation expectations for the second year returned to within the target range, and expectations for longer terms remained anchored within the target."
[3] For the usage of government bond yields as the risk-free rate in valuations, see Damodaran (2008).
[4] US data is from the Securities Industry and Financial Markets Association (SIFMA). UK data is from the UK Office of National Statistics (ONS). For the Israeli data, see https://www.boi.org.il/en/DataAndStatistics/Pages/MainPage.aspx?Level=3&Sid=40&SubjectType=2. In addition, according to the European Fund and Asset Management Association (EFAMA), the average holdings of European mutual funds in government bonds of European countries was 12.3% in 2018. See https://www.efama.org/Publications/AssetManagement%20in%20Europe%2026%20NOV%202020.pdf.

use a proprietary database that includes daily mutual fund inflows and outflows as well as net asset values (NAVs) and mutual funds asset holdings. The sample period is June 12, 2008 to September 30, 2020.[5] We focus on six government bond indices: short (0–2 years), intermediate (2–5 years), and long (5–10 years and 5+ years for CPI-linked and nominal bonds, respectively), for both nominal and CPI-linked bonds (hereafter, we refer to these six indices as bond categories). For each government bond category, we construct an aggregate measure of daily net flows using daily inflows and outflows of the mutual funds to government bonds. If, for example, nominal short-term bonds comprise 10% of the holdings of a certain fund, we associate 10% of this fund's net flow to this bond category (e.g., nominal short term). Each of the categories' daily net flows is then normalized by the previous day's aggregate value of the bonds in the category across all funds.

In Israel, flows are transmitted within 10–15 minutes to mutual funds that are required to meet their declared investment policies on a daily basis. Therefore, it is likely for correlations to be found between fund flows and bond returns in a daily resolution. However, the main question of this paper is whether there is a reversal pattern. As argued by Baker and Wurgler (2007), Tetlock (2007) and Zhou (2018), among others, a reversal of price changes is an indication that the initial price changes were caused by sentiment. This argument is in line with the microstructure models that imply price changes and reversals for uninformed transactions (see, among others, De Jong and Rindi, 2009).

We begin the analysis by examining the cross-correlation of normalized daily net flow measures. As expected, these flows are positively cross-correlated across the six categories, with correlations ranging from 0.25 to 0.87. Then, for each bond category, we examine the persistence in daily normalized net flows and find they are highly persistent: lagged flows predict flows with an average adjusted $R^2$ of around 70% across all bond categories.[6] Next, we find that the contemporaneous relation between normalized net flows and bond returns is positive in all six bond categories.

To further investigate what drives the contemporaneous relation between net flows to mutual funds and government bond returns, we decompose normalized net flows into their explained and unexplained parts (using lagged flows) in similar way to that of previous analyses of flows of equity mutual funds (e.g., Warther, 1995; Ben-Rephael, Kandel, and Wohl, 2011). We find that most of the contemporaneous relation between net flows and government bond returns

[5] The starting date for our sample period is due to data availability.
[6] The normalization of flows is a division by funds' value.

stems from its unexplained part, with adjusted $R^2$ values of 1.40%, 6.43%, and 7.87% (9.68%, 17.36%, and 11.73%) for short-term, intermediate-term, and long-term nominal (CPI-linked) bonds, respectively.[7]

Next, to examine whether mutual fund flows cause price pressure in government bond prices, we investigate the relation between lagged unexplained net flows and government bond returns. We focus on unexplained flows because we find this part of the flows is related to the bond returns. The results of the analysis are in the same direction across all government bond categories: lag net "unexplained" flows are negatively related to current government bond returns. The negative relation is consistent with the notion of price pressure induced by flows. In the nominal bonds, the reversal begins in the first lag, whereas in the CPI-linked bonds there is a continuation in the first and second lags (one lag in the intermediate maturity), followed by a negative relation between unexplained net flows and CPI-linked bond returns. We document a complete reversal in the nominal government bonds within 10 trading days, in which most of the reversal occurs within the first five trading days. There is only partial reversal in the CPI-linked bonds: 67%,71%, and 79% of the initial effect, depending on bond category. In all cases, the reversal is statistically significant. For example, in long-term nominal bonds one standard deviation of unexplained flows is related to a 7.5 basis points return. This effect is completely reversed within 10 trading days. Note that our results correspond to the effect of retail sentiment via mutual fund flows on equity stock markets. The most closely related paper is Ben-Rephael, Kandel, and Wohl (2011), who find that daily mutual fund flows create temporary price pressure in the Israeli equity market that is subsequently partially corrected.[8]

In addition, we investigate whether retail flows to mutual funds distort the market's expected inflation through their flows to nominal and CPI-linked government bonds. To examine this, we calculate the *break-even inflation* (BEI): the spread between nominal and CPI-linked government bonds with comparable maturities using zero-coupon yields.[9] The BEI is a popular proxy for inflation expectations that is closely monitored by many market participants, such as economists, policymakers, and professional investors (D'Amico, Kim, and Wei, 2018). First, we verify that net flows to nominal (CPI-linked) bonds are contemporaneously negatively (positively) correlated with the change in the BEI. The reason is that positive net flows to

[7] The adjusted $R^2$ reported in Ben-Rephael, Kandel and Wohl (2011)'s study, which analyzes the relation between mutual fund flows stock return, in the Israeli market, is higher than these figures at 23.6%.

[8] Ben-Rephael, Kandel, and Wohl (2012) find that aggregate monthly net exchanges to equity funds in the US, as a proxy for shifts between bond funds and equity funds, are positively contemporaneously correlated with aggregate stock market returns

[9] Because the real interest rate is close to zero, this measure is very close to the measure derived from the Fisher equation.

nominal (CPI-linked) bonds increase nominal (CPI-linked) bond prices and decrease nominal (CPI-linked) yields, and this causes a decrease (increase) in the BEI. Then, similarly to the previous analysis, we document a reversal pattern: the initial effect of nominal (CPI-linked) flows on the change in BEI is fully (partially) reversed within 10 days. The combination of contemporaneous relation and subsequent reversal indicates that mutual fund flows distort the measure for expected inflation.

Finally, to demonstrate the magnitude of government bond mispricing, we employ a trading rule that is based on the negative relation between unexpected lagged flows and government bond returns for each of the six bond categories.[10] We find that throughout our sample period (June 12, 2008, to September 30, 2020), the cumulative return of the strategy is 38%, compared with 24% in a risk-equivalent portfolio.

Our findings relate to previous papers that find that price pressure in government bonds is caused by non-fundamental factors. Brandt and Kavajecz (2004) investigate the US Treasury market and find that order-flow imbalances (excess buying or selling pressure) account for up to 26% of the day-to-day variation in yields on days without major macroeconomic announcements. Greenwood and Vayanos (2010) find that the UK pension reform of 2004 and the US Treasury buyback program of 2000–2001 caused large changes in long-term interest. In a similar vein, Ceballos and Romero (2020) find significant price pressure in government bond yields after portfolio-switching recommendations of pension funds in Chile. D'Amico and King (2013) find that fluctuations in the supply of government bonds affect their yield by studying the effect of the Federal Reserve's large-scale asset purchases in 2009. Lou, Yan, and Zhang (2013) find that US Treasury prices in the secondary market decrease significantly few days before Treasury auctions and recover shortly afterward, even though the time and amount of each auction are known in advance. They note that the decrease in prices is consistent with the interpretation that large dealers tend to hedge their risk in the secondary market, thus exerting temporary downward price pressure. Taken together, the empirical evidence regarding price pressure in the government bond market is due to large market players, such as dealers and pension funds.[11] As far as we know, this is the first paper that shows that retail investors (through their trading activity in mutual funds) cause temporary price changes in government bonds and inflation expectations.

[10]This rule is based on information that is not publicly available at the current time.

[11] Czech, Huang, Lou, and Wang (2020) use transaction data in secondary market trades of UK government bonds and find that mutual fund trading positively predicts future returns.

The remainder of the paper is as follows. Section 2 provides background on the Israeli market. Section 3 presents the data and our flow variables. Section 4 presents summary statistics. Section 5 analyzes the relation between flows and lagged flows. Section 6 and 7 investigate the contemporaneous and dynamic relation between flows and government bond returns, respectively. Section 8 examines the contemporaneous and dynamic relation between flows and the BEI. Section 9 employs a trading rule that is based on the relation between net flows and government bond returns. Section 10 concludes.

## 2. The Israeli market: Background

### 2.1 The Israeli government bond market

Israeli bonds—both corporate and government—have been traded historically on the TASE (Abudy and Wohl, 2018).[12] This contrasts with the common practice used worldwide, particularly in the US, of trading bonds mostly over-the-counter (OTC). CPI-linked bonds were introduced in Israel in the early 1950s, and historically their market share has been significant. In December 2020, there were 18 nominal government bonds and 12 CPI-linked government bonds with a total market value of 351 and 234 billion NIS, respectively.[13] The number of government bond series in Israel is small compared with that of the US because the government often expands current bond series instead of issuing new ones. Therefore, there are no *on-the-run* or *off-the-run effects*. The liquidity of CPI bonds is roughly similar to the liquidity of nominal bonds. The time-series daily averages nominal bond spreads (not tabulated) are 1.6, 1.6, and 2.8 basis points (bps) for short-term, intermediate-term, and long-term, respectively. For CPI-linked bonds, the respective numbers are of a similar magnitude: 1.6, 2.0, and 3.3 bps.

In Israel, the market cap of government bonds is comparable to the stocks' market cap and twice the corporate bonds' market cap: 718 billion NIS vs. 842 billion NIS and 355 billion NIS, respectively.[14] For comparison, in the US, the market cap of government bonds is half of the market cap of stocks and twice the market cap of corporate bonds ($21 trillion, $42 trillion, and $10 trillion, respectively).[15]

The trading mechanism for government bonds at the TASE is similar to the trading of stocks and corporate bonds: a continuous limit order book trading with opening and closing auction

[12] For the corporate bond market in Israel, see also Gershgoren, Hadad, and Kedar-Levy (2020).
[13] We do not analyze government floating rate bonds because their duration is very low and therefore their price variability is low. As of December 2020, their total market cap was 46 billion NIS ($14 billion).
[14] These figures are from www.tase.co.il. The value of government bonds includes 87 billion NIS of short-term bills (called Makam). In December 2020 one NIS (New Israeli Shekel) was equal to about $0.31.
[15] As of the end of 2020, according to sifma.org. The estimate for government bonds includes bonds, notes, and bills.

trading sessions. There were minor changes in the trading hours at the TASE during the sample period. As of December 2020, the pre-opening stage for government bonds begins at 9:25, and the opening stage is conducted arbitrarily between 9:55 and 9:56, followed immediately by the continuous stage. On Mondays–Thursdays (Sunday), the pre-closing stage begins between 17:14 and 17:15 (15:39 and 15:40) and is followed by a closing stage between 17:24 and 17:25 (15:39 and 15:40).

**2.2 Israeli mutual funds**

Similarly to common practices worldwide, Israeli mutual funds primarily cater retail investors. According to Bank of Israel (BOI) data, in January 2020, retail investors held 92% of the NAV of the three mutual fund categories of government bonds (see Section 3.1). The remaining 8% is held by corporations. Mutual funds do not provide investors with any tax benefits, and therefore retirement savings are made through other entities, such as pension funds. The market value of the mutual fund industry has increased substantially in recent decades, from about 39 billion NIS in January 2000 to 224 billion NIS in September 2020. Mutual funds may hold various financial assets and are classified into categories (for a more detailed description of the mutual fund industry in Israel, see Mugerman, Steinberg, and Wiener, 2020).

Investors can buy and sell mutual funds during most of the trading hours of the TASE. Investors transmit flows to mutual funds to their brokers. The brokers immediately transfer these flows to a centralized system.[16] This system transmits the flows to the mutual funds every 10–15 minutes. The deadline for transferring flows, the *final hour*, varies between 15:00 and 16:00, according to the mutual fund investment policy and the day of the week. An order transmitted after the *final hour* is transferred to the next trading day. This allows the fund managers sufficient time to adjust their positions according to the daily flows. Each mutual fund has a declared investment policy (e.g., investing at least 90% of the assets in CPI-linked government bonds), and it needs to meet this policy on a daily basis. At the end of the trading day (17:25 on Mondays–Thursdays and 15:50 on Sundays), each fund calculates and transmits its NAV to the TASE for clearing. The investors' orders are executed at the NAV. Mutual funds publicly disclose information on their monthly flows and their security holdings approximately two months after the end of each month (e.g., information on monthly flows and holdings of January are published at the beginning of April).

[16] This is a system operated by the TASE but it is not related to its trading system.

## 3. Data and main variables

### 3.1 Data

The paper uses proprietary daily mutual fund data obtained from the BOI that is not publicly available. The sample period ranges from June 12, 2008, to September 30, 2020: a total of 2,887 trading days. The data include daily net flows and NAVs of all mutual funds in Israel during the sample period.

The mutual funds are classified according to their investment style. Each mutual fund can be classified into only one category. The classifications are set by the Israeli Securities Authority (which is the Israeli equivalent of the American Security and Exchange Commission, SEC). There are 14 classifications in total, and fund classifications are reexamined on a monthly basis. We concentrate on three classifications that hold a non-negligible amount of government bonds. These classifications are:

- *Local bonds: general*—funds with principal holdings in corporate and government bonds.
- *Local bonds: nominal*—funds with principal holdings in nominal bonds, both government and corporate.
- *Local bonds: sovereign*—funds with principal holdings in government bonds, both nominal and CPI-linked bonds.

We find 1,420 mutual funds that belonged to one of the three abovementioned classifications for at least one month during the sample period (per day, the average number of funds in the sample is 656). The mutual funds in these three classifications held about 90% of the entire mutual fund holdings in government bonds throughout the sample period.[17] The rest of the mutual fund holdings in government bonds are spread across the other fund classes and are in small quantities (e.g., mainly stock funds and mixed funds).

In addition to the BOI mutual fund data, we use data on monthly holdings in government bonds for each mutual fund: its end of the month percentage holdings in government bonds according to the bond categories we examine—type (nominal or CPI-linked) and maturity (short, intermediate, and long). These data are obtained from Praedicta, a financial services company.

To examine whether mutual fund flows generate price noises in government bonds, we obtain TASE's daily returns of government bond indices. The TASE calculates three indices grouped

[17] Of the 90%, 54% were in "local bonds: sovereign," 29% in "local bonds: general," and 7% in "local bonds: nominal."

by maturity for each type of government bond (i.e., nominal and CPI-linked). This results in a total of six indices: short (0–2 years), intermediate (2–5 years), and long (5–10 and 5+ years for CPI-linked and nominal bonds, respectively). The return of the nominal (CPI-linked) bond index with maturity group $i$ ($i\in$ {short-term, intermediate-term, long-term}) on day $t$ is denoted as $RET\_NOMINAL_{i,t}$ ($RET\_REAL_{i,t}$).

Finally, we obtain from the BOI a daily estimate of the term structure of nominal and real interest rates with zero-coupon yields.[18] We use these estimates to calculate the BEI for the three maturity categories we use.

### 3.2 Construction of mutual fund flow measures

A mutual fund can invest in government bonds of all types (i.e., nominal and CPI-linked) and maturity (i.e., short, intermediate, and long) according to its declared "investment policy." For each day $t$ and each mutual fund $m$, we calculate the value held of each bond category. For nominal (CPI-linked) bonds with maturity $i$ we denote it by $CBV\_NOMINAL_{t,m,i}$ ( $CBV\_REAL_{t,m,i}$). This value is a multiplication of the percentage holdings in the government bond category at the end of the previous month by the daily NAV (in million NIS) of the mutual fund. The sum of all fund holdings in the government bond category $i$ – denoted by $CNAV\_NOMINAL_{i,t}$ ($CNAV\_REAL_{i,t}$) – is the sum over all mutual funds of $CBV\_NOMINAL_{t,m,i}$ ($CBV\_REAL_{t,m,i}$). Next, we calculate an estimate of daily net flows (inflows minus outflows), for each government bond category: first, we multiply the daily net flow of fund $m$ by the fund's percentage holding in the bond category. Then, we sum this estimate across all funds. We denote the estimated nominal and CPI-linked net flows (in million NIS) of maturity $i$ on day $t$ as $NFLOWS\_NOMINAL_{i,t}$ and $NFLOWS\_REAL_{i,t}$, respectively. We then define the nominal normalized net flow of maturity $i$ on day $t$ as:

$$NNFLOWS\_NOMINAL_{i,t} = \frac{NFLOWS\_NOMINAL_{i,t}}{CNAV\_NOMINAL_{i,t-1}},$$

and the CPI-linked normalized flows as:

$$NNFLOWS\_REAL_{i,t} = \frac{NFLOWS\_REAL_{i,t}}{CNAV\_REAL_{i,t-1}}.$$

[18] The Bank of Israel uses a cubic spline method to interpolate the synthetic zero-coupon yields.

For brevity, we refer to these flows as "nominal flows" and "real flows," respectively (see Appendix for variable definitions).

## 4. Summary statistics

Table 1 presents summary statistics of the sample. The summary statistics are presented across our government bond categories—short, medium, and long maturity—for nominal (Panel A) and CPI-linked (Panel B) bonds. The first three rows in each panel refer to the mutual funds, and the last two lines refer to government bonds.

According to Table 1, the mutual funds holdings in government bonds (denoted as CNAV) is increasing with maturity in both nominal and CPI-linked bonds (values of 5,267, 7,505, and 8,317 million NIS vs. 6,794, 7,196, and 11,042 million NIS in nominal and CPI-linked bond maturity categories, respectively). The absolute value of daily net flows is of similar magnitude in both nominal and CPI-linked bonds. Because the market cap of nominal bonds is larger than the market cap of CPI-linked bonds, their trading volume is also larger.

[INSERT TABLE 1 ABOUT HERE]

Table 2 presents the cross-correlation between the six normalized flow measures of the bond categories. The cross-correlation is positive across all six measures. We also note that some cross-correlations are high. For example, the correlation between normalized flows of short and intermediate maturity of CPI-linked government bonds is 0.87.

[INSERT TABLE 2 ABOUT HERE]

## 5. Flow persistence

Before examining the relation between normalized net flows and their lags, we present in Figure 1 the normalized net flows over time. Panel A (B) presents the average of these variables across three maturity categories of nominal (CPI-linked) government bonds. Two observations stand out. First, daily flows are highly persistent. Second, one can pinpoint periods of market turmoil because they coincide with periods of large outflows, such as the financial crisis of 2008 and the recent COVID-19 crisis that began in March 2020.

[INSERT FIGURE 1 ABOUT HERE]

To further analyze the persistence of flows, we estimate the relation between normalized net flows and their lags by estimating the following regression model, conducted separately for each of the six bond categories:[19]

$$NNFLOWS\_NOMINAL_{i,t} = \alpha_i + \sum_{k=1}^{5} \beta_{i,k} \cdot NNFLOWS\_NOMINAL_{i,t-k} + u_{i,t}, \tag{1.1}$$

$$NNFLOWS\_REAL_{i,t} = \chi_i + \sum_{k=1}^{5} \delta_{i,k} \cdot NNFLOWS\_REAL_{i,t-k} + v_{i,t}, \tag{1.2}$$

Table 3 presents the estimation results; Panel A (Panel B) shows the results for nominal (CPI-linked) government bonds.[20] The *t*-statistics in the table are calculated using the Newey–West heteroskedasticity and autocorrelation (HAC) corrected *t*-statistics (Newey and West, 1987). We find a high and statistically significant positive correlation between normalized net flows and their respective lagged variables. A one-day lag of normalized net flows has coefficients that vary from 0.52 to 0.58 in the nominal category (Panel A) and 0.58 to 0.66 in the CPI-linked category (Panel B). The one-day lag estimates are statistically significant, with *t*-statistics higher than 5.52. The regressions' adjusted $R^2$ values vary from a low of about 64% in the short maturity of nominal government flows to a high of about 77% in the short maturity of the CPI-linked flows.[21]

[INSERT TABLE 3 ABOUT HERE]

## 6. The contemporaneous relation between flows and government bond returns

Table 3 shows that daily normalized net flows are highly persistent. Therefore, we decompose normalized flows into their expected and unexpected components based on Warther (1995) and Ben-Rephael, Kandel, and Wohl (2011). We do this by running a regression of the nominal and real normalized flows on five of their lags, based on the specification in Table 3.[22] For each bond category, the predicted value of the regression (denoted as $EXP\_NNFLOWS\_NOMINAL_{i,t}$ and $EXP\_NNFLOWS\_REAL_{i,t}$ for nominal and real flows,

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[19] We find evidence of a positive effect of lagged returns on flows. Since this is not the focus of our paper and the effect is not strong, we do not report this analysis.

[20] We use five lags of net flows in our specification in all six categories because this was the optimal number of lags in most of the categories according to the Akaike Information Criteria.

[21] For comparison, Edelen and Warner (2001) report an $R^2$ value of 55% for US equities and Ben-Rephael, Kandel, and Wohl (2011) report an adjusted $R^2$ of 10.3% for Israeli equities.

[22] Adding lagged returns to lagged flows for the explanatory part contributes very little to explaining current flows. Therefore, for simplicity, we use only lagged flows in the decomposition of flows to the "explained" and "unexplained" parts.

respectively) measures the expected normalized net flows, whereas the regression's residuals (denoted as $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $UNEXP\_NNFLOWS\_REAL_{i,t}$) measure the unexpected part.

Table 4 presents the estimations of time-series regression of daily nominal index returns $RET\_NOMINAL_{i,t}$ in Panel A (CPI-linked index returns $RET\_REAL_{i,t}$ in Panel B) on $NNFLOWS\_NOMINAL_{i,t}$ ($NNFLOWS\_REAL_{i,t}$) in the first specification; and on $EXP\_NNFLOWS\_NOMINAL_{i,t}$ ($EXP\_NNFLOWS\_REAL_{i,t}$) with $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ ($UNEXP\_NNFLOWS\_REAL_{i,t}$) separately and together, in the (2)–(4) specifications, respectively. The table shows that the relation between bond returns and normalized net flows arises from their unexpected part in all bond categories. In all the regressions in both panels, $EXP\_NNFLOWS\_NOMINAL_{i,t}$ and $EXP\_NNFLOWS\_REAL_{i,t}$ are insignificant. In addition, in both panels, the adjusted $R^2$ of Column (4) is almost equal to the adjusted $R^2$ of Column (3), which only uses $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $UNEXP\_NNFLOWS\_REAL_{i,t}$.

[INSERT TABLE 4 ABOUT HERE]

## 7. The relation between unexpected flows and subsequent government bond returns

In the previous section, we found a positive contemporaneous relation between mutual fund flows and government bond returns. This section analyzes the relation between unexpected flows—the driver of the contemporaneous relation between flows and subsequent government bond returns. In the spirit of Ben-Rephael, Kandel, and Wohl (2011) for the equity market, a negative relation between lagged flows and government bond returns supports the hypothesis of a temporary price pressure caused by flows (that are transmitted to mutual funds transactions). Such findings will provide evidence for retail sentiment (via their flows to mutual funds) in the government bond market.

To examine the relation between lagged unexpected net flows and government bond returns, we first need to determine the best fit for the number of lags of unexpected flows. We use the Akaike information criteria (AIC) to determine the number of lags for each government bond category. With the exception of the nominal short maturity category (which resulted in a best fit of nine lags), the optimal number of lags in all other bond categories is 10. Therefore, we use 10 lags in the entire analysis.

Table 5 reports the regressions of government bond returns on 10 lags of unexpected flows. For each government bond maturity, we run the following regression:

$$RET\_NOMINAL_{i,t} = \alpha_i + \sum_{k=1}^{10} \beta_{i,k} UNEXP\_NNFLOWS\_NOMINAL_{i,t-k} + u_{i,t}. \quad (2.1)$$

$$RET\_REAL_{i,t} = \chi_i + \sum_{k=1}^{10} \delta_{i,k} UNEXP\_NNFLOWS\_REAL_{i,t-k} + \nu_{i,t}. \quad (2.2)$$

Panel A (B) shows the result of the regression of the nominal (CPI-linked) government bond maturities. The results reveal that in all categories, most lags are negatively related to government bond returns with varying degrees of significance. Moreover, the *p*-value of the *F*-test of the lagged coefficients in all the regressions is statistically significant. These results indicate a negative relation between unexpected flows and subsequent returns.

[INSERT TABLE 5 ABOUT HERE]

To show the results more compactly, we sum the first five lags and the last five lags of the unexpected net flows into single variables and regress bond returns on these variables. Formally, for each nominal and CPI-linked government bond maturity, we run the following regression:

$$RET\_NOMINAL_{i,t} = \alpha_i + \beta_{i,1}\left(\sum_{k=1}^{5} UNEXP\_NNFLOWS\_NOMINAL_{i,t-k}\right) + \ldots$$
$$+ \beta_{i,2}\left(\sum_{k=6}^{10} UNEXP\_NNFLOWS\_NOMINAL_{i,t-k}\right) + u_{i,t}. \quad (2.3)$$

$$RET\_REAL_{i,t} = \chi_i + \delta_{i,1}\left(\sum_{k=1}^{5} UNEXP\_NNFLOWS\_REAL_{i,t-k}\right) + \ldots$$
$$+ \delta_{i,2}\left(\sum_{k=6}^{10} UNEXP\_NNFLOWS\_REAL_{i,t-k}\right) + \nu_{i,t}. \quad (2.4)$$

Panel C (D) shows the result of the regression of the nominal (CPI-linked) government bond categories. It can be seen that in each of the six regressions, both coefficients are negative, and in each regression, there is at least one significant coefficient. This is a clear indication of the reversal pattern.

To estimate the magnitude of the reversal, we perform regressions of cumulative bond returns for different future horizons on unexpected standardized flows on day *t*. The unexpected standardized flows are calculated as unexpected daily flows divided by its daily standard deviation, and denoted as $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ ($STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$) for nominal (real) flows. This enables us to interpret the coefficients in standard deviation units. Formally, for the nominal and CPI-linked bond maturity *i*, we run the following regression:

$$RET\_NOMINAL_{i,t+k->t+n} = \alpha_i + \beta_i \cdot STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t} + u_{i,t}, \quad (2.5)$$

$$RET\_REAL_{i,t+k->t+n} = \alpha_i + \beta_i \cdot STD\_UNEXP\_NNFLOWS\_REAL_{i,t} + v_{i,t}, \quad (2.6)$$

where $RET\_NOMINAL_{i,t+k->t+n}$ ($RET\_REAL_{i,t+k->t+n}$) denotes the cumulative future nominal (CPI-linked) government bond return from $t+k$ to $t+n$ for each bond maturity $i$.

[INSERT TABLE 6 ABOUT HERE]

Panel A (B) shows the results of regression 2.5 (2.6) for nominal (CPI-linked) government bond categories. For ease of reading, Column (1) in each category presents the contemporaneous relation between unexpected standardized flows and government bond return (similar to Column (3) in Table 4, but in this case, the explanatory variable is standardized). Focusing on nominal government bond categories, Panel A shows that one standard deviation of unexpected standardized flows is related to 0.35 bps, 2.74 bps, and 7.5 bps return in the short, intermediate, and long maturity, respectively. All the results are statistically significant. Crucially, we observe a complete reversal of the initial response within five to 10 days, depending on maturity. For CPI-linked government bonds (Panel B), one standard deviation of unexpected standardized flows is related to 2.54 bps, 6.38 bps, and 8.57 bps return in the short, intermediate, and long maturity respectively. In the case of the CPI-linked bonds, we observe only a partial reversal within 10 trading days.

Panel C of Table 6 summarizes the reversal over five and 10 trading days. For example, the five-day reversal of the nominal long-maturity bond index is 69% because the coefficient in the regression that explains the five-day subsequent return is −5.15, which is 69% of the coefficient that explains the contemporaneous return. It can be seen that the reversal is full and relatively quick in the nominal bonds category. There is a partial reversal in the CPI-linked bonds category (between 67% and 79%), and it is slower than the nominal case.

As mentioned above, the initial effect on bond prices, followed by a reversal, indicates price pressure on government bond prices caused by mutual fund flows.

## 8. The relation between flows and break-even inflation

After verifying that flows to mutual funds cause price pressure in the government bond market, we investigate the effect of fund flows on the break-even inflation rate (BEI), defined as the spread between nominal and real interest rates with the same maturity using zero-coupon yields. Many market participants, including policymakers and professional investors, monitor the BEI rate as a proxy for expected inflation (D'Amico, Kim, and Wei, 2018). Because we find in previous sections that net flows to nominal and CPI-linked government bonds distort their prices, one may expect that these flows also distort the BEI rate. However, this is not necessarily the case. If flows to nominal bonds and CPI-linked bonds are highly correlated, it may be that their effect on the BEI is small. We find that the correlations between nominal and CPI-linked normalized net flows are not very high: 0.25, 0.46, and 0.76 for short-term, intermediate-term, and long-term maturity, respectively. Therefore, we expect net flows to government bonds to affect the BEI rate. Indeed, in the following subsections, we show that mutual fund flows distort the BEI. In line with the previous analysis, we first verify that relations between the BEI rate and normalized flows exist. Then, we study the dynamics of this relation and demonstrate a reversal pattern.

### 8.1 The contemporaneous relation between net flows and the BEI rate

We begin by investigating the contemporaneous relation between the daily changes in the BEI rate and normalized net flows. To conduct this analysis, we use a daily estimate of the BEI from the BOI. The central bank calculates a daily term structure of nominal and real zero-coupon yields, which we use to estimate the BEI (the spread between the nominal and real yields, in yearly terms).

We use these daily data (which are not publicly available) and estimate an average BEI for each of our maturity groups.[23] That is, we calculate an estimate of short-term maturity BEI (0–2 years), intermediate-term maturity BEI (2–5 years), and long-term maturity BEI (5–10 and 5+ years for CPI-linked and nominal bonds, respectively).[24] Then, we run a regression for each maturity category where the explained variable is the daily change in the BEI, $\Delta BEI$. The explanatory variables are the contemporaneous unexpected normalized net flows to nominal

[23] While the daily BEI is not publicly available, a monthly estimate of zero-coupon term structure is available on the BOI website.

[24] To calculate the BEI for short-term, intermediate-term, and long-term maturity, we average the nominal and real zero-coupon yields with 1–2, 3–5, and 6–10 years to maturity, respectively, and calculate the spread.

and CPI-linked bonds for each maturity, respectively. Formally, the regression takes the following form:

$$\Delta BEI_{i,t} = \alpha_i + \beta_i \cdot UNEXP\_NNFLOWS\_NOMINAL_{i,t} + \ldots$$
$$+ \chi_i \cdot UNEXP\_NNFLOWS\_REAL_{i,t} + u_{i,t}. \qquad (3.1)$$

Table 7 reveals that the $\Delta BEI$ is correlated, as expected, with both the nominal and the real unexpected normalized net flows. These relations hold for all bond maturities and are statistically significant (except for the nominal net flow in the short-term maturity, which is insignificant). The coefficients have the "correct" sign. For $UNEXP\_NNFLOWS\_NOMINAL$ ($UNEXP\_NNFLOWS\_REAL$), the relation with $\Delta BEI$ is negative (positive). That is, a positive flow to nominal (CPI-linked) government bonds increases their prices and decreases the nominal (real) yields. Therefore, the relation with $\Delta BEI$ is negative (positive). The adjusted $R^2$ values of these regressions range from 5% to 9.3%.

[INSERT TABLE 7 ABOUT HERE]

## 8.2 The relation between unexpected net flows and subsequent changes in the BEI

After finding that mutual fund net flows are contemporaneously correlated with changes in the BEI, we turn to examining the economic magnitude of the relation and whether there is a subsequent reversal in the BEI. Consequently, in Table 8, we show the results of regressing cumulative changes in the BEI on the standardized unexpected nominal and CPI-linked flows, $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$. Formally, we employ the following analysis:

$$\Delta BEI_{i,t+k->t+n} = \alpha_i + \beta_i \cdot STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t} + \ldots$$
$$+ \chi_i \cdot STD\_UNEXP\_NNFLOWS\_REAL_{i,t} + u_{i,t}, \quad (3.2)$$

where $\Delta BEI_{i,t+k->t+n}$ denotes the cumulative changes in the BEI from $t+k$ to $t+n$ in maturity category $i$.

[INSERT TABLE 8 ABOUT HERE]

Panel A of Table 8 presents a reversal pattern, and Panel B summarizes the reversal over five and 10 trading days. For example, the five-day reversal of the long-maturity BEI is 67% because the coefficient in the regression that explains the five-day ΔBEI is 0.26, which is 67% of the coefficient that explains the contemporaneous change in BEI. The reversal is full and relatively quick for nominal flows in all bond categories and the long-term CPI-linked flows. There is a partial reversal for the short- and intermediate-term CPI-linked flows (between 53% and 48%, respectively).

In conclusion, Tables 7 and 8 indicate that the noise caused by mutual fund flows also distort the BEI.

## 9. Economic calibration: A strategy based on lagged net flows

To illustrate the magnitude of mutual fund flows on government bond prices, we employ a trading rule based on the negative relation between unexpected lagged flows and government bond returns for each of the six bond categories. Since we aim to avoid a look-ahead bias, instead of using our measure of unexpected lagged flows (that uses data estimated during the entire sample period), we construct a simple measure for unexpected flows that uses past information at time *t* for each government bond category. We call this variable *approximated unexpected normalized net flows* and denote it as *APP_UNEXP_NNFLOWS*. For each bond category, we calculate:[25]

$$APP\_UNEXP\_NNFLOWS\_NOMINAL_{i,t} = NNFLOWS\_NOMINAL_{i,t} - \frac{\left(NNFLOWS\_NOMINAL_{i,t-1} + NNFLOWS\_NOMINAL_{i,t-2} + NNFLOWS\_NOMINAL_{i,t-3}\right)}{3} \quad (4.1)$$

$$APP\_UNEXP\_NNFLOWS\_REAL_{i,t} = NNFLOWS\_REAL_{i,t} - \frac{\left(NNFLOWS\_REAL_{i,t-1} + NNFLOWS\_REAL_{i,t-2} + NNFLOWS\_REAL_{i,t-3}\right)}{3} \quad (4.2)$$

For each government bond type, we find that this measure is highly correlated with our daily unexpected flow measure of Section 6 ($UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $UNEXP\_NNFLOWS\_REAL_{i,t}$). All correlations are above 0.85 (for brevity, these correlations are not reported).

For each of the six bond categories, we employ the following rule:

- For each trading day, calculate the sum of the approximated unexpected normalized net flows on days *t-5*, *t-6*, and *t-7*.[26]

[25] Constructing the approximated unexpected flow measure with two or four lags does not change the result qualitatively.
[26] We aim to present an identical trading rule for both the nominal and the CPI-linked bonds. Therefore, the use of information from days *t-5*, *t-6*, and *t-7* is based on the results of previous analyses.

- If the sum is negative, invest in the government bond index of this bond category. Otherwise, invest in the BOI interest rate.

[INSERT TABLE 9 ABOUT HERE]

It should be emphasized that this is a hypothetical trading rule because it is based on information that is not publicly available. Nevertheless, we employ this rule to provide clear and intuitive insight for the magnitude of the reversal effect.

Panel A of Table 9 shows the economic calibration results for all six bond categories. The first column of Panel A shows the percentage of days the strategy is "in" and "out" of the government bond market. In all strategies, the proportion "in" the bond market is roughly half. Furthermore, the bonds' average return and excess return (bonds' index return minus the BOI's risk-free rate) are higher in the days "in" than in the days "out." The difference between the two series' average return is statistically significant for all maturities except for nominal short maturity, where it is marginally significant (the *t*-statistic is 1.75). The same applies to excess returns. Note that the standard deviation of the return series is almost the same as that of the excess return series.

Next, we combine the strategies of our six bond categories into a single *comprehensive strategy*. The comprehensive strategy invests each day 1/6 in the strategy of each bond category. For example, if on day *t* the trading rule of the short (long) nominal bond is to invest "in" the market ("out" of the market), then 1/6 of the comprehensive strategy will be invested in the short nominal index (BOI interest rate) on that day. We compare this strategy with a *benchmark strategy*, which invests 50% in BOI rate and 1/12 in each of the six bond categories each day. The proportions in the benchmark strategy are based on the "in" and "out" proportions in the bond categories' strategies, which are roughly 50% in all categories. The results are presented in Panel B of Table 9. The comprehensive strategy yields a significantly higher average daily return compared with the benchmark strategy: 1.13 bps vs. 0.76 bps. The *t*-statistics for the difference is 3.36. The standard deviation of returns is roughly the same in the comprehensive strategy and the benchmark strategy: 6.71 bps vs. 6.60 bps. The *F*-test for the difference in variances is insignificant. In addition, we calculate Sharpe ratios for both strategies, and find that in daily terms, the Sharpe ratio of the comprehensive strategy is 0.128, compared with 0.074 for the benchmark strategy. To illustrate the difference in the returns of the two strategies, Figure 2 plots the cumulative returns of the comprehensive and the benchmark strategies. According to the estimate, the comprehensive strategy yields a cumulative return of about 38% during the sample period compared with 24% for the benchmark strategy.

## 10. Conclusion

Previous literature has investigated the effect of retail investor sentiment on stock prices and returns. We are not aware, however, of research on the effect of retail investors on government bond markets. Government bonds are traded mainly by institutional and professional investors. Therefore, intuitively, their prices are less likely to be affected by retail investing. In this paper, we show that contrary to this intuition, retail investors distort government bond prices through their flows in and out of mutual funds.

We use a proprietary database that includes daily flows of Israeli mutual funds that hold government bonds. We divide government bonds into six categories according to type (nominal and CPI-linked) and maturity (short-term, intermediate-term, and long-term). We find that net flows have a high and positive contemporaneous correlation with daily government bond returns. We also find that most of the contemporaneous relation between net flows and government bond returns stems from its unexplained component. We find that these price changes are fully or partially reversed within 10 trading days, and most of the reversal occurs within five trading days. We interpret these results as evidence of a "noise" caused by retail sentiment through their flows to mutual funds. Because flows to nominal and CPI-indexed bonds are not highly correlated, we find that mutual funds flows are related to BEI, a popular measure of inflation expectations. These effects are reversed fully or partially within 10 trading days, and most of the reversal occurs within five trading days. This reversal pattern is evidence that the BEI—a measure of expected inflation—is distorted by mutual fund flows. To demonstrate the economic significance of government bond mispricing, we employ a trading rule based on our findings. Throughout the sample period, we find the cumulative return of this trading rule is about 60% higher than that of a naive strategy of a risk-equivalent portfolio (a cumulative return of 38% vs. 24%).

The government bond market is of fundamental importance. It is considered a benchmark for estimating the risk-free rate for various maturities and the basis of determining the discount rates for a wide range of asset classes. In addition, government bond returns are used to estimate expected inflation. Therefore, the price noises caused by retail investors through mutual fund flows may have a distortive effect beyond that of the government bond market.

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## Table 1: Summary statistics

The table presents summary statistics of flows to government bonds funds and of the government bond market. The statistics are presented for the three maturities: short-term (0–2 years), intermediate-term (2–5 years), and long-term (5+ years for nominal bonds, and 5–10 for CPI-linked bonds)—a total of six categories. Panels A and B present statistics for nominal and CPI-linked bonds, respectively. The construction of the flow measures is detailed in Section 3.2. The sample period ranges from June 12, 2008, to September 30, 2020 (2,887 trading days). *CNAV* is the sum of all fund holdings in a certain bond category. *Absolute value of daily net flows* is the absolute value of daily net flows of each mutual fund category (in millions NIS). *Daily return of government bonds* is the daily return of the government bond index. See Appendix for other variable definitions.

### Panel A: Nominal government bonds

| | | Short | | | Intermediate | | | Long | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | Median | STD | Mean | Median | STD | Mean | Median | STD |
| CNAV_NOMINAL (in NIS millions) | 2887 | 5,267 | 5,293 | 1,371 | 7,505 | 7,005 | 2,387 | 8,317 | 9,938 | 3,596 |
| Normalized net flows (% of CNAV) | 2887 | -0.026% | -0.023% | 0.189% | 0.010% | 0.017% | 0.245% | 0.013% | 0.015% | 0.312% |
| Absolute value of daily net flows (in NIS millions) | 2887 | 5.13 | 3.41 | 6.89 | 10.08 | 7.60 | 11.09 | 14.62 | 10.42 | 17.28 |
| Daily return of government bonds (bps) | 2887 | 0.66 | 0.31 | 3.10 | 1.53 | 0.93 | 12.20 | 2.97 | 2.96 | 30.91 |
| Daily trading volume (in NIS millions) | 2887 | 210 | 160 | 194 | 451 | 400 | 279 | 809 | 756 | 407 |

### Panel B: CPI-linked government bonds

| | | Short | | | Intermediate | | | Long | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | Median | STD | Mean | Median | STD | Mean | Median | STD |
| CNAV_REAL (in NIS millions) | 2887 | 6,794 | 6,831 | 3,595 | 7,196 | 7,213 | 3,527 | 11,042 | 11,189 | 2,706 |
| Normalized net flows (% of CNAV) | 2887 | -0.0496% | -0.0125% | 0.4770% | 0.0070% | 0.0003% | 0.4835% | 0.0131% | 0.0154% | 0.3125% |
| Absolute value of daily net flows (in NIS millions) | 2887 | 7.21 | 4.18 | 11.26 | 10.22 | 6.34 | 14.15 | 11.39 | 7.70 | 12.78 |
| Daily return of government bonds (bps) | 2887 | 0.27 | 0.41 | 8.59 | 0.73 | 1.10 | 16.12 | 1.69 | 2.68 | 26.44 |
| Daily trading volume (in NIS millions) | 2887 | 158 | 125 | 135 | 256 | 229 | 158 | 318 | 290 | 180 |

## Table 2: Correlation of daily normalized net flows

The table presents the cross-correlation between the daily normalized net flows of the six government bond categories ( $NNFLOWS\_NOMINAL_{i,t}$ and $NNFLOWS\_REAL_{i,t}$ ). Sample period and maturity groups are detailed in Table 1. The construction of the normalized net flows is detailed in Section 3.2.

| | Short maturity (nominal) | Intermediate maturity (nominal) | Long maturity (nominal) | Short maturity (CPI-linked) | Intermediate maturity (CPI-linked) | Long maturity (CPI-linked) |
|---|---|---|---|---|---|---|
| Short maturity (nominal) | 1 | | | | | |
| Intermediate maturity (nominal) | 0.73 | 1 | | | | |
| Long maturity (nominal) | 0.55 | 0.81 | 1 | | | |
| Short maturity (CPI-linked) | 0.25 | 0.40 | 0.35 | 1 | | |
| Intermediate maturity (CPI-linked) | 0.30 | 0.56 | 0.48 | 0.87 | 1 | |
| Long maturity (CPI-linked) | 0.46 | 0.74 | 0.76 | 0.70 | 0.78 | 1 |

### Table 3: Regressions of flows on lagged flows

The table presents the coefficients of time-series regressions of daily nominal and CPI-linked normalized net flows with maturity *i* ( $NNFLOWS\_NOMINAL_{i,t}$ , $NNFLOWS\_REAL_{i,t}$ , in percent) on their lagged variables. Panel A (B) refers to flows to nominal (CPI-linked) government bonds. Sample period and maturity groups are detailed in Table 1. The *t*-statistics (in parentheses) are the Newey–West HAC corrected *t*-statistics (Newey and West, 1987).

**<u>Panel A: Nominal flows</u>**

| | Dependent variable: daily normalized net nominal flows ( $NNFLOWS\_NOMINAL_{i,t}$ ) | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| *Intercept* | −0.0020 | 0.0011 | 0.0015 |
| | (−1.87) | (0.5) | (0.52) |
| $NNFLOWS\_NOMINAL_{i,t-1}$ | 0.52 | 0.57 | 0.58 |
| | (17.76) | (9.71) | (10.96) |
| $NNFLOWS\_NOMINAL_{i,t-2}$ | 0.11 | 0.10 | 0.05 |
| | (3.34) | (1.80) | (0.75) |
| $NNFLOWS\_NOMINAL_{i,t-3}$ | 0.13 | 0.07 | 0.12 |
| | (4.55) | (1.88) | (2.92) |
| $NNFLOWS\_NOMINAL_{i,t-4}$ | 0.02 | 0.03 | 0.03 |
| | (0.70) | (1.34) | (0.52) |
| $NNFLOWS\_NOMINAL_{i,t-5}$ | 0.11 | 0.10 | 0.10 |
| | (3.97) | (2.10) | (1.94) |
| $Adj.R^2$ (%) | 64.59 | 69.70 | 67.91 |

**<u>Panel B: Real flows</u>**

| | Dependent variable: daily normalized net real flows ( $NNFLOWS\_REAL_{i,t}$ ) | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| *Intercept* | −0.0019 | 0.0002 | −0.0002 |
| | (−1.03) | (0.05) | (−0.11) |
| $NNFLOWS\_REAL_{i,t-1}$ | 0.66 | 0.60 | 0.58 |
| | (16.88) | (5.88) | (5.52) |
| $NNFLOWS\_REAL_{i,t-2}$ | 0.11 | 0.25 | 0.17 |
| | (2.02) | (3.27) | (1.53) |
| $NNFLOWS\_REAL_{i,t-3}$ | 0.02 | 0.00 | 0.02 |
| | (0.45) | (−0.01) | (0.39) |
| $NNFLOWS\_REAL_{i,t-4}$ | 0.05 | 0.00 | 0.03 |
| | (1.05) | (−0.03) | (1.00) |
| $NNFLOWS\_REAL_{i,t-5}$ | 0.08 | 0.08 | 0.10 |
| | (2.70) | (2.17) | (3.09) |
| $Adj.R^2$ (%) | 77.04 | 75.82 | 70.99 |

## Table 4: Contemporaneous regressions of returns on flows

This table presents the coefficients from time-series regressions of daily nominal government bond returns (Panel A, in bps) and CPI-linked government bond returns (Panel B, in bps) on the respective flow variables. Sample period and maturity groups are detailed in Table 1. The construction of the daily normalized net flows measures is detailed in Section 3.2. We construct the nominal and CPI-linked expected (denoted as $EXP\_NNFLOWS\_NOMINAL_{i,t}$ and $EXP\_NNFLOWS\_REAL_{i,t}$) and unexpected (denoted as $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $UNEXP\_NNFLOWS\_REAL_{i,t}$) daily normalized net flow measures, respectively, as follows: we auto-regress daily normalized net flows on their five lags. The residuals are the measure of the unexpected flow, while the predicted value measures the expected flow. The *t*-statistics (in parentheses) are the Newey–West HAC corrected *t*-statistics (Newey and West, 1987).

### Panel A: Flows to nominal government bonds

| | Dependent variable: daily nominal government bond returns | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Short maturity | | | | Intermediate maturity | | | | Long maturity | | | |
| | [1] | [2] | [3] | [4] | [1] | [2] | [3] | [4] | [1] | [2] | [3] | [4] |
| $Intercept$ | 0.698 | 0.662 | 0.653 | 0.666 | 1.454 | 1.541 | 1.507 | 1.511 | 2.703 | 2.947 | 2.955 | 2.902 |
| | (9.97) | (7.55) | (7.69) | (7.70) | (5.24) | (3.31) | (3.54) | (3.70) | (4.16) | (3.37) | (3.79) | (3.81) |
| $NNFLOWS\_NOMINAL_{i,t}$ | 1.763 | | | | 5.331 | | | | 16.206 | | | |
| | (3.69) | | | | (2.88) | | | | (4.25) | | | |
| $EXP\_NNFLOWS\_NOMINAL_{i,t}$ | | -0.163 | | -0.244 | | -1.139 | | -1.368 | | -1.164 | | -1.907 |
| | | (-0.20) | | (-0.33) | | (-0.43) | | (-0.57) | | (-0.35) | | (-0.59) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | | | 3.806 | 3.806 | | | 25.483 | 25.483 | | | 48.137 | 48.137 |
| | | | (3.35) | (3.34) | | | (4.97) | (5.03) | | | (7.25) | (7.26) |
| $Adj.R^2$ (%) | 0.91 | -0.10 | 1.40 | 1.35 | 0.88 | -0.12 | 6.43 | 6.40 | 2.47 | -0.14 | 7.87 | 7.83 |

### Panel B: Flows to CPI-linked government bonds

| | Dependent variable: daily CPI-linked bond returns | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Short maturity | | | | Intermediate maturity | | | | Long maturity | | | |
| | [1] | [2] | [3] | [4] | [1] | [2] | [3] | [4] | [1] | [2] | [3] | [4] |
| $Intercept$ | 0.420 | 0.311 | 0.258 | 0.326 | 0.628 | 0.715 | 0.710 | 0.684 | 1.690 | 1.678 | 1.677 | 1.676 |
| | (2.35) | (1.83) | (1.81) | (1.98) | (1.57) | (2.61) | (2.96) | (2.98) | (2.81) | (3.00) | (3.47) | (3.46) |
| $NNFLOWS\_REAL_{i,t}$ | 5.679 | | | | 7.597 | | | | 34.854 | | | |
| | (4.96) | | | | (3.93) | | | | (4.30) | | | |
| $EXP\_NNFLOWS\_REAL_{i,t}$ | | 0.711 | | 0.731 | | -0.834 | | -0.930 | | -3.255 | | -3.679 |
| | | (0.53) | | (0.62) | | (-0.48) | | (-0.76) | | (-0.57) | | (-0.84) |
| $UNEXP\_NNFLOWS\_REAL_{i,t}$ | | | 18.931 | 18.931 | | | 32.775 | 32.775 | | | 104.124 | 104.124 |
| | | | (5.79) | (5.78) | | | (15.37) | (15.45) | | | (12.09) | (11.89) |
| $Adj.R^2$ (%) | 3.99 | -0.04 | 9.68 | 9.69 | 4.21 | -0.05 | 17.36 | 17.37 | 4.87 | -0.06 | 11.73 | 11.73 |

## Table 5: Regressions of returns on lagged unexpected flows

This table presents the coefficients from time-series regressions of daily nominal government bond returns (Panel A) and CPI-linked government bond returns (Panel B) on their respective mutual fund lagged unexpected net flows. Panels C and D present the coefficients from time-series regressions of daily nominal and CPI-linked government bond returns on lagged sums of unexpected net flows. Sample period and maturity groups are detailed in Table 1. The construction of the daily normalized net flows measures is detailed in Section 3.2. The daily unexpected nominal and CPI-linked net flow measures (denoted as $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $UNEXP\_NNFLOWS\_REAL_{i,t}$, respectively) are the residuals of an auto-regression of the daily normalized net flows on their five lags. The *t*-statistics (in parentheses) are the Newey–West HAC corrected *t*-statistics (Newey and West, 1987).

### Panel A: Nominal returns on lags of unexpected flows

| | **Dependent variable:** $RET\_NOMINAL_{i,t}$ | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| *Intercept* | 0.66 | 1.83 | 3.73 |
| | (11.72) | (7.51) | (6.40) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-1}$ | −1.75 | −7.33 | −7.65 |
| | (−1.78) | (−1.52) | (−0.85) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-2}$ | −1.54 | −5.98 | −7.03 |
| | (−1.61) | (−1.21) | (−0.81) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-3}$ | −1.44 | −13.20 | −15.18 |
| | (−1.58) | (−2.74) | (−1.89) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-4}$ | −0.64 | −6.61 | 0.13 |
| | (−0.70) | (−1.51) | (0.01) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-5}$ | 0.56 | −4.19 | −10.10 |
| | (0.59) | (−0.96) | (−1.26) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-6}$ | −0.68 | −6.41 | −13.37 |
| | (−0.87) | (−1.59) | (−1.72) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-7}$ | −0.19 | −9.26 | −16.54 |
| | (−0.29) | (−2.05) | (−2.10) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-8}$ | −0.51 | −1.19 | −3.20 |
| | (−0.77) | (−0.30) | (−0.45) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-9}$ | −0.87 | −1.93 | −0.66 |
| | (−1.20) | (−0.55) | (−0.10) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-10}$ | 0.11 | −2.70 | −2.21 |
| | (0.14) | (−0.83) | (−0.33) |
| $Adj.\,R^2$ (%) | 0.35 | 2.32 | 0.73 |
| *p*-value of *F*-test of regression | 0.0178 | < 0.01 | < 0.01 |

**Panel B: CPI-linked returns on lags of unexpected flows**

| | Dependent variable: $RET\_REAL_{i,t}$ | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| *Intercept* | 0.35 | 0.65 | 2.13 |
| | (3.32) | (3.67) | (4.91) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-1}$ | 2.36 | 0.40 | 4.20 |
| | (0.75) | (0.05) | (0.45) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-2}$ | 0.85 | −0.66 | 5.01 |
| | (0.37) | (−0.13) | (0.68) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-3}$ | −5.08 | −11.33 | −9.81 |
| | (−2.67) | (−2.46) | (−1.41) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-4}$ | −4.17 | −6.95 | −9.07 |
| | (−2.42) | (−1.68) | (−1.41) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-5}$ | −3.11 | −6.86 | −8.89 |
| | (−1.77) | (−1.69) | (−1.49) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-6}$ | −1.80 | −6.94 | −16.19 |
| | (−0.99) | (−1.87) | (−2.66) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-7}$ | 1.21 | −5.00 | −14.26 |
| | (0.57) | (−1.18) | (−2.24) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-8}$ | 0.55 | −2.54 | −1.79 |
| | (0.24) | (−0.63) | (−0.34) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-9}$ | 3.46 | 2.64 | 0.90 |
| | (1.11) | (0.62) | (0.16) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-10}$ | −1.08 | −6.92 | −8.42 |
| | (−0.35) | (−1.32) | (−1.02) |
| $Adj.\, R^2$ (%) | 1.56 | 1.65 | 1.38 |
| *p*-value of *F*-test of regression | < 0.01 | < 0.01 | < 0.01 |

**Panel C: Nominal returns on lags of sums of unexpected flows**

| | Dependent variable: $RET\_NOMINAL_{i,t}$ | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| $Intercept$ | 0.66 | 1.83 | 3.73 |
| | (13.17) | (8.53) | (7.16) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-1->t-5}$ | −0.97 | −7.56 | −8.08 |
| | (−1.97) | (−2.91) | (−1.88) |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t-6->t-10}$ | −0.38 | −4.27 | −7.28 |
| | (−1.15) | (−1.97) | (−1.99) |
| $Adj.\,R^2$ (%) | 0.29 | 1.98 | 0.55 |
| $p$-value of $F$-test of regression | < 0.01 | 0.0107 | < 0.01 |

**Panel D: CPI-linked returns on lags of sums of unexpected flows**

| | Dependent variable: $RET\_REAL_{i,t}$ | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| $Intercept$ | 0.36 | 0.65 | 2.13 |
| | (2.28) | (4.10) | (5.43) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-1->t-5}$ | −1.86 | −5.14 | −3.93 |
| | (−2.03) | (−2.05) | (−1.00) |
| $UNEXP\_NNFLOWS\_REAL_{i,t-6->t-10}$ | 0.31 | −3.96 | −8.20 |
| | (0.20) | (−1.50) | (−2.11) |
| $Adj.\,R^2$ (%) | 0.35 | 0.97 | 0.66 |
| $p$-value of $F$-test of regression | < 0.01 | < 0.01 | < 0.01 |

## Table 6: Cumulative returns on lagged scaled unexpected flows

This table presents the coefficients from time-series regressions of cumulative daily nominal bond returns between time *t+k* and time *t+n* (Panel A) and CPI-linked bond returns (Panel B) on the respective lagged standardized unexpected net flow variables at time *t*. The standardized unexpected flow variables are the normalized net flows divided by their daily standard deviation (denoted as $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$). Sample period and maturity groups are detailed in Table 1. The construction of the daily normalized net flows measure is detailed in Section 3.2. The daily unexpected nominal and CPI-linked net flows are the residuals of an auto-regression of the daily normalized net flows on their five lags. The *t*-statistics (in parentheses) are the Newey–West HAC corrected *t*-statistics (Newey and West, 1987). Panel C of this table presents a summary of the reversals: the coefficients for the returns from (*t + 1*) to (*t + 5*) divided by the coefficient on the return on *t* is the five-day reversal. The 10-day reversal is also estimated in this manner.

### Panel A: Cumulative nominal government bond returns

| | Short maturity | | | |
|---|---|---|---|---|
| | $RET\_NOM_{i,t}$ | $RET\_NOM_{i,t+1->t+5}$ | $RET\_NOM_{i,t+6->t+10}$ | $RET\_NOM_{i,t+1->t+10}$ |
| Intercept | 0.65 | 3.26 | 3.23 | 6.50 |
| | (7.69) | (22.64) | (22.55) | (28.14) |
| $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | 0.35 | -0.39 | -0.05 | -0.44 |
| | (3.35) | (-1.98) | (-0.66) | (-1.71) |
| $Adj. R^2$ (%) | 1.40 | 0.11 | -0.04 | 0.06 |

| | Intermediate maturity | | | |
|---|---|---|---|---|
| | $RET\_NOM_{i,t}$ | $RET\_NOM_{i,t+1->t+5}$ | $RET\_NOM_{i,t+6->t+10}$ | $RET\_NOM_{i,t+1->t+10}$ |
| Intercept | 1.51 | 7.54 | 7.51 | 15.05 |
| | (3.54) | (14.65) | (10.88) | (18.87) |
| $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | 2.74 | -2.50 | -0.67 | -3.17 |
| | (4.97) | (-2.70) | (-1.39) | (-2.07) |
| $Adj. R^2$ (%) | 6.43 | 1.42 | 0.19 | 0.78 |

| | Long maturity | | | |
|---|---|---|---|---|
| | $RET\_NOM_{i,t}$ | $RET\_NOM_{i,t+1->t+5}$ | $RET\_NOM_{i,t+6->t+10}$ | $RET\_NOM_{i,t+1->t+10}$ |
| Intercept | 2.96 | 14.48 | 14.78 | 29.25 |
| | (3.79) | (12.79) | (12.83) | (17.42) |
| $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | 7.50 | -5.15 | -2.73 | -7.88 |
| | (7.25) | (-2.14) | (-1.05) | (-1.99) |
| $Adj. R^2$ (%) | 7.87 | 0.31 | 0.04 | 0.34 |

## Panel B: Cumulative CPI-linked government bond returns

| | Short maturity | | | |
|---|---|---|---|---|
| | $RET\_REAL_{i,t}$ | $RET\_REAL_{i,t+1->t+5}$ | $RET\_REAL_{i,t+6->t+10}$ | $RET\_REAL_{i,t+1->t+10}$ |
| Intercept | 0.26 | 1.29 | 1.27 | 2.56 |
| | (1.81) | (7.01) | (1.52) | (9.63) |
| $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$ | 2.54 | -1.61 | -0.09 | -1.70 |
| | (5.79) | (-2.06) | (-0.10) | (-1.98) |
| *Adj.* $R^2$ (%) | 9.68 | 0.53 | -0.06 | 0.25 |

| | Intermediate maturity | | | |
|---|---|---|---|---|
| | $RET\_REAL_{i,t}$ | $RET\_REAL_{i,t+1->t+5}$ | $RET\_REAL_{i,t+6->t+10}$ | $RET\_REAL_{i,t+1->t+10}$ |
| Intercept | 0.71 | 3.55 | 3.53 | 7.08 |
| | (3.07) | (7.67) | (3.50) | (10.62) |
| $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$ | 6.38 | -2.61 | -1.88 | -4.50 |
| | (15.37) | (-2.08) | (-1.04) | (-1.99) |
| *Adj.* $R^2$ (%) | 17.36 | 0.31 | 0.13 | 0.48 |

| | Long maturity | | | |
|---|---|---|---|---|
| | $RET\_REAL_{i,t}$ | $RET\_REAL_{i,t+1->t+5}$ | $RET\_REAL_{i,t+6->t+10}$ | $RET\_REAL_{i,t+1->t+10}$ |
| Intercept | 1.68 | 8.37 | 8.39 | 16.75 |
| | (3.47) | (10.10) | (10.01) | (14.18) |
| $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$ | 8.57 | -2.55 | -4.11 | -6.67 |
| | (12.09) | (-1.17) | (-2.20) | (-2.03) |
| *Adj.* $R^2$ (%) | 11.73 | 0.08 | 0.31 | 0.42 |

**Panel C: Summary of the reversal effects**

| Category | | 5-day reversal | 10-day reversal |
|---|---|---|---|
| Nominal | short | 111% | 126% |
| | intermediate | 91% | 116% |
| | long | 69% | 105% |
| CPI-linked | short | 63% | 67% |
| | intermediate | 41% | 71% |
| | long | 30% | 79% |

## Table 7: Contemporaneous regressions of the change in break-even inflation on unexpected flows

This table presents the coefficients from time-series regressions of daily changes in break-even inflation on unexpected normalized net mutual fund flows to nominal and CPI-linked government bonds. Sample period and maturity groups are detailed in Table 1. The dependent variable is the daily changes in break-even inflation: $\Delta BEI$, where BEI is expressed in basis points and in annual terms. The BEI is the difference between the nominal and the real zero-coupon interest rates for our maturity categories. The construction of the daily normalized net flows measures is detailed in Section 3.2. The daily unexpected nominal and CPI-linked net flow measures (denoted as $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $UNEXP\_NNFLOWS\_REAL_{i,t}$, respectively) are the residuals of an auto-regression of the daily normalized net flows on their five lags. The *t*-statistics are corrected for heteroscedasticity using the Newey–West HAC corrected *t*-statistics (Newey and West, 1987).

| | **Dependent variable: $\Delta BEI$** | | |
|---|---|---|---|
| | **Short maturity** | **Intermediate maturity** | **Long maturity** |
| *Intercept* | −0.06 | −0.06 | −0.07 |
| | (−0.58) | (−0.60) | (−1.36) |
| $UNEXP\_NNFLOW\_NOMINAL_{i,t}$ | −2.86 | −7.34 | −2.33 |
| | (−1.30) | (−3.41) | (−3.44) |
| $UNEXP\_NNFLOW\_REAL_{i,t}$ | 7.16 | 10.10 | 8.94 |
| | (3.75) | (4.93) | (6.53) |
| $Adj.\,R^2$ (%) | 7.26 | 9.32 | 5.05 |

## Table 8: Cumulative changes in the break-even inflation rate and lagged standardized unexpected normalized net flows

Panel A of this table presents the coefficients from time-series regressions of cumulative daily changes in break-even inflation on unexpected standardized normalized net mutual fund flows to nominal and to CPI-linked government bonds. The standardized unexpected flow variables are the normalized net flows divided by their daily standard deviation (denoted as $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ and $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$). The sample period ranges from June 12, 2008, to September 30, 2020 (2,887 trading days). Maturity categories are detailed in Table 1. The dependent variable is the daily changes in break-even inflation: $\Delta BEI$, defined in Table 7. The BEI is the difference between the nominal and the real zero-coupon interest rates in each of the maturity categories. The construction of the daily normalized net flows measures is detailed in Section 3.2. The daily unexpected nominal and CPI-linked net flow measures are the residuals of an auto-regression of the daily normalized net flows on their five lags. The *t*-statistics are corrected for heteroscedasticity using the Newey–West HAC corrected *t*-statistics (Newey and West, 1987). Panel B of this table presents a summary of the reversals: the coefficients for BEI change from ($t + 1$) to ($t + 5$) divided by the coefficient BEI change on time *t* is the five-day reversal. The 10-day reversal is also estimated in this manner.

**<u>Panel A: The relation between lagged flows and BEI</u>**

| | Short maturity | | | | Intermediate maturity | | | | Long maturity | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\Delta BEI_t$ | $\Delta BEI_{t+1\to t+5}$ | $\Delta BEI_{t+6\to t+10}$ | $\Delta BEI_{t+1\to t+10}$ | $\Delta BEI_t$ | $\Delta BEI_{t+1\to t+5}$ | $\Delta BEI_{t+6\to t+10}$ | $\Delta BEI_{t+1\to t+10}$ | $\Delta BEI_t$ | $\Delta BEI_{t+1\to t+5}$ | $\Delta BEI_{t+6\to t+10}$ | $\Delta BEI_{t+1\to t+10}$ |
| Intercept | -0.06 | 0.06 | -0.08 | -0.02 | -0.06 | -0.19 | -0.36 | -0.56 | -0.07 | -0.14 | -0.35 | -0.49 |
| | (-0.58) | (0.20) | (-0.13) | (-0.04) | (-0.60) | (-0.37) | (-0.64) | (-0.56) | (-1.36) | (-0.50) | (-1.22) | (-2.34) |
| $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | -0.26 | 0.37 | -0.01 | 0.36 | -0.77 | 0.49 | 0.31 | 0.80 | -0.39 | 0.26 | 0.14 | 0.40 |
| | (-1.30) | (1.56) | (-0.02) | (1.12) | (-3.41) | (2.91) | (1.94) | (2.63) | (-3.44) | (2.37) | (1.72) | (2.07) |
| $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$ | 1.65 | -0.82 | -0.06 | -0.88 | 2.07 | -0.92 | -0.07 | -0.99 | 0.74 | -0.72 | -0.03 | -0.74 |
| | (3.75) | (-2.00) | (-0.08) | (-1.84) | (4.93) | (-2.03) | (-0.15) | (-1.91) | (6.53) | (-2.56) | (-0.11) | (-1.98) |
| $Adj.R^2$ (%) | 7.26 | 0.46 | 0.13 | 0.10 | 9.32 | 0.58 | 0.23 | 0.52 | 5.05 | 0.74 | 0.19 | 0.43 |

**<u>Panel B: The reversals of BEI</u>**

| Flow type | Maturity | 5-day reversal | 10-day reversal |
|---|---|---|---|
| Nominal | short | 142% | 138% |
| | intermediate | 64% | 104% |
| | long | 67% | 103% |
| CPI-linked | short | 50% | 53% |
| | intermediate | 44% | 48% |
| | long | 97% | 100% |

## Table 9: Trading strategy

The table reports the results of trading strategies. The sample period ranges from June 12, 2008, to September 30, 2020 (2,887 trading days). For each bond category (detailed in Table 1), and for each day, we construct a measure called *adjusted unexpected flows*, which is the day's NNFLOWS minus the average of three lags of this variable. The trading rule is as follows: for each category of government bonds, if at day *t* the sum of the *adjusted unexpected flows* at time $t-7, t-6,$ and $t-5$ is negative, invest in the government bond index of that category. Otherwise, we invest in BOI's risk-free daily rate. For each alternative of the strategy, Panel A reports the proportion of days the strategy invests in the bond index and the BOI risk-free daily rate, the average market return, the market excess return over the risk-free daily rate, and the standard deviation of these returns. Panel B compares between a trading strategy that is based on investment in the trading rule (denoted as *comprehensive strategy*), in which we create a portfolio where we invest 1/6 in each of six bond categories mentioned above. The second strategy (denoted as *benchmark strategy*) invests 50%, with equal weights, in each of the six bond categories and 50% in the BOI risk-free rate.

**Panel A: Daily return of trading strategy**

| | Decision proportion (%) | Average market return | Std | Excess market return | Std |
|---|---|---|---|---|---|
| **Short-term maturity nominal:** | | | | | |
| In the market | 48.92 | 0.77 | 3.17 | 0.49 | 3.12 |
| Out of the market | 51.08 | 0.57 | 2.97 | 0.30 | 2.92 |
| *t*-stat of the difference | | (1.77) | | (1.75) | |
| **Intermediate-term maturity nominal:** | | | | | |
| In the market | 49.16 | 2.32 | 11.93 | 2.03 | 11.89 |
| Out of the market | 50.84 | 0.77 | 12.17 | 0.49 | 12.16 |
| *t*-stat of the difference | | (3.44) | | (3.41) | |
| **Long-term maturity nominal:** | | | | | |
| In the market | 50.56 | 4.09 | 29.38 | 3.82 | 29.38 |
| Out of the market | 49.44 | 1.81 | 32.19 | 1.54 | 32.18 |
| *t*-stat of the difference | | (1.98) | | (1.98) | |
| **Short-term maturity CPI-linked:** | | | | | |
| In the market | 47.24 | 0.63 | 8.59 | 0.35 | 8.57 |
| Out of the market | 52.76 | −0.03 | 8.50 | −0.31 | 8.51 |
| *t*-stat of the difference | | (2.07) | | (2.05) | |
| **Intermediate-term maturity CPI-linked:** | | | | | |
| In the market | 50.31 | 1.47 | 16.50 | 1.20 | 16.49 |
| Out of the market | 49.69 | −0.03 | 15.64 | −0.31 | 15.65 |
| *t*-stat of the difference | | (2.50) | | (2.51) | |
| **Long-term maturity CPI-linked:** | | | | | |
| In the market | 47.89 | 2.91 | 26.17 | 2.62 | 26.17 |
| Out of the market | 52.11 | 0.57 | 26.54 | 0.29 | 26.54 |
| *t*-stat of the difference | | (2.37) | | (2.36) | |

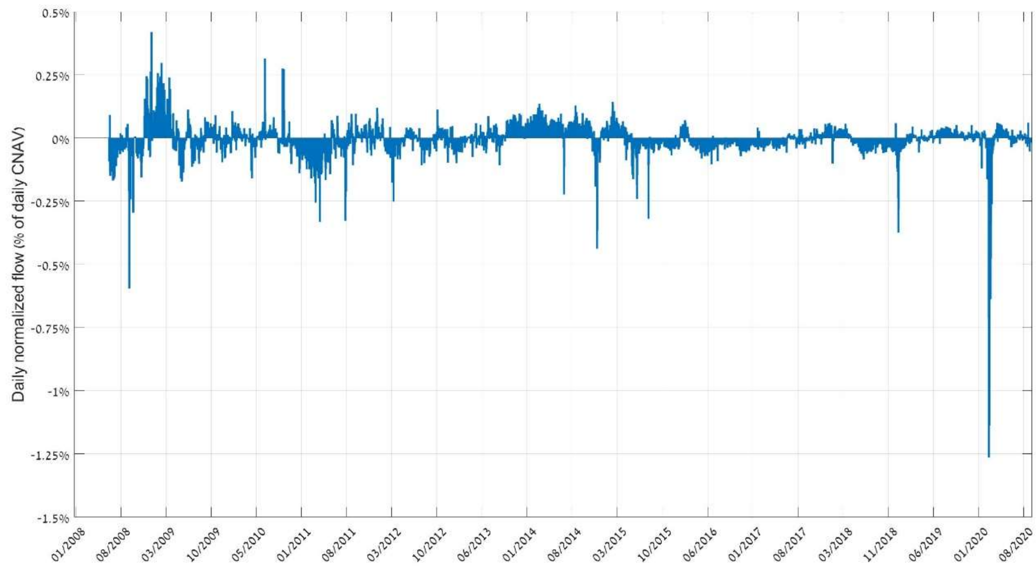
**Panel B: Comparison of the comprehensive strategy to the benchmark strategy**

| | Average return | Std | Excess return | Std | Sharpe |
|---|---|---|---|---|---|
| Comprehensive strategy | 1.13 | 6.71 | 0.86 | 6.70 | 0.128 |
| Benchmark strategy | 0.76 | 6.60 | 0.48 | 6.59 | 0.074 |
| *t*-stat of the difference | (3.36) | | (3.36) | | |
| *p*-value of *F*-test between variances | | 0.36 | | 0.36 | |

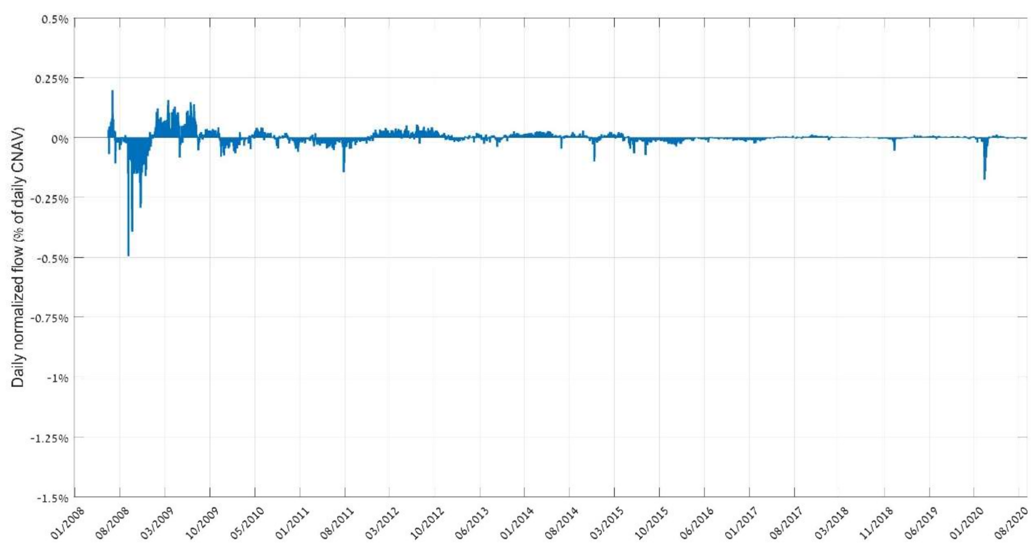
**Figure 1: Normalized daily net flows**

The figure plots the daily normalized net flows of mutual funds (in percent; relative to previous daily CNAV) of government bonds. Panel A (Panel B) refers to nominal (CPI-linked) government bonds. The flows for each type of government bonds (i.e., nominal and CPI-linked) are averaged across the maturity. Sample period and maturity groups are detailed in Table 1. The construction of the normalized net flow measures is detailed in Section 3.2.

**Panel A: Nominal flows**




**Panel B: Real flows**



## Figure 2: Cumulative returns of trading strategies

The figure plots the accumulated returns of the comprehensive trading strategy and the benchmark trading strategy. The strategies are defined in Table 9. The sample period is detailed in Table 1.

## Appendix

### Table A.1: Variable definitions

| Variable | Definition |
|---|---|
| $RET\_NOMINAL_{i,t}$ | Daily returns of nominal government bond indices (in basis points) on day *t* in maturity *i*. |
| $RET\_REAL_{i,t}$ | Daily returns of CPI-linked government bond indices (in basis points) on day *t* in maturity *i*. |
| $CBV\_NOMINAL_{t,m,i}$ | The daily value of each nominal government bond maturity *i* on day *t* in fund *m* in million NIS. It is calculated as $NOMINAL\_HOLDINGS_{t,m,i} \times NAV_{t,m}$, where $NOMINAL\_HOLDINGS_{t,m,i}$ is the percentage holdings in the nominal government bond maturity *i* at the end of the previous month of trading day *t* in fund *m*, and $NAV_{t,m}$ is the net asset value on day *t* in fund *m* in million NIS. |
| $CBV\_REAL_{t,m,i}$ | The daily value of each CPI-linked government bond maturity *i* on day *t* in fund *m* in million NIS. It is calculated as $REAL\_HOLDINGS_{t,m,i} \times NAV_{t,m}$, where $REAL\_HOLDINGS_{t,m,i}$ is the percentage holdings in the CPI-linked government bond maturity *i* at the end of the previous month of trading day *t* in fund *m*, and $NAV_{t,m}$ is the net asset value on day *t* in fund *m* in million NIS. |
| $CNAV\_NOMINAL_{i,t}$ | The daily sum of the value of all funds' holdings in nominal government bonds at day *t* in maturity *i* in million NIS. Formally, it equals $\sum_m CBV\_NOMINAL_{t,m,i}$. |
| $CNAV\_REAL_{i,t}$ | The daily sum of the value of all funds' holdings of CPI-linked government bonds at day *t* in maturity *i* in million NIS. Formally, it equals $\sum_m CBV\_REAL_{t,m,i}$. |
| $NFLOWS\_NOMINAL_{i,t}$ | The daily nominal government bonds net flow, in million NIS, calculated as: $NFLOW\_NOMINAL_{i,t} = \sum_m NOMINAL\_HOLDINGS_{t,m,i} \times NFLOW\_NOMINAL_{t,m}$, where $NFLOWS\_NOMINAL_{t,m}$ is the net flow of fund *m* on day *t* in million NIS and $NOMINAL\_HOLDINGS_{t,m,i}$ is the percentage holdings in the nominal government bond in maturity *i* at the end of the previous month of trading day *t* of fund *m*. |
| $NFLOWS\_REAL_{i,t}$ | The daily CPI-linked government bonds net flow, in million NIS, calculated as: $NFLOW\_REAL_{i,t} = \sum_m REAL\_HOLDINGS_{t,m,i} \times NFLOWS\_REAL_{t,m}$, where $NFLOWS\_REAL_{t,m}$ is the net flow of fund *m* on day *t* in million NIS and $REAL\_HOLDINGS_{t,m,i}$ |

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| | is the percentage holdings in the CPI-linked government bond maturity *i* at the end of the previous month of trading day *t* of fund *m*. |
| $NNFLOWS\_NOMINAL_{i,t}$ | The daily normalized net flow of nominal government bonds, in percent. It is obtained by dividing the aggregate net flows by the previous day's CNAV of the funds: $NNFLOWS\_NOMINAL_{i,t} = \frac{NFLOWS\_NOMINAL_{i,t}}{CNAV\_NOMINAL_{i,t-1}}.$ |
| $NNFLOWS\_REAL_{i,t}$ | The daily normalized net flow of CPI-linked government bonds in percent. It is obtained by dividing the aggregate net flows by the previous day's CNAV of the funds: $NNFLOWS\_REAL_{i,t} = \frac{NFLOWS\_REAL_{i,t}}{CNAV\_REAL_{i,t-1}}.$ |
| $EXP\_NNFLOWS\_NOMINAL_{i,t}$ | The expected daily nominal normalized net flow in percent. It is calculated for each maturity group as the expected value of the following regression: $NNFLOWS\_NOMINAL_{i,t} = \alpha_i + \sum_{k=1}^{5} \beta_{i,k} NNFLOWS\_NOMINAL_{i,t-k} + u_{i,t},$ where *t* is the time index, and *i* is the bond maturity group. |
| $EXP\_NNFLOWS\_REAL_{i,t}$ | The expected daily CPI-linked normalized net flow in percent. It is calculated for each maturity group as the expected value of the following regression: $NNFLOWS\_REAL_{i,t} = \chi_i + \sum_{k=1}^{5} \delta_{i,k} NNFLOWS\_REAL_{i,t-k} + v_{i,t},$ where *t* is the time index, and *i* is the bond maturity group. |
| $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | The unexpected daily nominal normalized net flow in percent. It is calculated as the residual of the following regression: $NNFLOWS\_NOMINAL_{i,t} = \alpha_i + \sum_{k=1}^{5} \beta_{i,k} NNFLOWS\_NOMINAL_{i,t-k} + u_{i,t},$ where *t* is the time index, and *i* is the bond maturity group. |
| $UNEXP\_NNFLOWS\_REAL_{i,t}$ | The unexpected daily CPI-linked normalized net flow in percent. It is calculated as the residual value of the following regression: $NNFLOWS\_REAL_{i,t} = \chi_i + \sum_{k=1}^{5} \delta_{i,k} NNFLOWS\_REAL_{i,t-k} + v_{i,t},$ where *t* is the time index, and *i* is the bond maturity group. |
| $STD\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | The unexpected daily nominal normalized net flow ( $UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ ) divided by its daily standard deviation. |
| $STD\_UNEXP\_NNFLOWS\_REAL_{i,t}$ | The unexpected daily CPI-linked normalized net flow ( $UNEXP\_NNFLOWS\_REAL_{i,t}$ ) divided by its daily standard deviation. |

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| $\Delta BEI_{i,t}$ | Daily change in the break-even inflation (in basis points). To calculate the BEI for the short-term, intermediate-term, and long-term maturity, we average the nominal and real zero-coupon yields with 1–2, 3–5, and 6–10 years to maturity respectively and calculate the spread. |
| $ADJ\_UNEXP\_NNFLOWS\_NOMINAL_{i,t}$ | Daily adjusted nominal unexpected normalized net flows. For day *t* and maturity group *i* it is calculated as $NNFLOWS\_NOMINAL_{i,t} - \frac{1}{3} \times (NNFLOWS\_NOMINAL_{i,t-1} + NNFLOWS\_NOMINAL_{i,t-2} + NNFLOWS\_NOMINAL_{i,t-3})$ |
| $ADJ\_UNEXP\_NNFLOWS\_REAL_{i,t}$ | Daily adjusted CPI-linked unexpected normalized net flows. For day *t* and maturity group *i* it is calculated as $NNFLOWS\_REAL_{i,t} - \frac{1}{3} \times (NNFLOWS\_REAL_{i,t-1} + NNFLOWS\_REAL_{i,t-2} + NNFLOWS\_REAL_{i,t-3})$. |