Exchange-traded Funds, Investment Strategies, and Financial Stability

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Abstract

Exchange-traded Funds (ETFs) are easy to understand, cost-efficient ways of investing in asset markets that have become very popular for both institutional and retail investors. The dynamics of the index and its underlying assets depend among others on the different types of traders in the market, price trends in individual stocks and the overall market, as well as over- or undervaluation of individual stocks and the index. Investing in an index of assets via an ETF can generate quite complex and sometimes counter-intuitive investment behaviors on the level of individual assets. Seemingly stabilizing investment behavior on the level of the ETF might actually lead to destabilizing effects on the level of individual stocks.

Keywords Exchange-traded index funds; ETF; index fund; financial stability; trading behavior

JEL codes D01, G10, G11

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1 Introduction

Exchange-traded Funds (ETFs) are easy to understand, cost-efficient, and liquid investment vehicles that have become very popular for both institutional and retail investors (Gastineau, 2010; Oura et al., 2015; Wiandt and McClatchy, 2002). While the typical ETF tracks the performance of an underlying stock index, ETFs are also available for a wide variety of indices of other asset classes such as bonds and for a broad spectrum of alternative investment strategies (see Martin et al., 2017). Therefore it does not come as a surprise that ETFs have seen an extraordinary growth since their introduction in the mid-1990s with assets under management of around 3.4 trillion USD by mid-2016 (Kremer, 2016).

As the ETF spectrum has expanded greatly with respect to assets, investment strategies, and market significance, regulators and researchers have increasingly asked how these developments might affect market quality, financial market governance, and financial stability (see e.g. Fichtner et al., 2017; Ivanov and Lenkey, 2014; Ockenfels and Schmalz, 2016b; Pan and Zeng, 2017; Cuoco and Kaniel, 2011). However, there is still only limited understanding of the longer term effects of ETFs' dramatic growth.

Empirical research indicates that ETFs have sizeable effects on asset prices, giving rise to phenomena such as index and asset-class effects. In a first step ETFs' growth can be seen as part of a more general trend in the asset management industry to move from active to passive investment strategies. A lot can be learned from work that tries to explain this trend and to explore the implications for market quality (see e.g. Ben-David et al., 2017). On the one hand the spread of passive investment is seen as evidence of improved market efficiency as arbitrage opportunities have disappeared (Stambaugh, 2014). On the other hand Baker and Wurgler (2011) point to a number of potential adverse effects of increased indexation as it might create distortions in securities' valuation, such as inclusion and deletion effects (e.g., see Shleifer, 1986; Wurgler and Zhuravskaya, 2002; Kaul et al., 2000; Greenwood, 2005) comovement of the stock with the index (e.g., see Greenwood and Sosner, 2007; Da and Shive, 2016), and higher sensitivity to bubbles and subsequent crashes. As it is difficult to explain such phenomena within standard representative-agent asset pricing models, Basak and Pavlova (2013) allow for heterogeneity in investors in their theoretical analysis. They show that institutional investors by demanding a higher fraction of risky stocks than retail investors not only amplify index stock volatilities and aggregate stock market volatility but also induce excess correlations among stocks that belong to their benchmark index, the asset-class effect.

More specifically Ben-David et al. (2014) find that ETF ownership of stocks in general increases volatility and turnover. ETFs are likely to affect the process of price discovery in asset markets. Glosten et al. (2016) find that stocks incorporate information more quickly once they are included in ETF portfolios.

Da and Shive (2016) document an increased comovement in returns of stocks that are part of the same index. When investors trade on news related to the index, the mechanical basket trading of the underlying securities tied to the ETF through arbi-

trage exhibits higher return comovements and causes basket stocks to lose part of their idiosyncratic volatility. Individual stock response are likely to be less sensitive and less timely to idiosyncratic earnings news (see also Sullivan and Xiong, 2012; Israeli et al., 2017, for supporting evidence).

Possible negative effects of ETFs on informational efficiency are related among others to lower analyst coverage (e.g., Israeli et al., 2017), slower price discovery (Bradley and Litan, 2011, 2010), impact of retail investor sentiments (Da et al., 2015), and increased attractiveness of ETFs for short-horizon noise traders with correlated demand across investment styles (Broman, 2016). In related research a number of studies analyze how ETFs might transmit noise to the underlying assets. ETFs have seen high turnover and are traded by traders who tend to make directional bets with short time horizon implying low informational efficiency, deterring long-term investors and exacerbating price drops in times of market turmoil (e.g. Stratmann and Welborn, 2012; Cella et al., 2013; Ben-David et al., 2014). Chinco and Fos (2016) analyze how ETFs' rebalancing needs in case of price changes are likely to trigger large rebalancing cascades that exacerbate the original price shock. In a broad analysis of the asset management industry Oura et al. (2015) raise the issue of systemic risks and identify risk-creating mechanisms even for seemingly simple financial products such as ETFs. They conclude that it is not so much the size of ETFs per se that is relevant for systemic risk but rather the investment strategies that appear to be more important.

This study takes up this important policy issue and examines the transmission channels from ETF investments to price behavior of individual stocks. In particular it asks whether ETFs' dramatic growth could imperil financial stability. It contributes to the literature by systematically bringing together important aspects that have so far not received the necessary scrutiny, namely on the one hand the specific relation between ETF and the underlying assets, the so-called rebalancing effect, and on the other hand the specific trading strategies ETFs are used for.

The interaction between the rebalancing effect and the specific ETF trading strategies can imply very complex, seemingly counterintuitive trading strategies on the level of the individual stocks depending on among others

- the strategy of ETF investors, e.g., fundamentalist or chartist,
- the price dynamics of the individual stocks, i.e., increasing or decreasing,
- the prices of the individual stocks relative to their fundamental values, i.e., situation of over- or undervaluation, and

Take, e.g., a bull market in which stock A rises more slowly than the overall market (index). An index chartist pursuing a trend following strategy would invest in such situation, i.e., she would invest in all stocks in the index according to their relative weight. If the stocks in the index are price weighted as, e.g., in the Dow Jones Industrial Average, the relative weight of stock A in the index decreases as its price declines relative to the remaining asset prices in the index. The necessary rebalancing of the index implies that the index trader invests relatively less in stock A and can even disinvest from that

stock, a behavior which is obviously opposite to her trading on the level of the overall index. As a consequence of these complex interactions, seemingly destabilizing investment strategies such as trend following can have stabilizing effects on the level of the individual stock while a fundamentalist on the index level might induce instabilities on the level of individual stocks. Thus, depending on specific price developments, rebalancing effects can imply that, e.g., trend following index investors behave like fundamentalists for individual stocks.

By offering easy to use, cost-efficient ways to invest in standardized pools of securities these products might play a crucial role in amplifying shocks and destabilizing price dynamics when compared to a situation in which investors invest directly in individually selected securities. The importance of such risks is likely to have risen due to structural changes in the financial systems of advanced economies. Not only has the relative weight of such products increased considerably, but also banks have tended to backtrack as market makers, possibly contributing to lower market liquidity. The effects of large-scale funds, respectively large-scale investment strategies, might be more far-reaching than in the past.

Section 2 presents some analytical findings on the effects of index based investment strategies. Section 3 discusses some counterintuitive price effects for individual stocks that can result from strategies of fundamentalists and chartists, in particular trend followers, based on index funds. Section 4 generalizes this analysis and examines how investment strategies increase or decrease market stability depending on alternative market settings. Section 5 concludes.

2 Investment Strategies and Price Dynamics of Indices and their Underlying Assets

As a passive investment vehicle a typical ETF replicates a specific asset index, e.g. the Dow Jones Industrial Average. We define as *index* both a publicly known set of assets that are considered to be representative for a market as well as the price of that basket of assets which is defined as the sum of the weighted asset prices. To simplify our analysis, we assume that the price of the index is available to all market participants at any time at no costs.

The implicit net asset position $I_i^\ell(t)$ of ETF trader ℓ in stock i at time t is given by

$$\begin{aligned} I_i^\ell(t) &= I^\ell(t) \cdot \pi_i(t) \\ &= I^\ell(t) \cdot \frac{p_i(t)}{p(t)} \end{aligned} \tag{1}$$

where $I^\ell(t)$ denotes trader ℓ's net asset position in the ETF with price $p(t) = \sum_{j=1}^{N} p_j(t)$. With market price $p_i(t)$, stock i's relative weight in the index is $\pi_i(t)$. Note that ETF investors resemble chartists, especially trend followers, since the ETF is investing in rising stocks and disinvesting from falling ones.

Investments on the level of the ETF imply specific trades on the level of the individual

stocks depending on two determinants, namely the net asset position $I^\ell(t)$ (*level* or *quantity effect*) and the stocks's relative weight $\pi_i(t)$ (*rebalancing*, *price*, or *composition effect*).[1] Given past net asset position, current investment in the index, and index's rebalancing dynamics, we derive an ETF trader's investment in individual stocks.

Proposition 1. The investment in stock i of an ETF trader ℓ with net asset position I^ℓ in period t is given by

$$\Delta I_i^\ell(t) = \Delta I^\ell(t)\pi_i(t) + I^\ell(t-1)\Delta\pi_i(t) \tag{2}$$

Proof. It holds:

$$\begin{aligned}
\Delta I_i^\ell(t) &= I_i^\ell(t) - I_i^\ell(t-1) \\
&= I^\ell(t)\pi_i(t) - I^\ell(t-1)\pi_i(t-1) \\
&= I^\ell(t)\pi_i(t) - I^\ell(t-1)\pi_i(t) + I^\ell(t-1)\pi_i(t) - I^\ell(t-1)\pi_i(t-1) \\
&= \Delta I^\ell(t)\pi_i(t) + I^\ell(t-1)\Delta\pi_i(t)
\end{aligned}$$

□

To better understand how ETF investments implicitly affect investments in the underlying stocks we analyze the quantity and price dimensions of these investments in greater detail. Firstly, the investment in an individual stock i depends on the investment in the index given the relative weight of the stock in the index, i.e., $\Delta I^\ell(t)\pi_i(t)$ (*level effect*). Secondly, the investment in individual stocks also depends on how the fund reallocates the overall investment in the index due to changes in the relative weight of the individual stocks, i.e., $\Delta\pi_i(t)$ (*rebalancing effect*). The level effect, i.e., the first summand of Equation (2), depends on the trader's strategy and her investment $\Delta I^\ell(t)$, whereas the rebalancing effect, the second summand, depends on the change of the relative price of the stock, i.e., on market dynamics that traders take as given. Thus, an ETF trader actively controls her investment only on the level of the index, while passively tolerating the implied investments on the level of the individual assets. As the two effects can work in the same or in opposite directions, the net effect of index trading on individual stocks is a priori indeterminate and depends on the relative size of the level and the rebalancing effects. The interactions of these two effects can have complex and sometimes counterintuitive effects of ETF investments on the underlying stocks, as we illustrate further below.

[1] A trader's gain is independent of trading in ETF shares or in the underlying stocks according to Equation (1), see Appendix A.1 for a proof.

3 Level vs. Rebalancing Effect—A Counterintuitive Example

We conduct some simple simulations to illustrate how investment strategies on the level of an index can imply quite different investment behavior on the level of the underlying individual stocks due to changes in the relative prices of individual stocks and the subsequent rebalancing. We compare how investment decisions on the ETF level affect investments in individual stocks under different price dynamics and for alternative investment strategies.[2]

In particular, we specify simple trading strategies for chartists, actually trend followers, and fundamentalists while differentiating between traders who invest in individual stocks or ETF stock indices giving rise to four distinct types of traders, namely chartists investing in individual stocks (C) or ETFs (E-C) as well as fundamentalists investing in individual stocks (F) or ETFs (E-F). To keep our analysis simple, we assume that traders can only change their net asset position by a constant amount $\overline{\Delta I}$ per period and per stock and that price dynamics are given, i.e., traders are price takers as their investments are too small to affect market prices.

Chartists in individual stocks invest the amount $\overline{\Delta I}$ according to

$$\begin{aligned}\Delta I_i^C(t) &= \begin{cases} +\overline{\Delta I}, & p_i(t) > p_i(t-1) \wedge t > 1, \\ -\overline{\Delta I}, & p_i(t) < p_i(t-1) \wedge t > 1, \\ 0, & p_i(t) = p_i(t-1) \vee t = 0, \end{cases} \\ &= \overline{\Delta I} sgn(p_i(t) - p_i(t-1)) \mathbb{I}_{t>0} \qquad \forall i \in \{1, \ldots, N\}\end{aligned}$$

while ETF chartists invest according to

$$\begin{aligned}\Delta I^{E-C}(t) &= \begin{cases} +N\overline{\Delta I}, & p(t) > p(t-1) \wedge t > 1, \\ -N\overline{\Delta I}, & p(t) < p(t-1) \wedge t > 1, \\ 0, & p(t) = p(t-1) \vee t = 0, \end{cases} \\ &= N\overline{\Delta I} sgn(p(t) - p(t-1)) \mathbb{I}_{t>0}\end{aligned}$$

where N denotes the number of stocks that comprise the index. Note that the investment of an ETF chartist is diversified across the individual stocks according to Equation (1).

Analogously, fundamentalists who invest in individual stocks follow

$$\begin{aligned}\Delta I_i^F(t) &= \begin{cases} +\overline{\Delta I}, & p_i(t) < f_i(t+1), \\ -\overline{\Delta I}, & p_i(t) > f_i(t+1), \\ 0, & p_i(t) = f_i(t+1), \end{cases} \\ &= \overline{\Delta I} sgn(f_i(t+1) - p_i(t)) \qquad \forall i \in \{1, \ldots, N\},\end{aligned}$$

[2] In the case of the buy-and-hold trader, the most simple type of trader in our analysis, there is no difference between directly investing in the index's stocks and investing in an ETF, see Appendix A.1.

while ETF fundamentalists invest according to

$$\Delta I^{E-F}(t) = \begin{cases} +N\overline{\Delta I}, & p(t) < f(t+1), \\ -N\overline{\Delta I}, & p(t) > f(t+1), \\ 0, & p(t) = f(t+1), \end{cases}$$
$$= N\overline{\Delta I} sgn(f(t+1) - p(t))$$

for given expected fundamental values f_i for all stocks i and respective fundamental value of the index $f = \sum_{i=1}^{N} f_i$. The market environment is assumed to be non-stochastic, i.e., there is no noise in the fundamentals.

In the subsequent scenario analysis, we assume an index with $N = 30$ stocks with starting price $p_{1-30}(0) = 1$ on time grid $\mathcal{T} = \{0, 1, \ldots, T = 250\}$. The price of stock 1 follows $p_1(t+1) = p_1(t)e^{\frac{\mu_1}{250}}$ and the index develops according to $p(t+1) = p(t)e^{\frac{\mu}{250}}$ where $\mu_1 > -1$ and $\mu > -1$ are fixed and $p_i(t) = p_j(t)\ \forall t\ \forall i, j \in \{2, \ldots, N\}$. The trends μ_1 and μ are chosen so that $p_i(t) > 0$ is fulfilled for all $t \in \mathcal{T}$ and all $i \in \{1, \ldots, N\}$. Additionally, we set $0 < f_i \equiv \overline{f_1}$ as constant for all i and so $\overline{f} \equiv N\overline{f_1}$ is constant as well. (Dis)Investment per period is $\pm\overline{\Delta I} = \pm 1$. The parameters under investigation are μ_1, μ, and $\overline{f}$.

Given this simple framework, we identify different scenarios in which ETF investments have interesting, seemingly counterintuitive effects on the level of individual stocks due to the complex interactions of level and rebalancing effects.[3]

Scenario: modestly rising stock in a bull market We assume the price of stock 1 to rise with trend $\mu_1 = 0.1$, and the price of the index to increase with trend $\mu = 2$, i.e., π_1, the relative price of stock 1, falls. All stocks are assumed to be overvalued relative to their fundamental values f_i that are set to unity, i.e., $p_i > f_i = 1$ and $p > f = 30$ holds ($t > 0$) (see. Figures 1 and 2). Prices of stock 1 and the other stocks increase over the 250 trading days and are above their respective fundamental values (see Figure 1). However, stock 1 differs from the other stocks as its relative price π_1 declines (see Figure 2).

Given these price dynamics, how do the different traders allocate their funds? As the prices of all stocks rise, chartists that trade in individual stocks or the index invest in their respective target asset. In contrast, single stock and index fundamentalists disinvest from their respective target assets as the individual stocks and the index are overvalued.

Investments of single stock investors are straight forward and serve as benchmark to evaluate ETFs implied investments in individual stocks. In the case of stock 1 single stock chartists invest as the price rises, while fundamentalists disinvest as the stock is overvalued (see Figure 3).

In contrast, investments by ETF traders might result in rather complex price effects

[3]See Appendix A.2 for two additional scenarios in which ETF trading has counterintuitive effects on individual stocks.

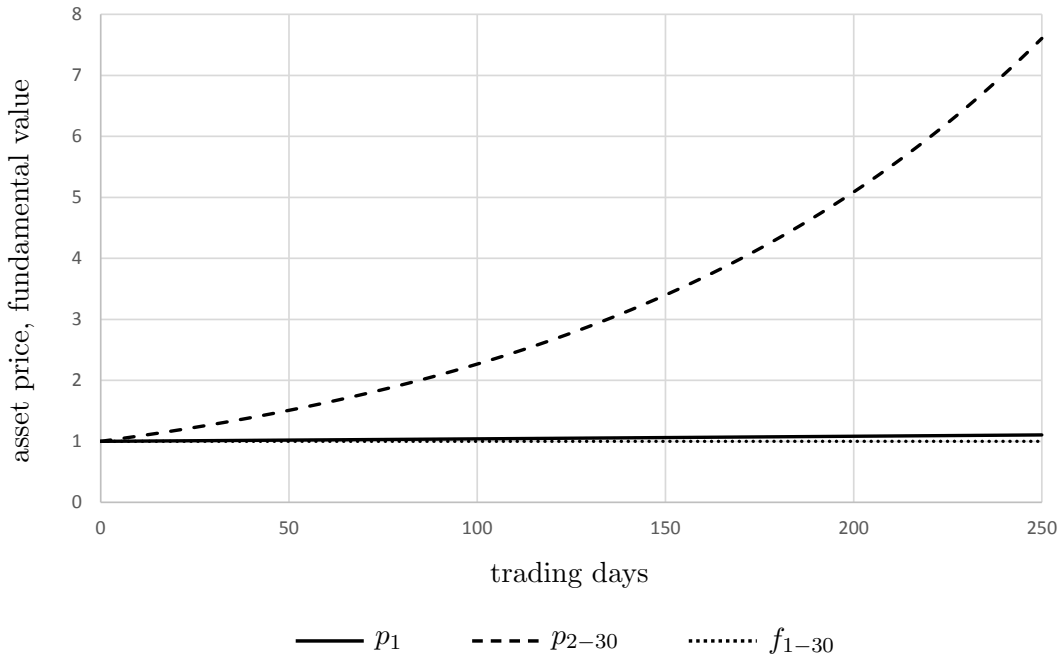

Figure 1: Price paths p_1 of stock 1 and p_{2-30} of stocks 2-30.

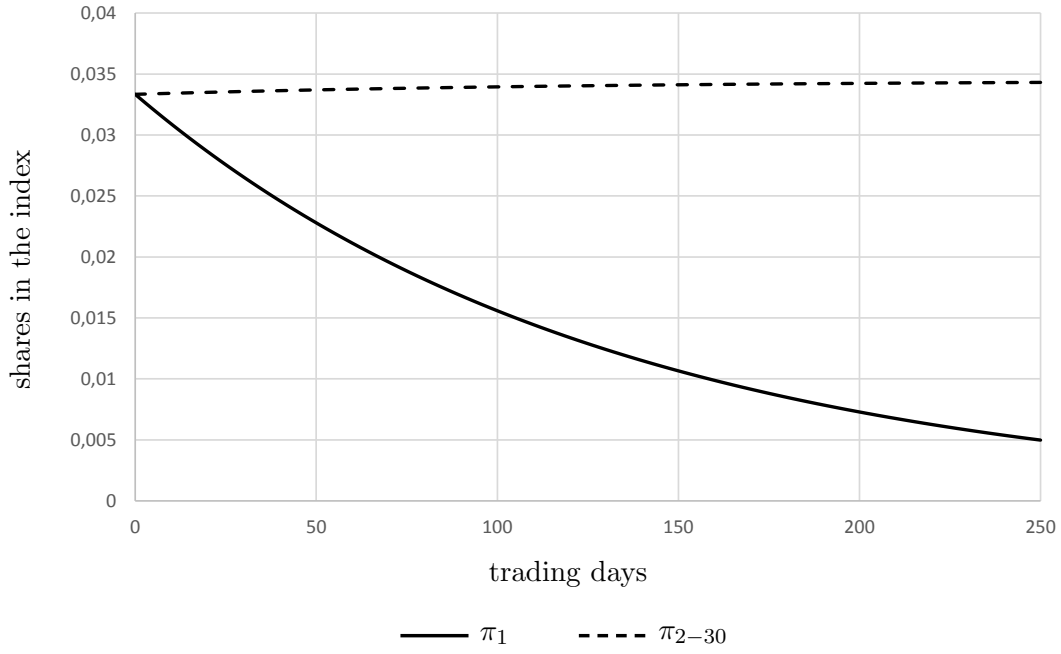

Figure 2: Change of the ratio π_1 and π_{2-30} of stock 1 and stocks 2-30, respectively.

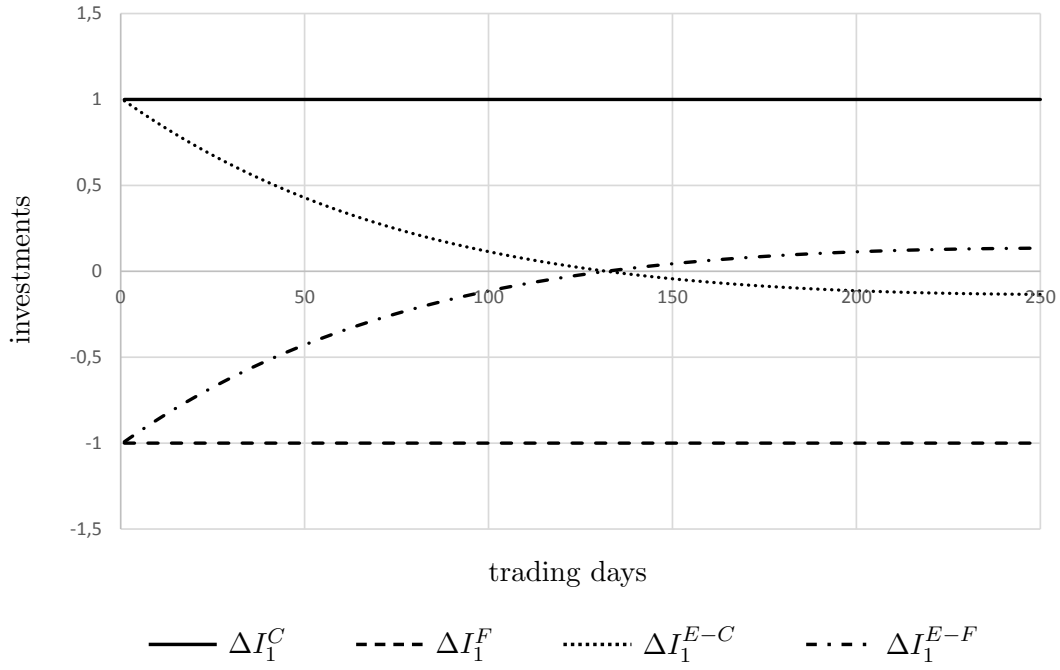

Figure 3: Investment ΔI_1^ℓ in stock 1 if the stock price rises more slowly than index price.

on the level of individual stocks. As the index is assumed to be overvalued and its price rises (see Figure 4), ETF chartists invest, while ETF fundamentalists disinvest on average, with seemingly counterintuitive effects on the investment dynamics on the level of stock 1. ETF chartists implicitly invest less and less as the relative price of stock 1, π_1, and thus its relative weight in the index declines (see Figure 2), i.e., the level effect of their investment decreases as less funds $\Delta I^{E-C}\pi_i(t)$ are allocated to stock 1 (see Equation (2)). At the same time the rebalancing effect, the second part of Equation (2), calls for disinvesting from stock 1 to account for its reduced weight in net asset position I^{E-C}. Eventually, the rebalancing effect dominates the level effect, so that the net investment turns negative and the ETF chartists disinvest from stock 1 (see Figure 3). In contrast, ETF fundamentalists start off disinvesting from the overvalued index and thus implicitly from stock 1. Over time they disinvest less and less of this stock (see Figure 3) as its relative price and thus its relative weight in the index decreases. While they disinvest from ETF shares due to the overvaluation of the index (level effect), they implicitly invest in stock 1 to assure the appropriate portfolio allocation (rebalancing effect). As the relative price of stock 1 continues to fall, the positive rebalancing effect eventually dominates the level effect and ETF fundamentalists become de facto net investors in an overvalued stock.

Taken together and somewhat counterintuitively, ETF chartists end up disinvesting from a rising stock, while ETF fundamentalists invest in an overvalued stock. From the perspective of financial stability and counter the conventional perception, ETF chartists

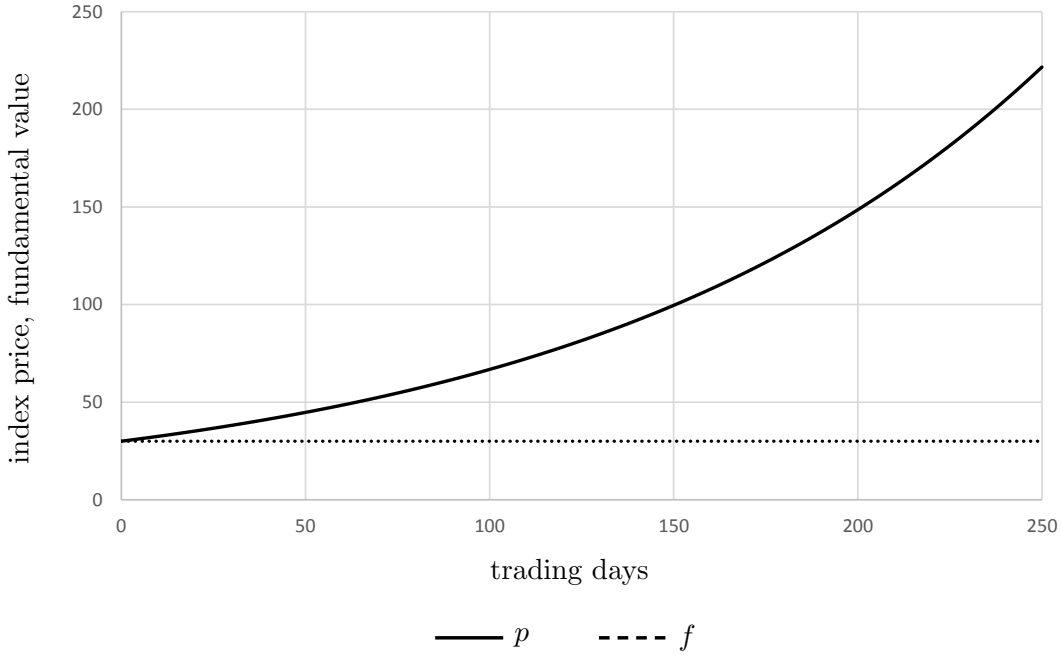

Figure 4: Market price p and fundamental price f of index.

stabilize, while ETF fundamentalists destabilize the price of this specific stock. Ultimately, these investment dynamics are driven by the complex interactions of investment strategies, fundamental and market price dynamics of individual stocks and the index, as well as the initial net asset position of investors. Appendix 4 analyzes in greater detail how these interrelations work to (de)stabilize stock prices. Obviously, these counterintuitive effects only hold for the "outlier" stock 1, while for stocks 2-30 the effects of chartists and fundamentalists are as conventionally expected (see Figure 5).[4] The strategies of the traders are the same for stock 1 and stocks 2-30. However, there is a difference in the effects caused by the outlying dynamics of stock 1.

4 (De)Stabilizing Effects of ETF traders on individual asset prices

In a next step, we generalize and summarize the (de)stabilizing effects of ETF trading for ETF fundamentalists (Table 1) and ETF chartists (Table 2) on a single asset i. We identified two factors determining investment in asset i that differ between ETF fundamentalists and ETF chartists and two factors that are independent of the traders'

[4]Appendix A.2 contains two more examples of counterintuitive investments by ETF traders, namely *scenario 2: a rising stock in a bear market* and *scenario 3: falling stock in a bull market with the index crossing its fundamental value from below.*

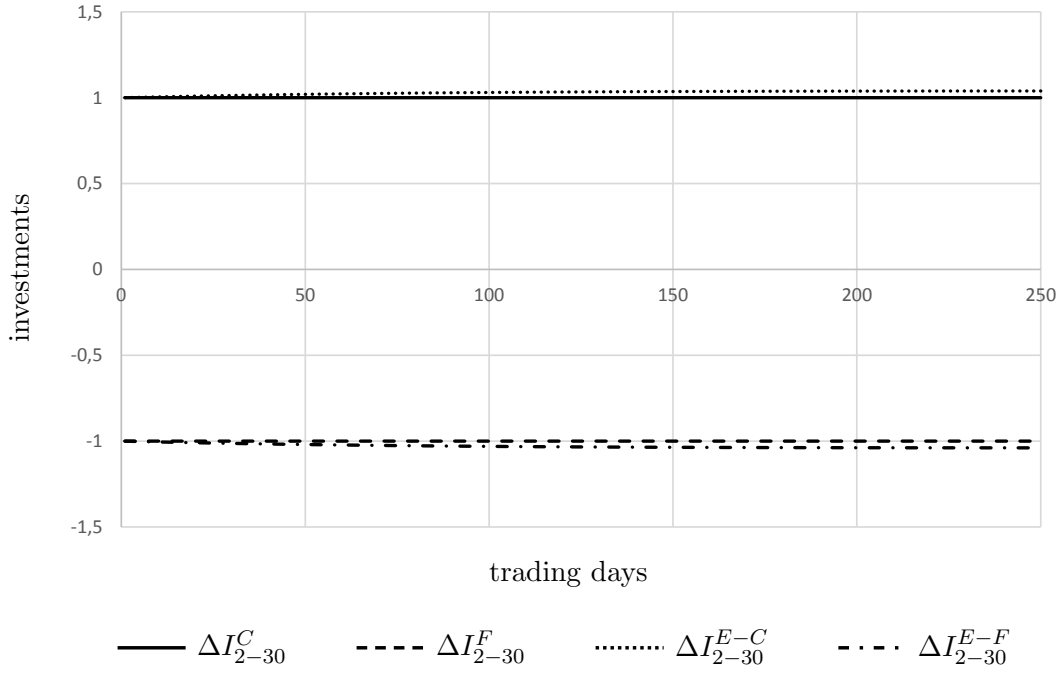

Figure 5: Alterntative traders' investment ΔI^{ℓ}_{2-30} in stocks 2-30.

investment strategies (see Equation (2)).

In the case of ETF fundamentalists it is their previous net asset positions and the ratio of (expected) fundamental price and market price.

- In the past, the index has been under-/overvalued, leading to a positive net asset position ($I^{E-F}(t-1) > 0$) or to a negative one ($I^{E-F}(t-1) < 0$).
- The index is currently undervalued ($\frac{f(t+1)}{p(t)} > 1$) or overvalued ($\frac{f(t+1)}{p(t)} < 1$).

In case of the ETF chartists the relevant factors are their previous net asset positions and the market price dynamics.

- In the past, the index has been increasing/decreasing, leading to a positive net asset position ($I^{E-C}(t-1) > 0$) of the E-C or to a negative one ($I^{E-C}(t-1) < 0$).
- The price of the index is currently increasing ($\frac{p(t)}{p(t-1)} > 1$) or decreasing ($\frac{p(t)}{p(t-1)} < 1$).

Independent of the ETFs' specific trading strategy, the change of the relative weight of asset i in the index is of importance (also taken from Equation (2)) as well as the price p_i of asset i relative to its fundamental value f_i:

- The relative share of asset i in the index can be either increasing ($\Delta\pi_i(t) > 0$) or decreasing ($\Delta\pi_i(t) < 0$).

- The i^{th} asset is now undervalued ($\frac{f_i(t+1)}{p_i(t)} > 1$) or overvalued ($\frac{f_i(t+1)}{p_i(t)} < 1$). This parameter is needed for determining the stabilizing or destabilizing effect of the respective trader.

ETF fundamentalists		$\frac{f_i(t+1)}{p_i(t)} > 1$		$\frac{f_i(t+1)}{p_i(t)} < 1$	
		$\Delta\pi_i(t) > 0$	$\Delta\pi_i(t) < 0$	$\Delta\pi_i(t) > 0$	$\Delta\pi_i(t) < 0$
$I^{E-F}(t-1) > 0$	$\frac{f(t+1)}{p(t)} > 1$	s	?	d	?
	$\frac{f(t+1)}{p(t)} < 1$	?	d	?	s
$I^{E-F}(t-1) < 0$	$\frac{f(t+1)}{p(t)} > 1$	?	s	?	d
	$\frac{f(t+1)}{p(t)} < 1$	d	?	s	?

Table 1: Price dynamics imposed by past net asset position, over-/undervaluated index, over-/undervaluated asset, and increasing/decreasing relative share of the asset in the index leading to (de)stabilizing effects of ETF fundamentalists.

ETF chartists		$\frac{f_i(t+1)}{p_i(t)} > 1$		$\frac{f_i(t+1)}{p_i(t)} < 1$	
		$\Delta\pi_i(t) > 0$	$\Delta\pi_i(t) < 0$	$\Delta\pi_i(t) > 0$	$\Delta\pi_i(t) < 0$
$I^{E-C}(t-1) > 0$	$\frac{p(t)}{p(t-1)} > 1$	s	?	d	?
	$\frac{p(t)}{p(t-1)} < 1$	?	d	?	s
$I^{E-C}(t-1) < 0$	$\frac{p(t)}{p(t-1)} > 1$	?	s	?	d
	$\frac{p(t)}{p(t-1)} < 1$	d	?	s	?

Table 2: Price dynamics imposed by past net asset position, increasing/decreasing index price, over-/undervaluated asset, and increasing/decreasing relative share of the asset in the index leading to (de)stabilizing effects of ETF chartists.

Combining these effects, we determine the sign of the investment decision for the i^{th} asset. We characterize an investment as destabilizing (d) if traders disinvest from an undervalued asset or invest in an overvalued one. An investment is considered as stabilizing (s), if traders invest in an undervalued asset or disinvest in an overvalued one. In the cells marked with a questionmark (?), the direction of the investment cannot be determined in general without knowing the specific parameter values. This is the case when one summand is positive and the other one is negative in Equation (2), i.e., if the level effect is positive and the rebalancing effect is negative or vice versa. Consider, for example, the cell of the first row and the first column of Table 1. According to

Equation (2), a positive net asset position together with a rising ratio of asset i (i.e., $I^{E-F}(t-1)\Delta\pi_i(t) > 0$) plus an undervalued index price resulting in a positive investment (i.e., $\Delta I^{E-F}(t)\pi_i(t) > 0$ where $\pi_i(t) > 0$ for all t) leads to a positive investment in asset i (i.e., $\Delta I_i^{E-F}(t) > 0$). Together with the condition of undervaluation of asset i ($\frac{f_i(t+1)}{p_i(t)} > 1$), the ETF fundamentalist's effect on asset i is stabilizing. In contrast, if asset i is overvalued (first row, third column of Table 1), her effect on asset i is destabilizing. Note that the 16 cases in the two tables differ between ETF fundamentalists and chartists. For ETF fundamentalists, the ratio between fundamental value of tomorrow and price of today is important whereas for ETF chartists the ratio of today's price and yesterday's price is of interest.

5 Conclusion

Exchange-traded Funds are easy to understand, cost-efficient ways of investing in stock market indices that have become very popular for both retail and institutional investors. The discussion of the wider repercussions of ETFs have just begun and typically focus on the rapid growth of these financial products. In our study we focus on the investment strategies underlying the use of ETFs and how they affect markets of individual underlying assets. Under the complex interactions caused by index investments on the price dynamics of individual stocks, we find that the conventional assessment that fundamentalists tend to stabilize, while chartists tend to destabilize price dynamics does not necessarily hold anymore.

ETFs might play a crucial role in amplifying shocks and destabilizing price dynamics when compared to a situation in which investors invest directly in individually selected securities. The importance of such risks is likely to have risen due to structural changes in the financial systems of advanced economies. Not only has the relative weight of such products increased considerably, but also banks have tended to backtrack as market makers, possibly contributing to lower market liquidity. The effects of large-scale funds, respectively large-scale investment strategies, might thus be more far-reaching than in the past.

An important lesson to be drawn from this analysis suggests a refocussing of financial market regulation. New financial products such as ETFs are not (de)stabilizing per se and regulation should not (only) concentrate on their sheer size and speed of growth. Rather it is the specific use of these products that is of interest and should be at the focus of financial market regulators, an idea also suggested from the perspective of market governance, e.g., Ockenfels and Schmalz (2016a). More generally, even simple and seeming innocuous products like ETFs might have substantial side effects and deserve close scrutiny in particular with respect to alternative market situations and trading strategies.

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List of Abbreviations and Symbols

abbreviations:

C	chartist/trend follower
d	destabilizing effect
E	ETF; Exchange-traded Fund
E-C	ETF chartist/ETF trend follower
E-F	ETF fundamentalist
E-H	ETF buy-and-hold trader
ETF	Exchange-traded Fund
F	fundamentalist
H	buy-and-hold trader
s	stabilizing effect
?	unknown (de)stabilizing effect

parameters and variables:

D, D^ℓ	demand function for the index (of trader ℓ)
D_i, D_i^ℓ	demand function for asset i (of trader ℓ)
f	fundamental value of the index
f_i	fundamental value of asset i
I, I^ℓ	net asset position of the index (of trader ℓ)
I_i, I_i^ℓ	net asset position of asset i (of trader ℓ)
N	number of assets in the index
μ	trend
p	price of the index
p_i	price of asset i
roi	return on investment
σ	volatility
t	time
T	termination time
$\mathcal{T}$	time grid

A Appendix

This is the Appendix to the paper "Exchange-traded Funds and Financial Stability" by Michael Heinrich Baumann, Michaela Baumann, and Bernhard Herz, University of Bayreuth, Germany, February 2018. Here, we provide some basic analytic results, robustness checks, as well as a few more examples, simulations, and insights.

A.1 Further Basic Analytical Results

In this section, before analyzing the buy-and-hold trader as a very straightforward kind of trader, we show that a trader's outcome does not depend on whether she is investing in ETF shares or whether the trader is investing directly in the underlying stocks according to Equation (1). Although it can be expected that investing in an index or directly in stocks does not make any difference, in real-world markets it can be observed that index funds are more volatile than the underlying assets, i.e., that people are more often shifting their index investments than their direct asset investments (Shiller, 1980). More precisely, we show that if a trader is investing directly in assets with the same weighting as these assets have in the index, then her total gain is the same as she would have invested the same sum in the index. With

$$\Delta g_i^\ell(t) = I_i^\ell(t-1) \cdot \frac{\Delta p_i(t)}{p_i(t-1)}$$

as the period gain of trader ℓ at time t from stock i when investing $I_i^\ell(t-1)$ at time $t-1$ in stock i we propose the following proposition.

Proposition 2. The total profit up to period t

$$g^\ell(t) = \sum_{\tau=1}^{t} \sum_{i=1}^{N} I_i^\ell(\tau-1) \cdot \frac{p_i(\tau) - p_i(\tau-1)}{p_i(\tau-1)}$$

of investing in all stocks $(1, \ldots, N)$ of trader ℓ selecting her portfolio according to Equation (1) only depends on her cumulated investment I^ℓ over all stocks and on the index's return on investment. In particular, for the period gain $\Delta g^\ell(t) = g^\ell(t) - g^\ell(t-1)$ it holds

$$\Delta g^\ell(t) = I^\ell(t-1) \cdot \frac{p(t) - p(t-1)}{p(t-1)}$$

which adds up to a total gain of

$$g^\ell(t) = \sum_{\tau=1}^{t} I^\ell(\tau-1) \cdot \frac{p(\tau) - p(\tau-1)}{p(\tau-1)}.$$

Proof. Exploiting Equation (1) leads to:

$$\begin{aligned}\Delta g^{\ell}(t) &= \sum_{i=1}^{N} I^{\ell}(t-1) \cdot \frac{p_i(t-1)}{p(t-1)} \cdot \frac{p_i(t) - p_i(t-1)}{p_i(t-1)} \\ &= \sum_{i=1}^{N} I^{\ell}(t-1) \cdot \frac{p_i(t) - p_i(t-1)}{p(t-1)} \\ &= I^{\ell}(t-1) \cdot \frac{p(t) - p(t-1)}{p(t-1)}\end{aligned}$$

Adding up over the time periods leads to the specified total gain formula which is independent of the single asset investments. □

Next, we will see that for a buy-and-hold trader there is no difference between directly investing in the index's stocks $1, \ldots, N$ or investing in an ETF, i.e., her investment decisions are the same in both cases. The proposed property seems to be obvious (by heuristics). If the reader is in doubt of this property, because ETF buy-and-hold traders indirectly reallocate there investment due to the rebalancing effect, we give a formal proof. A buy-and-hold trader (H) as well as an ETF buy-and-hold trader (E-H) buys a specific amount of assets at a certain point of time and keeps these assets irrespective of their price development. Specifically, the net asset position of an ETF buy-and-hold trader is given by

$$\begin{aligned}I^{E-H}(t) &= I^{E-H}(0) + g^{E-H}(t) \\ &= I^{E-H}(t-1) + I^{E-H}(t-1) \cdot \frac{p(t) - p(t-1)}{p(t-1)} \\ &= I^{E-H}(t-1) \cdot \frac{p(t)}{p(t-1)}\end{aligned} \tag{3}$$

since $g^{E-H}(t)$ is exactly her shares' increase in value. For a "normal" buy-and-hold trader directly investing in stock i, it holds

$$\begin{aligned}I_i^{H}(t) &= I_i^{H}(0) + g_i^{H}(t) \\ &= I_i^{H}(t-1) + I_i^{H}(t-1) \cdot \frac{p_i(t) - p_i(t-1)}{p_i(t-1)} \\ &= I_i^{H}(t-1) \cdot \frac{p_i(t)}{p_i(t-1)}\end{aligned}$$

where $g_i(t)$ denotes the cumulated gain of stock i up to time t.

Proposition 3. The investment decision for stock i is the same for buy-and-hold traders directly investing in the index's stocks and for buy-and-hold traders investing in the ETF.

Proof. We use mathematical induction for proving Proposition 3 and show

$$I_i^H(t-1) = I_i^{E-H}(t-1) \Rightarrow \Delta I_i^H(t) = \Delta I_i^{E-H}(t).$$

We define $roi(t) := \frac{p(t)-p(t-1)}{p(t-1)}$ and $roi_i(t) := \frac{p_i(t)-p_i(t-1)}{p_i(t-1)}$. Note that for buy-and-hold traders the investment equals the period gain, i.e., the change of total gain $\Delta g_i^H(t)$, as they do not change the invested amount subsequently. With Equation (2) the investment in an individual stock is given by

$$\begin{aligned}
\Delta I_i^{E-H}(t) &= \Delta I^{E-H}(t)\pi_i(t) + I^{E-H}(t-1)\Delta\pi_i(t) \\
&= \left(I^{E-H}(t) - I^{E-H}(t-1)\right)\frac{p_i(t)}{p(t)} + I^{E-H}(t-1)\left(\pi_i(t) - \pi_i(t-1)\right) \\
&\overset{(3)}{=} I^{E-H}(t-1)roi(t)\cdot\frac{p_i(t)}{p(t)} + I^{E-H}(t-1)\left(\frac{p_i(t)}{p(t)} - \frac{p_i(t-1)}{p(t-1)}\right) \\
&= I^{E-H}(t-1)\left(\frac{p(t)}{p(t-1)}\cdot\frac{p_i(t)}{p(t)} - \frac{p_i(t)}{p(t)} + \frac{p_i(t)}{p(t)} - \frac{p_i(t-1)}{p(t-1)}\right) \\
&= I^{E-H}(t-1)\left(\frac{p_i(t)}{p(t-1)} - \frac{p_i(t-1)}{p(t-1)}\right) \\
&= \frac{I_i^{E-H}(t-1)}{\pi_i(t-1)}\cdot\frac{p_i(t)-p_i(t-1)}{p(t-1)} \\
&= I_i^{E-H}(t-1)\cdot\frac{p(t-1)}{p_i(t-1)}\cdot\frac{p_i(t)-p_i(t-1)}{p(t-1)} \\
&= I_i^{E-H}(t-1)roi_i(t) \\
&= \Delta I_i^H(t).
\end{aligned}$$

□

This equation shows that the buy-and-hold trader is of no interest for us in the analyses of this paper as mentioned although the E-H trader consistently reallocates her investment because of $\Delta\pi_i$ in Equation (2). But this reallocation resp. the E-H trader has the same effects on the market as the "normal" buy-and-hold trader has.

At the end of this section we will show that $D_i^\ell(t) = D^\ell(t)\pi_i(t) \Rightarrow I_i^\ell(t) = I^\ell(t)\pi_i(t)$ by induction. Note that it is an important assumption that all buy and sell orders in the markets are always fulfilled.

Proposition 4. With $I_{(i)}^\ell(t) = I_{(i)}^\ell(t-1)\cdot\frac{p_{(i)}(t)}{p_{(i)}(t-1)} + D_{(i)}^\ell(t)$ it holds

$$D_i^\ell(t) = D^\ell(t)\pi_i(t) \Rightarrow I_i^\ell(t) = I^\ell(t)\pi_i(t).$$

Proof. Fot $t = 0$ it holds $I_i^\ell(0) = D_i^\ell(0) = D^\ell(0)\pi_i(0) = I^\ell(0)\pi_i(0)$. If the proposition is

true for $t-1$ we conduct:

$$\begin{aligned}
I_i^\ell(t) &= D_i^\ell(t) + I_i^\ell(t-1) \cdot \frac{p_i(t)}{p_i(t-1)} \\
&= D_i^\ell(t) + I^\ell(t-1)\pi_i(t-1) \cdot \frac{p_i(t)}{p_i(t-1)} \\
&= D^\ell(t)\pi_i(t) + I^\ell(t-1)\pi_i(t-1) \cdot \frac{p_i(t)}{p_i(t-1)} \\
&= D^\ell(t)\pi_i(t) + I^\ell(t-1)\pi_i(t-1) \cdot \frac{p(t-1)}{p(t)} \cdot \frac{p(t)}{p(t-1)} \cdot \frac{p_i(t)}{p_i(t-1)} \\
&= \frac{p_i(t)}{p_(t)} \left(D^\ell(t) + I^\ell(t-1) \cdot \frac{p(t)}{p(t-1)} \right) \\
&= I^\ell(t)\pi_i(t)
\end{aligned}$$

□

That means, the ETF can fulfill the indexing by simply buying or selling an equal quantity of the stocks in the index.

A.2 Further Market Scenario Examples

In the following, we show two further example developments for specific market situations (scenarios 2 and 3) with C, F, E-C, and E-F. The traders as well as the background are the same as in Section 3.

Scenario 2: rising stock in a bear market In the second case, we assume that the absolute price of stock 1 rises with trend $\mu_1 = 0.1$ while the absolute price of the index falls with trend $\mu = -0.1$. As a consequence the relative price of stock 1 increases. Stock 1 is assumed to be overvalued, the index to be undervalued ($t > 0$). The fundamental values of the stocks are again set to $f_i \equiv 1$. Since stock 1 is overvalued and its price increases (see Figure 6), fundamentalists disinvest from and chartists invest in this stock. Since the index is undervalued and its price falls (see Figure 9), ETF fundamentalists invest on average, while ETF chartists disinvest overall.

Figure 8 depicts the investment of the four types of traders in stock 1. ETF chartists implicitly disinvest more and more of stock 1 as its relative price π_1 and thus its relative weight in the index rises (see Figure 7). The level effect of the ETF chartist causes a disinvestment in stock i which is even amplified through a high ratio of stock 1 in the index. The rebalancing effect through an increase of $\Delta\pi_1$ cannot compensate this. In contrast, ETF fundamentalists invest more in stock 1 as its relative price (weight) increases. While they invest in stock 1 as part of investing in the ETF due to the undervaluation of the index (level effect), they overproportionally invest in stock 1 due to its high ratio in the index, which is even increasing (rebalancing effect). The investment in the other assets (Figure 10) does not show significant changes over time. Again we find

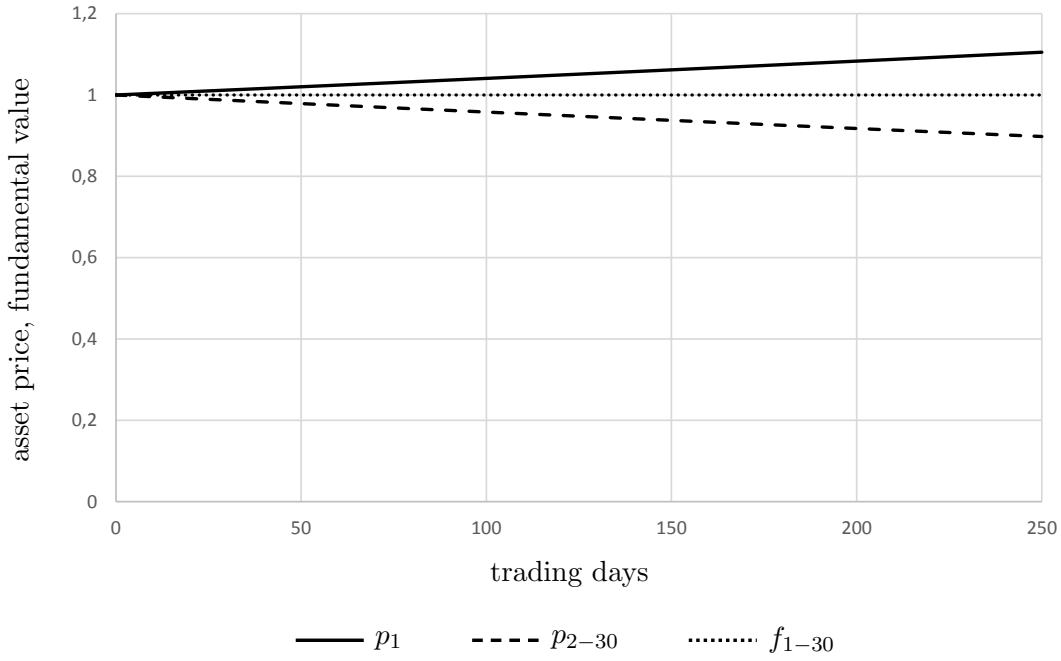

Figure 6: Price paths p_1 of stock 1 and p_{2-30} of stocks 2-30 in scenario 2.

the counterintuitive effects that implicitly ETF fundamentalists invest in an overvalued stock thereby destabilizing the market, while ETF chartists disinvest from a rising stock with a stabilizing effect on the market.

Scenario 3: falling stock in a bull market with the index crossing its fundamental value from below For the third scenario, we assume a bull market in which a specific stock falls. The index's price starts below its fundamental value and is undervalued at first, but later due to trend $\mu = 2$ surpasses its fundamental value. Stock 1 is undervalued and its price falls against the general market trend with rate $\mu_1 = -0.5$ (see Figures 11 and 14). For expositional reasons, the fundamental value of the index is set to $f \equiv 30 \cdot 1.3$, i.e., the fundamental values of the individual stocks are set to $f_i \equiv 1.3$.

As has been discussed above, the calculus of ETF and single stock chartists and fundamentalists is straightforward. In the case of index investors, ETF chartists invest, while ETF fundamentalists first invest in the undervalued index and later disinvest from the overvalued index ETF. In case of stock 1 fundamentalists invest as the stock is undervalued while chartists disinvest (see Figure 13).

Again, we analyze how the investment decisions of ETF investors affect stock 1 and how this compares to the behavior of investors that only target stock 1. ETF chartists invest overall due to the index's rising price. On the level of stock 1 they implicitly invest less and less as its relative price π_1 and thus its relative weight in the index declines (see Figure 12). The level effect of E-C investment decreases as less of the newly invested

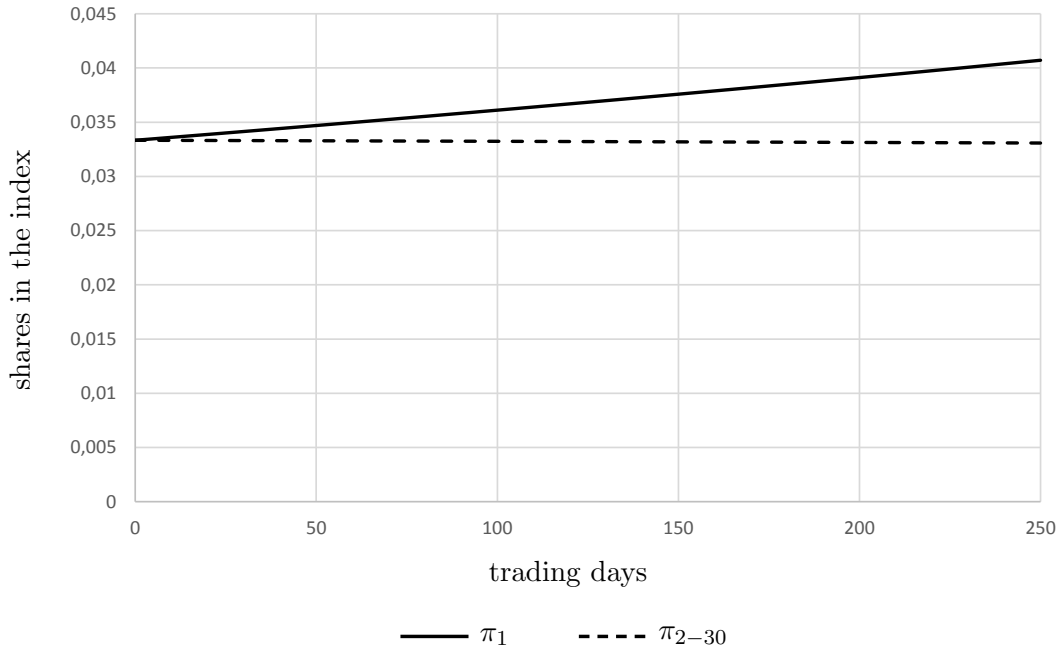

Figure 7: Change of the ratio π_1 and π_{2-30} of stock 1 and stocks 2-30, resp., in scenario 2.

money ΔI^{E-C} is allocated to stock 1, and due to rebalancing, E-C investors disinvest from stock 1 to account for the reduced weight of stock 1 in their overall portfolio I^{E-C}.

ETF fundamentalists pursue similar investments as long as stock 1 is undervalued (see Figure 13). Once the index's price surpasses its fundamental value they switch to disinvesting from the index and implicitly stock 1 due to the overvaluation of the index (see Figure 14). Due to the need to rebalance their portfolio because of the falling relative weight of stock 1, they implicitly invest in stock 1 to assure the correct portfolio allocation. As the relative price of stock 1 continues to fall the positive rebalancing effect eventually dominates the level effect. In the mean time ETF fundamentalists have disinvested from an undervalued stock. The ETF fundamentalist's investment behavior in stock 1 suddenly changes although neither the trend nor the fundamental value of stock 1 changes. Concerning stocks 2-30 (Figure 15), we see that both the fundamentalist and the ETF fundamentalist suddenly disinvenst when they get overvalued (Figure 11). This behavior is just as expected.

To sum up, ETF chartists invest for some time in a falling stock, while ETF fundamentalists disinvest from an undervalued stock. Also in this case ETF chartists tend to stabilize, while ETF fundamentalists tend to destabilize stock price developments. This behavior is somewhat counterintuitive.

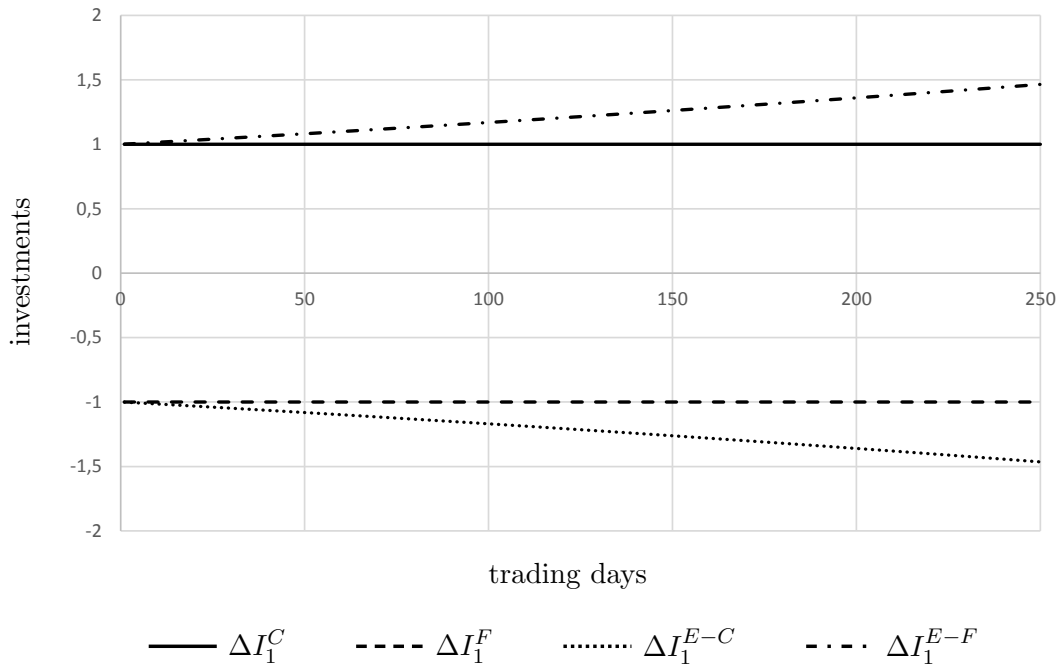

Figure 8: Investment ΔI_1^ℓ in stock 1 if this stock is rising when the index falls (scenario 2).

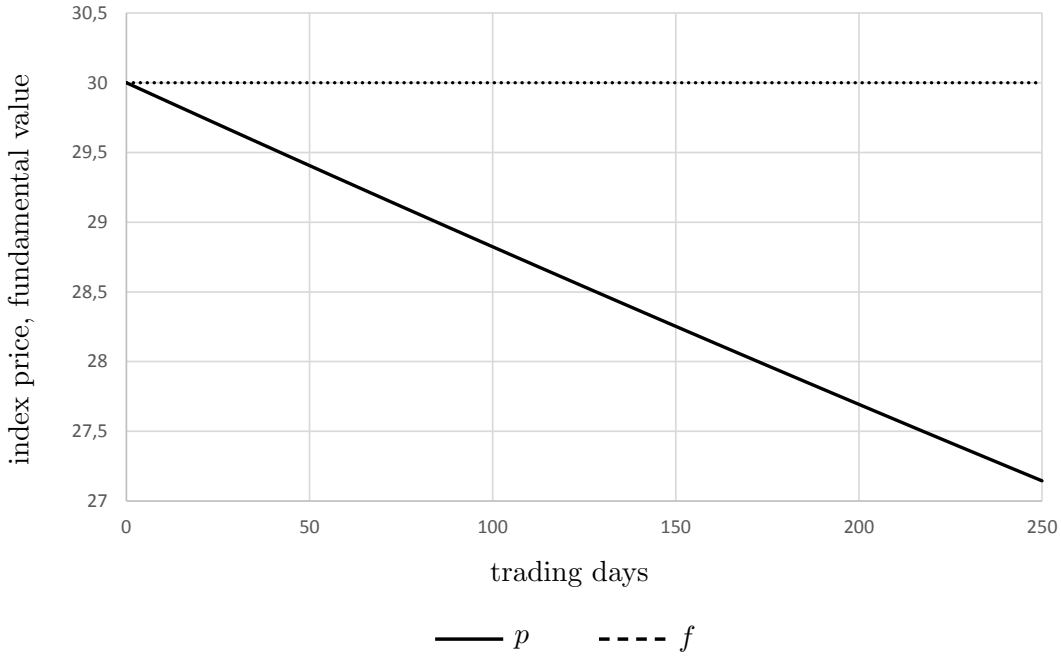

Figure 9: Price path p of the index in scenario 2.

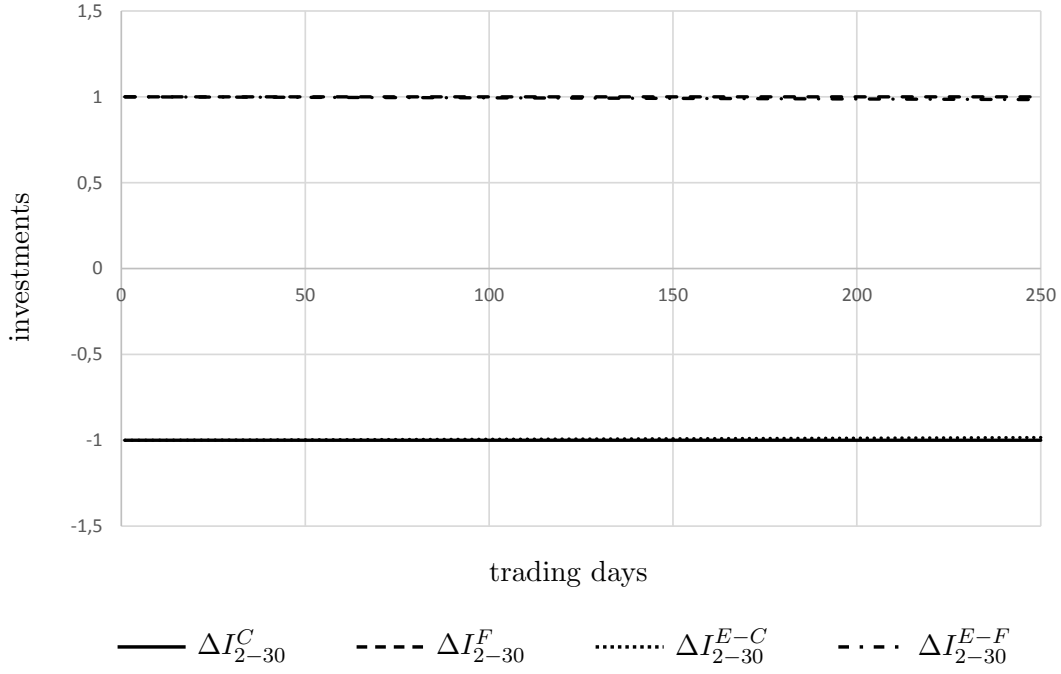

Figure 10: Investment ΔI^{ℓ}_{2-30} in stocks 2-30 in scenario 2.

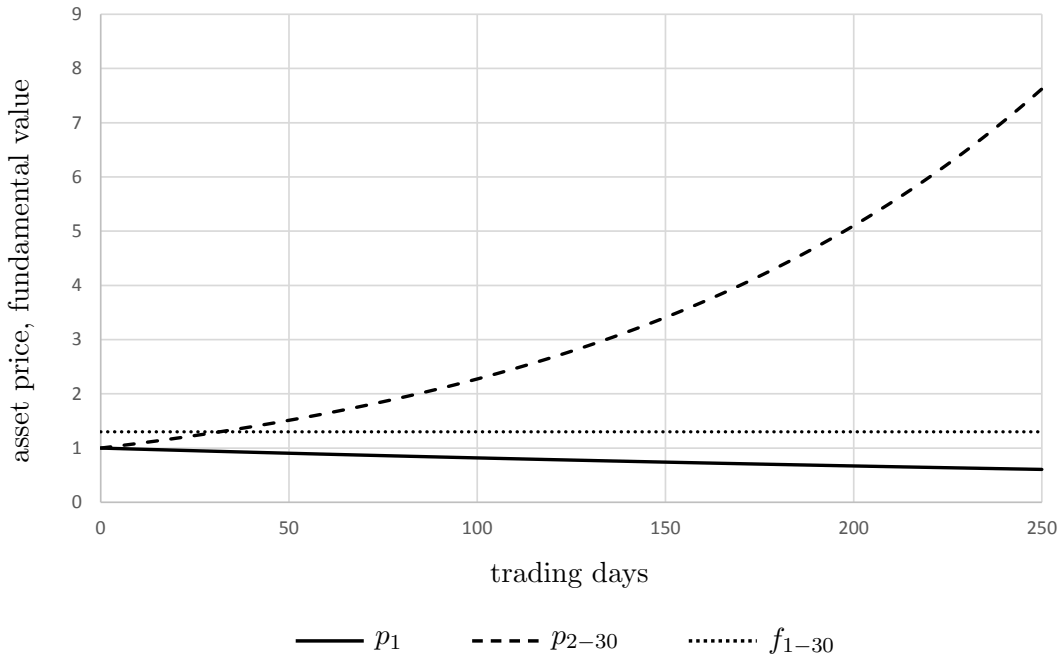

Figure 11: Price paths p_1 of stock 1 and p_{2-30} of stocks 2-30 in scenario 3.

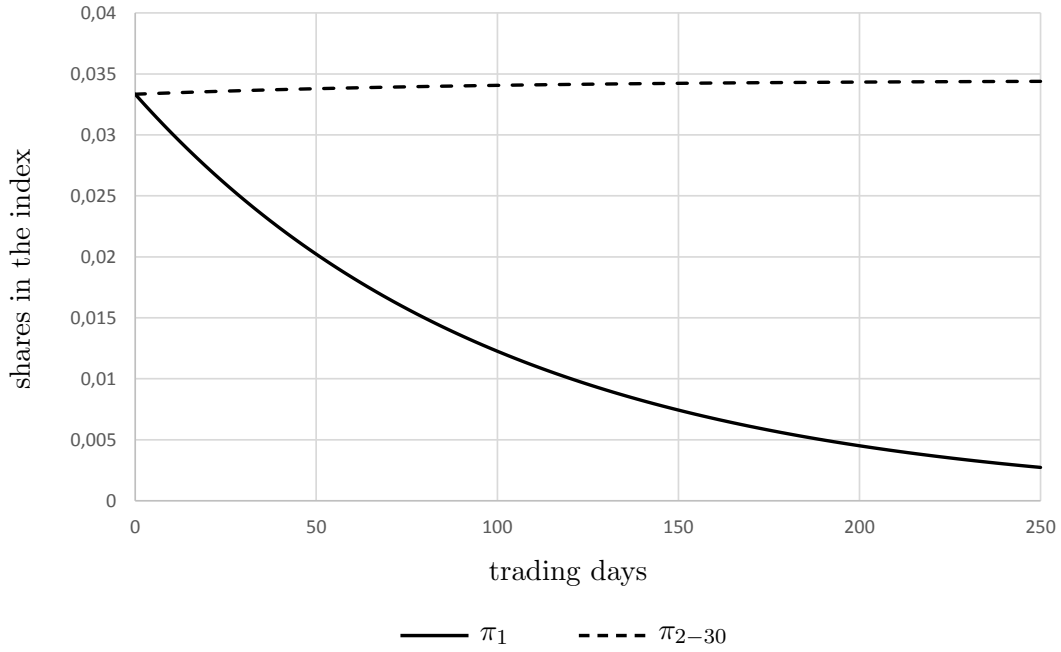

Figure 12: Change of the ratio π_1 and π_{2-30} of stock 1 and stocks 2-30, resp., in scenario 3.

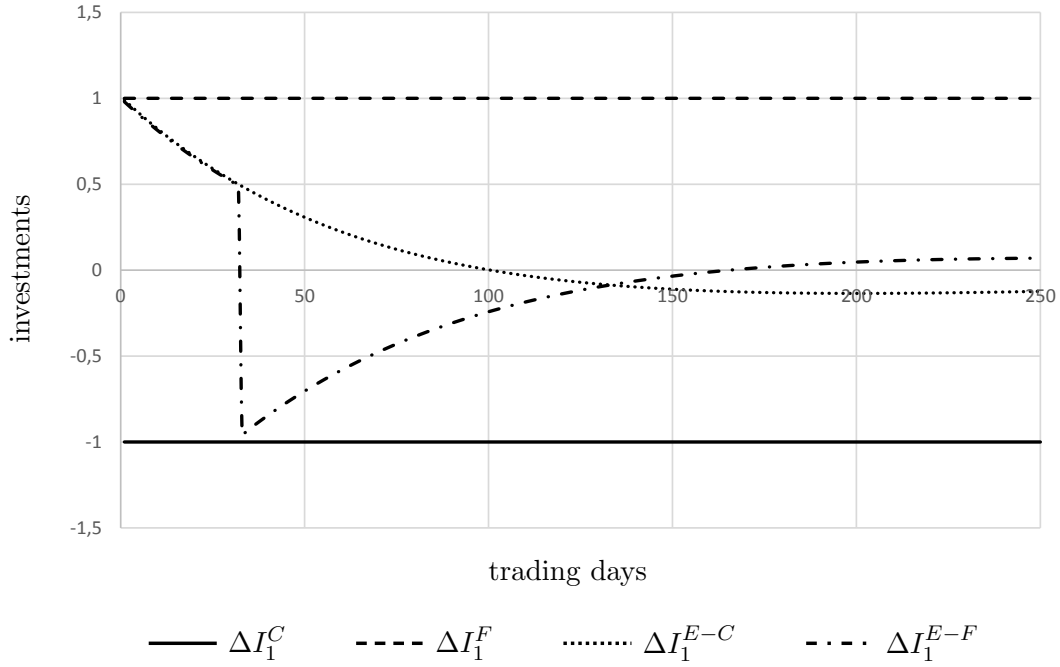

Figure 13: Investment ΔI_1^ℓ in stock 1 if this stock is falling when the index rises and crosses its fundamental value from below (scenario 3).

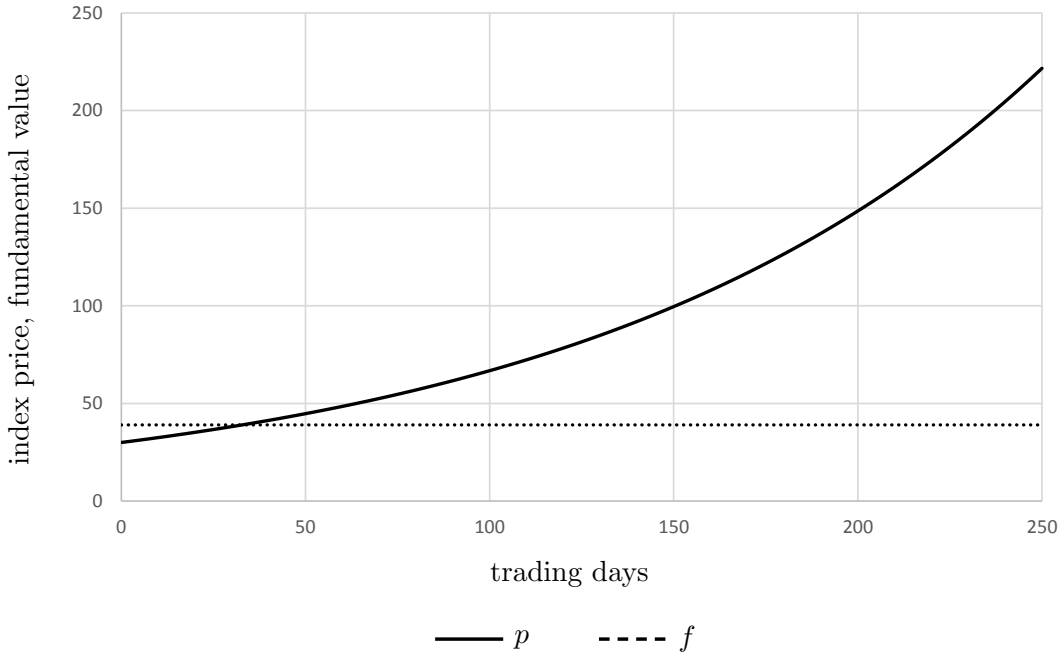

Figure 14: Price path p of the index in scenario 3.

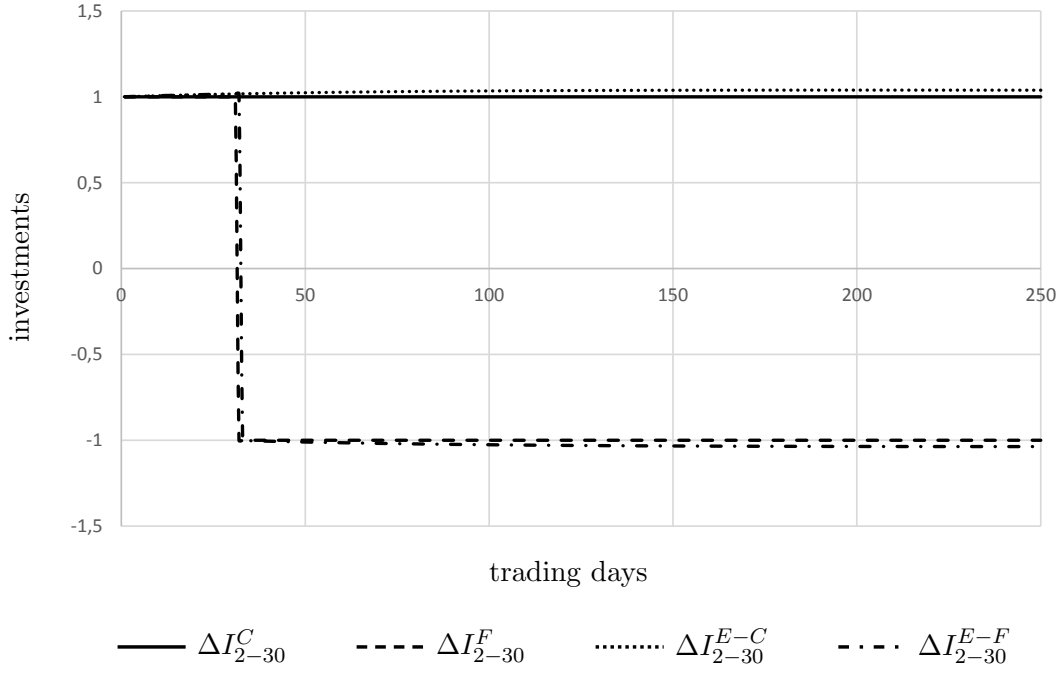

Figure 15: Investment ΔI^{ℓ}_{2-30} in stocks 2-30 in scenario 3.