SUSTAINABLE INVESTMENTS IN TIMES OF CRISIS

THE IMPACT OF COVID-19 ON GREEN AND BROWN FUNDS IN THE SWEDISH PREMIUM PENSION SYSTEM

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Abstract:

This paper examines the effect of Covid-19 on green and brown funds in the Swedish Premium Pension System (PPS). We apply the methodology derived in Berk and van Binsbergen (2015) in a difference-in-difference model with time-fixed effects to estimate the average effect of Covid-19 on green funds for both value added and conventional alpha measures. We find that, prior to the pandemic, green funds managed more money relative to brown funds, but green fund managers were compensated less compared to their conventional counterparts because of lower fees. After the pandemic, the relative difference in assets under management grew, and managerial compensation for green funds increased accordingly. Our results, obtained using three benchmarking methods to calculate abnormal return, suggest a relative decrease in gross alpha for green funds after the outbreak of Covid-19, primarily due to substantial inflows of capital. However, the effect on gross alpha is not statistically significant. We document a relative increase in value added for green funds during the pandemic, which is primarily attributable to larger cross-sectional differences in assets under management. Our findings contribute to a diverse body of literature on sustainable investments in crisis and provide Swedish pension savers with novel insights.

Keywords:

Funds' value added, Gross and net alpha, Covid-19, ESG, Green and brown funds

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1 Introduction

In recent years, there has been a gradual rise in environmental consciousness worldwide, leading to noticeable shifts in human consumption, production, and investment behavior. The integration of ESG-reporting into investment practices by a diversified range of mutual funds has brought sustainable finance to the forefront of nascent research. Following the outbreak of Covid-19 in the beginning of 2020, there has been a notable surge in ESG preferences. Early research indicates that, while most active funds underperform passive benchmarks, green funds perform better relative to their traditional counterparts (Pástor and Vorsatz, 2020). The fact that investors maintain their emphasis on sustainability during a worldwide crisis suggests that they perceive sustainability as a prerequisite rather than a luxury. The upward trend of sustainable finance, coupled with the ongoing debate on the performance of ESG funds, highlights the pivotal importance of understanding the dynamics of socially responsible investing.

Given prior research on the financial performance of sustainable investments, we want to further investigate to what extent the greenness of a fund impacts the ability of a fund manager to generate value during periods of financial turbulence. In doing so, we synthesize previous literature that has primarily focused on measuring the skill of actively and passively managed equity funds with a diverse body of research that examines the tradeoff between sustainability and the financial performance of ESG funds. On the one hand, as green funds seem more attractive to the public, they can potentially charge higher fees for less value added. On the other hand, due to self-imposed restrictions, green funds are more limited in the set of investments they can make. Exploring the dynamics of these competing forces, ex-post an exogenous shock to the economy, introduces a more profound dimension to the analysis of sustainable investments in times of crisis.

This study estimates the value added of green and brown funds pre and post Covid-19 to examine the ex-post effect of the pandemic on the value green and brown fund managers can extract from financial markets. To estimate the average effect of the pandemic on value added of green funds, we construct a difference-in-difference model with time-fixed effects. This enables us to observe and control for unobserved heterogeneity that may vary over time but is constant across funds, which allows for time-varying factors that influence the value added of green and brown funds. We compare the difference in value added before the outbreak of Covid-19 with the relative increase or decrease after the pandemic for green and brown funds to test whether there is a significant effect on the value fund managers generate. Consequently, this paper aims to answer the following research question:

> *Does the value fund managers generate differ between green and brown funds during periods of financial distress?*

Our model extends the work conducted by Berk and van Binsbergen (2015) by examining how the value that actively managed equity funds generate differs between green and brown funds during periods of financial distress. In their paper, Berk and van Binsbergen define managerial skill as the product of assets under management (AUM) and the excess return. The authors calculate the excess return by benchmarking the funds against the net return of 10 index funds and against the risk-adjusted Fama-French-Carhart four-factor model. We extend their work by using the state-default fund, the AP7 Equity Fund, in addition to the tradeable and theoretical benchmarks, to compute the abnormal return for green and brown funds in a comparison pre and post Covid-19.

The main contribution of our paper is to apply the same methodology to calculate the value added of actively managed equity funds pre and post Covid-19 to capture the treatment effect on green funds. More specifically, we calculate value added and value added net of managerial compensation, relative to the benchmarks, pre and post Covid-19. To form a more robust analysis to understand the dynamics that govern value added, we also investigate the treatment effect on AUM and managerial compensation, which

is defined as the product of AUM and the percentage fee that the fund charges. We use our difference-in-difference model to divide value added into the part that is taken out by fund managers as compensation and the part that is generated to investors, which we call value added net of managerial compensation. The analysis is further nuanced by estimating the ex-post effect of Covid-19 on the conventional measures of skill; gross and net alpha. When comparing these results, several insightful conclusions can be drawn in relation to Berk and van Binsbergen (2015).

Most prior literature on the relative performance of socially responsible funds, as well as the study by Berk and van Binsbergen (2015), have been concentrated on US mutual fund returns. We will, however, in line with Anderson and Robinson (2022), use data from the Swedish Pension Agency. The data set provided in the Swedish Premium Pension System (PPS) is feasible to conduct this study on since it contains a fixed component where 2,5% of participants' pensionable income is invested in mutual funds. Furthermore, the PPS contains pension savings data on 6,3 million working citizens in Sweden, and it includes a total of 482 funds (Pensionsmyndigheten, 2023).

We motivate our choice to use Swedish pension data based on its high representativeness and lack of industry bias, which increase the robustness of our results and contributes to the originality of this study. Moreover, the Swedish Pension System has been under public scrutiny in recent years after multiple pension funds have been caught gambling with investors' money and defrauding Swedish pension savers (Sveriges Radio, 2017; Lindeberg, 2023). Thus, our research on the relative performance of green and brown funds amidst the pandemic, seeks to increase the financial literacy and awareness among current and future pension savers.

We find that green funds exhibited higher assets under management in comparison to brown funds prior to the onset of the pandemic. However, our analysis reveals that managers of green funds received comparatively lower compensation in relation to their traditional counterparts. Following the outbreak of Covid-19, there was a notable increase in the relative disparity in assets under management between green and brown funds. We find that managerial compensation for green funds exhibited a relative rise compared to that of brown funds, indicating that compensation for green fund managers increased in line with the accumulation of more assets under management during the pandemic. The conventional measures of skill, gross and net alpha, saw a relative decline for green funds relative to brown funds following the pandemic. When employing three benchmarking methods, our findings suggest a relative increase in value added for green funds after the pandemic, thus contradicting the estimates for gross alpha. However, this effect lacks statistical significance. With the escalation of Covid-19, the increasing cross-sectional differences in AUM between green and brown funds coincided with a relative decline in value added net of managerial compensation for green funds, which is consistent with the trend observed for net alpha. Again, there is mutual consensus among the three benchmarking methods, but neither the pre-treatment difference, nor the interaction term, is statistically significant.

The remainder of this paper is structured as follows. In Section 2, we chronicle previous literature on mutual fund performance during periods of financial distress and develop our hypotheses for this paper. In Section 3, we describe the data collection and give an overview of the Swedish premium pension system. In Section 4, we outline the methodology Berk and van Binsbergen (2015) use to calculate the value added of a mutual fund and motivate our three benchmarking approaches. We also carefully explain why value added, according to Berk and van Binsbergen (2015), is a more accurate measure of skill than any conventional alpha measure, as previous literature has relied upon. Moreover, we construct our difference-difference model and test whether the parallel trends assumption holds. In Section 5, we present our empirical results and in Sections 6 and 7, we discuss our findings and provide concluding remarks.

2 Literature Review

2.1 Related Literature

The performance of socially responsible investments (SRI) during periods of financial distress is a heavily researched topic. In one of the first studies on the financial performance of green funds, White (1995) compares the performance of green funds in the US and Germany to the overall market. The paper finds that US green funds underperform the overall stock market while, in Germany, the performance of green funds does not significantly differ from the overall market. In a more recent paper, Climent and Soriano (2011) adopt a CAPM-based methodology to examine the performance of US green funds relative to their traditional counterparts. They find that green funds generated lower returns compared to their conventional peers from 1987-2001. However, during the period 2001-2009, green funds did not perform significantly different from conventional mutual funds. This is relevant to our paper since we investigate the value generated by green and brown funds during the pandemic with the same theoretical benchmark.

Adler and Kritzman (2008) examine the impact of socially responsible investing on portfolio performance. They argue that SRI involves a tradeoff between social responsibility and financial performance, and they seek to quantify this tradeoff by analyzing the costs associated with implementing SRI strategies. Using Monte Carlo simulation, the authors estimate the cost of investing in SRI to be between 0,08% and 2,71% in annual returns due to the self-imposed restrictions of such funds.

Another influential paper on this subject is written by Nofsinger and Varma (2014). Using data on US equity funds for the period 2000-2011, they test whether socially responsible funds lower downside risk for investors during periods of financial turbulence. The paper concludes that SRI funds tend to outperform conventional mutual funds during poor market conditions. However, they caution that this downside risk reduction comes at the expense of lower expected returns during normal times. Evidence from this paper bears a striking resemblance to the findings in Glode (2011), which postulates that increased demand for actively managed funds among investors could be attributed to the active managers' capacity to outperform during adverse market conditions, as opposed to favorable ones. We contribute to these findings by measuring the performance of green and brown funds in absolute terms, i.e. abnormal return times AUM, rather than as alpha measures, thus adding an additional layer to the debate between social responsibility and financial performance during periods of financial distress.

A similar study, conducted by Albuquerque, Koskinen, Yang, and Zhang (2020), reveals that U.S. stocks with high environmental and social ratings earn higher returns during the first quarter of 2020 relative to the overall market. The authors attribute this resiliency to increased investor loyalty for sustainable firms during times of crisis. These findings are in line with the fund-level data collected in Pástor and Vorsatz (2020), where the authors reaffirm that green assets can outperform brown assets during periods in which investors' preferences shift towards sustainable investments. Both the study by Albuquerque et al. (2020) and the research conducted by Pástor and Vorsatz (2020) indicate that this shift in preferences became more pronounced during the pandemic. Our research contributes to the existing literature by examining the evolution of investors' demand for sustainable investments in the post-Covid-19 period. We analyze data spanning from 2018 to 2023 to gain insights into this phenomenon.

The key paper for our analysis is Berk and van Binsbergen (2015) and our work extends their model. They contend that managerial skill should be estimated as the value fund managers generate, rather than gross or net alpha. This argument, initially put forward by Berk and Green (2004), suggests that managerial skill is a scarce resource and that managers face decreasing returns to scale in terms of positive net present value (NPV) investment opportunities. The authors quantify managerial skill as the product of gross alpha and AUM, and they show that the average mutual fund manager has been able to use this

skill to generate approximately $3,2 million per year. They find that large cross-sectional differences in value added is primarily attributable to the size of the fund and not gross alpha.

We adopt the same methodology of calculating funds' value added and introduce an additional benchmark to obtain the excess return of the funds in our sample. In addition to the linear projection and theoretical risk-adjusted return, we benchmark the return of green and brown funds in the PPS against the state-default fund available to all Swedish investors in the pension system. Furthermore, we calculate the value added and value added net of managerial compensation for green and brown funds pre and post Covid-19 to capture the ex-post effect on the managerial compensation of green funds and the respective value generated to investors. To the best of our knowledge, no literature on this topic has applied the value added measure in a difference-in-difference model to uncover the ex-post effect of an exogenous shock on green and brown funds. In addition, Berk and van Binsbergen (2015) solely focus on measuring value added, whereas we also decompose value added into value added gross and net of managerial compensation. The findings in this paper will not only offer valuable insights to industry professionals, but also be of importance to the millions of Swedish working citizens who are, or soon will be, registered in the PPS.

2.2 Hypothesis Development

In light of previous findings on the performance of green and brown funds during financial distress, we formulate the following hypotheses:

i. Given the rise in SRI post Covid-19, we hypothesize that there will be a greater inflow of capital to green funds relative to brown funds following the pandemic.

This hypothesis is based on the findings by Nofsinger and Varma (2014). The paper postulates that one explanation for the recent increase in the number, and AUM, of green funds is that socially responsible companies have a lower risk profile under turbulent market conditions, which, according to Glode (2011), compensates for underperformance in normal times. The paper by by Albuquerque et al. (2020), as well as the findings in Pástor and Vorsatz (2020), reveal that investors tend to favour sustainability in their capital allocation choices during times of financial distress. We expect to identify a similar surge in the relative size of green funds in the PPS following the outbreak of Covid-19.

ii. Accordingly, we hypothesize that there will be a reduction in expected abnormal return for green funds after the outbreak of Covid-19.

This prediction is based on the paper by Berk and van Binsbergen (2015). Given the predicted inflows in green funds relative to brown funds after the pandemic, we speculate that fund managers, as also discussed in Berk and Green (2004), will face decreasing returns to scale in terms of NPV positive investment opportunities. Accordingly, we may see a reduction in expected gross and net alpha. However, from a realized return perspective, we may identify a rise in abnormal return measured because a large body of literature suggests that green funds outperform their traditional counterparts during times of distress, see Nofsinger and Varma (2014); Albuquerque et al. (2020); Pástor and Vorsatz (2020). Given that a fund's value added is defined as the product of abnormal return and AUM, the following study will investigate which force dominates; either decreasing returns to scale or inflow of capital into the green funds. While Berk and van Binsbergen (2015) primarily attribute cross-sectional differences in value added to differences in AUM rather than in gross alpha, we will explore which force dominates in this context.

3 Data Collection

The Swedish Pension Agency has been the primary source of information and data collection for our study. This is primarily because the Swedish pension system contains a mandatory component where 2,5% of people's pensionable earnings is converted into fund units that can subsequently be invested into the Premium Pension System. Investors who do not make an active decision have their money automatically invested in the state-default fund called "AP7 Såfa" (Pensionsmyndigheten, 2023). By using Swedish pension data, we obtain a nationally representative sample without any risk of self-selection issues related to wealth, which could be the case if examining stock-market data. The characteristics of the Swedish pension system has been outlined in Engström and Westerberg (2003), Cronqvist and Thaler (2004), and in Palme, Sunden, and Söderlind (2007). In a recent study, Anderson and Robinson (2022) also use premium pension data to explore the relationship between financial literacy and green investment behavior by testing whether pro-environmental households are more likely to hold pro-environmental investments. We will now provide a brief description of the Swedish Premium Pension system to help explain our methodology.

3.1 The Swedish Premium Pension System

Following a nation-wide reform in 1999, the Swedish pension system today consists of three different components; general pension from the state of Sweden, which is administered by the Swedish Pension Agency, service pension through former employer(s), and personal retirement savings. The premium pension is part of the general pension where earned money is invested in funds. Each year, all registered working citizens may invest 2,5% of their individual pension account in up to five funds from a pool of 482 funds available as of January 2023. There are approximately 6,3 million participants in the PPS as of January 2023 (Pensionsmyndigheten, 2023).

Once a participant has chosen an allocation of funds, all future contributions are invested according to that allocation until the participant reallocates the selection of funds. The state default fund, AP7 Såfa, is the most popular fund among investors (Pensionsmyndigheten, 2023). This is a well-diversified fund that is a combination of two funds: AP7 Equity Fund and AP7 Fixed Income Fund. The distribution between the equity and fixed-income funds is adjusted for each individual investor's age. Up until the age of 55, the entire pension is invested into the equity fund. At the age of 56, the proportion invested in the AP7 Fixed Income Fund gradually increases while the proportion invested in the AP7 Equity Fund decreases until reaching an allocation of 67% fixed income and 33% equity at the age of 75 (AP7, 2023). The purpose of this transition is to enable high returns early in life and then subsequently lower the risk profile once the investor is approaching retirement (Pensionsmyndigheten, 2023).

In 2019, the Swedish Parliament imposed new requirements and contractual terms for fund companies that want to establish or maintain funds on the premium pension fund market (Sveriges Riksdag, 2018). The new requirements for fund companies include, among other things, more than 500 MSEK in AUM per fund outside the PPS, at least three years of operating history, and new minimum requirements for sustainability reporting. Since green and brown funds are subject to the same criteria, a comparative study between the two is feasible.

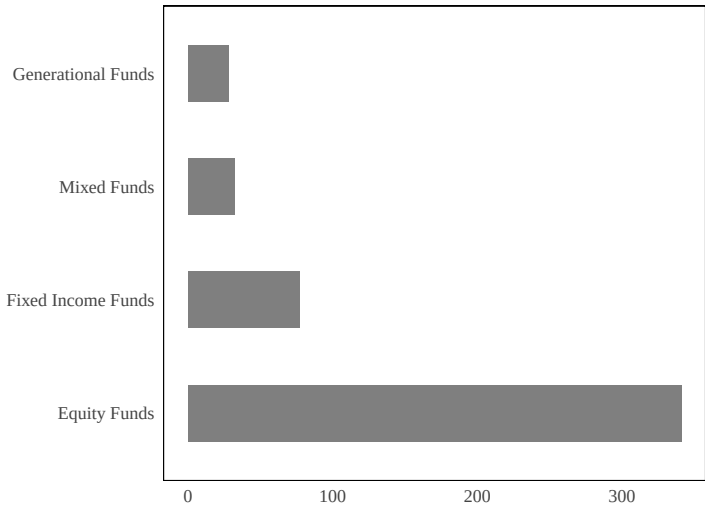
3.2 Data set

Monthly statistics on AUM, along with other relevant data such as Morningstar ESG-ratings, fees gross of discount, and fund categories, have been sourced from spreadsheets provided by the Swedish Pension Agency. Moreover, the geographical scope of a fund, that is, whether it invests in domestic or foreign equities, has also been collected from the Swedish Pension Agency. To ensure more precise estimations,

the monthly net return for each fund was extracted from Refinitiv Eikon, which provides net returns with two decimal places. Although the Swedish Pension Agency also provides information on monthly net returns, this data was rounded to integers. Furthermore, the funds' market betas and the daily bid yield of the 10-year Swedish government bond, which has been used to estimate the risk-free rate, were also extracted from Refinitiv Eikon. All data is collected for the relevant period of our study, that is, from January of 2018 to January 2023.

The data set on 31st January 2023 includes 482 mutual funds, in addition to the AP7 default funds. After removing funds with insufficient data, we are left with a total of 478 funds. The Swedish Pension Agency has already assigned categories to each fund. See Figure 1 for a summary of the asset categories for these funds.

Figure 1: Distribution of Funds across Asset Categories in the Premium Pension System (PPS)



The figure illustrates the distribution of funds across asset categories. The 478 funds available in the PPS as of January 2023 consist of 341 Equity Funds, 77 Fixed Income Funds, 32 Mixed Funds, and 28 Generational Funds.

3.3 Data Cleaning

The first step in the data cleaning process is to exclude all funds investing in fixed-income securities. There are a total of 77 funds investing in domestic and foreign short and long-term bonds that we remove. There are also 32 mixed funds that invest in multiple asset classes, which we exclude for the same reason. Generational funds are designed according to the age group of investors. They mostly contain shares in equity when there is a long time left until retirement. As an investor is approach retirement age, the money is gradually transferred from equities to interest-bearing securities to reduce the risk profile of the portfolio. The state-default fund AP7 Såfa is one example of a generational fund (Pensionsmyndigheten, 2023).

The Swedish Pension Agency has divided all generational funds into two subgroups; if the pension occurs in less than 10 years or if the pension occurs in more than 10 years (Pensionsmyndigheten, 2023). We remove all generational funds that mature in less than 10 years since they mainly contain fixed-income securities to form a lower risk profile. We do, however, include generational funds for people that retire in more than 10 years because they have yet to begin the process of transferring equity holdings to interest-bearing securities. This leaves us with a total of 355 equity funds.

The second step in the data cleaning process is to separate actively managed equity funds from passive index funds. To facilitate this process, we consulted a data analyst at the Swedish Pension Agency who

provided us with a full list of the passively and actively managed equity funds in the PPS. When removing 45 passive equity funds, we are left with 310 actively managed equity funds. We also exclude four Russian equity funds as these were closed for trading on February 28, 2022, in the premium pension fund market following Russia's invasion of Ukraine (Pensionsmyndigheten, 2022).

The third, and final step, is to create a balanced panel data set that allows us to test for the ex-post effect of Covid-19 on value added for green and brown funds. This is done by limiting our sample to active equity funds that have existed in the PPS for the entire five-year period we are examining, that is, from January 2018 to January 2023. As such, we remove all funds that are added or excluded from the PPS during this period as well as those funds that do not posit an ESG-Moringstar rating. Although this may lead to concerns about survivorship bias, we construct a balanced data set because it allows for an observation of the same unit in every time period, which reduces the noise inferred by unit heterogeneity in the case of unbalanced panels (Aptech, 2019). One could question why we have not complemented our data set from the Swedish Pension Agency to address this concern. The reason for this is that it proved very difficult to manually extract data on the approximately 300 funds that were removed from the PPS in 2019. Furthermore, ESG-Morningstar ratings were introduced to the PPS in 2020, which would make it impossible to categorize these funds into a treatment and control group for our study. Additionally, one could argue that, following the updated requirements on fund companies in the PPS, all funds listed on the premium pension market are subject to an inherent selection bias. Since both green and brown funds are subject to the same criteria, however, a comparative study remains feasible.

For the remainder of our study, we have 231 actively managed equity funds across 61 months in our sample. Based on the median ESG-Morningstar rating, these are divided into 110 green funds and 121 brown funds. See Table 12 and Table 13 for a list of the funds in each group, (see Appendix).

Table 1: Summary Statistics Green Funds

Variables	Mean	Median	Std	p10	p90	Observations
Assets Under Management	3.218,03	881,55	7.075,50	16,04	7.990,47	6710
Gross Alpha						
Linear Projection	1,29%	1,08%	2,10%	-0,43%	3,30%	6710
CAPM	1,31%	1,12%	3,17%	-1,70%	4,62%	6710
AP7 Equity Fund	1,08%	0,92%	3,32%	-2,15%	4,66%	6710
Percentage Fee	1,30%	1,40%	0,61%	0,41%	1,82%	6710
Net Alpha						
Linear Projection	-0,01%	-0,03%	2,00%	-1,77%	1,73%	6710
CAPM	0,01%	0,01%	3,11%	-3,07%	3,08%	6710
AP7 Equity Fund	-0,22%	-0,28%	3,27%	-3,53%	3,15%	6710
Value Added						
Linear Projection	26,62	5,02	113,59	-2,52	68,93	6600
CAPM	29,37	3,02	205,08	-17,20	93,15	6600
AP7 Equity Fund	22,16	1,44	206,30	-29,34	87,22	6600
Managerial Compensation	26,16	8,08	63,62	0,18	64,49	6600
Value Added Net of Managerial Compensation						
Linear Projection	0,46	-0,02	92,14	-23,71	25,72	6600
CAPM	3,21	0,01	189,70	-44,39	52,02	6600
AP7 Equity Fund	-4,00	-0,15	196,37	-60,90	50,16	6600

The table reports summary statistics for green funds of the variables Assets Under Management (AUM), Gross Alpha, Percentage Fee, Net Alpha, Value Added, Managerial Compensation (MC), and Value Added Net of Managerial Compensation from January 2018 to January 2023 across all three benchmarking methods. AUM, Value Added, and MC are calculated in MSEK. Gross Alpha, Percentage Fee, and Net Alpha are calculated in percentages. The data covers 110 green funds over 61 months.

Table 2: Summary Statistics Brown Funds

Variables	Mean	Median	Std	p10	p90	Observations
Assets Under Management	1.284,33	293,26	3.294,04	231,31	2.957,00	7381
Gross Alpha						
Linear Projection	1,67%	1,64%	2,53%	-0,85%	4,28%	7381
CAPM	1,59%	1,56%	4,04%	-2,73%	6,05%	7381
AP7 Equity Fund	1,37%	1,39%	4,16%	-3,21%	6,05%	7381
Percentage Fee	1,71%	1,69%	0,39%	1,29%	2,15%	7381
Net Alpha						
Linear Projection	-0,05%	-0,07%	2,51%	-2,55%	2,48%	7381
CAPM	-0,12%	-0,15%	4,03%	-4,45%	4,31%	7381
AP7 Equity Fund	-0,35%	-0,34%	4,16%	-4,90%	4,36%	7381
Value Added						
Linear Projection	17,60	2,51	68,91	-1,76	44,27	7260
CAPM	16,84	3,02	205,08	-10,63	54,22	7260
AP7 Equity Fund	13,83	1,19	125,01	-15,04	51,88	7260
Managerial Compensation	19,20	4,14	48,58	0,43	45,51	7260
Value Added Net of Managerial Compensation						
Linear Projection	-1,60	-0,04	92,14	-1,61	14,82	7260
CAPM	-2,36	-0,08	109,16	-29,49	28,10	7260
AP7 Equity Fund	-5,36	-0,18	122,55	-35,09	26,29	7260

The table reports summary statistics for brown funds of the variables Assets Under Management (AUM), Gross Alpha, Percentage Fee, Net Alpha, Value Added, Managerial Compensation (MC), and Value Added Net of Managerial Compensation from January 2018 to January 2023 across all three benchmarking methods. AUM, Value Added, and MC are calculated in MSEK. Gross Alpha, Percentage Fee, and Net Alpha are calculated in percentages. The data covers 121 brown funds over 61 months.

4 Methodology

In this section, we illustrate the methodology used to derive our empirical results. The first section motivates the underlying reasoning for using value added to measure the skill of fund managers. The second section details the methods we used to calculate a funds' value added. The third section presents our choice of benchmarks, and the fourth section presents our difference-in-difference model.

4.1 Why alpha is not an accurate measure of skill

While previous literature has used gross and net alpha to measure skill, Berk and van Binsbergen (2015) claim that managerial talent should be estimated as an absolute measure rather than a ratio. This proposition builds on the theory proposed by Berk and Green (2004), which suggests that managerial skill is a limited resource and fund managers experience diminishing returns as the fund size becomes larger.

$$\alpha_i^* = a_i - b_i q \tag{1}$$

This equation demonstrates the alpha that manager i generates from active management where $a_i > 0$ is the alpha on the first cent that the manager invests and $b_i > 0$ captures the decreasing returns of scale the manager faces. The extent of these decreasing returns to scale is dependent on the value of q, which denotes the fund size. Berk and Green (2004) show that, as a mutual fund grows in size, it becomes increasingly difficult for fund managers to generate net alpha. Any non-zero net alpha investment opportunities available to managers will eventually be eliminated, leading to an aggregate net alpha of zero for all managers. If skill is a scarce resource, then the net alpha will be determined by competition between investors, and not necessarily the skill of managers. Hence, as Berk and Green (2004) argues, net alpha alone can not be used to measure the skill of fund managers.

Based on this insight, some papers have proposed that gross alpha is a correct measure of skill. Expanding on eq. (1), Berk and van Binsbergen (2015), however, demonstrate that gross alpha only measures skill under the condition that all fund managers set their fees so that all funds have the same AUM, thus making the size of the fund unimportant. Assuming that investors are rational and markets are competitive, this will lead to an aggregate gross alpha that is equal to the fee charged.

The main argument for using an absolute measure to quantify skill rather than a return measure is that the latter does not assess the amount of money a mutual fund is able to extract from financial markets (Berk and van Binsbergen, 2015). For example, according to conventional alpha measures, a fund with 10 MSEK in AUM that generates 10% in gross or net alpha would outperform a fund with 1 000 MSEK that generates a gross or net alpha of 1%. However, when measuring skill based on the amount fund managers extract from financial markets, it becomes evident that the first fund only adds 1 MSEK in absolute value, whereas the second fund, despite a lower alpha measure, adds 10 MSEK in absolute value.

4.2 Measuring Managerial Skill

We extend the methodology introduced by Berk and van Binsbergen (2015) to answer our research questions. We calculate value added for green and brown pre and post Covid-19 and divide value added into the part that is taken out by managers as compensation and the part that ends up in the pockets of investors to capture the treatment effect ex-post Covid-19. We obtain the excess return for green and brown funds by employing a tradeable benchmark and a risk factor model similar to Berk and van Binsbergen (2015), while also comparing the funds' performance relative to that of the state-default fund, the AP7 Equity Fund, as a third benchmarking method.

To begin with, we let R^n_{it} denote the net return earned by investors for the ith fund in the PPS at time t, without subtracting the risk-free rate. In our case, t ranges from 1 to 61 and every t represents one month in our five-year data set, while i represents each individual fund in our sample. The net return R^n_{it} can be divided into the benchmark return of the investor's next best investment alternative, R^B_{it}, and the difference between the realized return and this benchmark, which we call ϵ_{it}.

$$R^n_{it} = R^B_{it} + \epsilon_{it} \tag{2}$$

The gross return for every fund, that is, the return to investors before a percentage fee is taken out by fund managers, is obtained by adding back the fee (before discount), $f_{i,t-1}$, to the net return earned by investors. Since funds in the PPS rarely adjust the percentage fees, we assume the fees for all funds to remain constant for the entire duration of our sample period (Pensionsmyndigheten, 2023).

$$R^g_{it} = R^n_{it} + f_{i,t-1} = R^B_{it} + f_{i,t-1} + \epsilon_{it} \tag{3}$$

We estimate the realized gross alpha for every fund by subtracting the gross return with the net return of the next best investment opportunity. This can be estimated as a product of ϵ_{it} and $f_{i,t-1}$, where T is the number of months that the funds appear in the data set. Since we have a balanced panel data set, T is equal 61 for all funds. This will provide the average gross alpha that a fund generates for the entire duration of our sample period, and the cross-sectional differences in gross alpha between green and brown funds are summarized in Tables 1 and 2 respectively.

$$\hat{\alpha}^g_i = \frac{1}{T}\sum_{t=1}^{T}(R^g_{it} - R^B_{it}) = \frac{1}{T}\sum_{t=1}^{T}(f_{i,t-1} + \epsilon_{it}) \tag{4}$$

Following this line of reasoning, the value that fund managers add to investors is equal to the product of the realized gross alpha at time t, $\hat{\alpha}^g_{it}$, and the size of the ith fund at the end of the previous period, $q_{i,t-1}$, as measured by AUM. This is what Berk and van Binsbergen (2015) refer to as the value added of a fund (V^g_{it}).

$$V^g_{it} \equiv q_{i,t-1}\hat{\alpha}^g_{it} = q_{i,t-1}f_{i,t-1} + q_{i,t-1}\epsilon_{it} \tag{5}$$

We calculate the time series expectation of value added, S^g_i, for green and brown funds pre and post Covid-19 to capture the ex-post effect of the aforementioned exogenous shock on the economy. This is what Berk and van Binsbergen (2015) refer to as managerial skill, and we use this to estimate the treatment effect in our difference-in-difference model.

$$S^g_i \equiv E[V^g_{it}] \tag{6}$$

The second equality in eq. (5) highlights that value added consists of two parts. First, the amount fund managers take as compensation for active management, which is referred to as managerial compensation. Second, the value that is generated for investors. We differentiate between these two components of value added and subsequently calculate value added net of managerial compensation for all funds at each point in time.

In this process, we obtain the realized net alpha for every fund, that is, the alpha earned by investors after fees and expenses are deducted. This can be estimated as a product of ϵ_{it}. This will provide the average net alpha that a fund generates for the entire duration of our sample period, and the cross-sectional differences in net alpha between green and brown funds are summarized in Tables 1 and 2 respectively.

$$\hat{\alpha}_i^n = \frac{1}{T}\sum_{t=1}^{T}(R_{it}^n - R_{it}^B) = \frac{1}{T}\sum_{t=1}^{T}\epsilon_{it} \tag{7}$$

Consequently, the value that fund managers add to investors, after fund managers are compensated, is equal to the product of the realized net alpha at time t, $\hat{\alpha}_{it}^n$, and the size of the ith fund at the end of the previous period, $q_{i,t-1}$. We refer to this as value added net of managerial compensation.

$$V_{it}^n \equiv q_{i,t-1}\hat{\alpha}_{it}^n = q_{i,t-1}\epsilon_{it} \tag{8}$$

We calculate the cross-sectional mean of value added net of managerial compensation for green and brown funds respectively before and after the pandemic to estimate the ex-post effect of Covid-19 on managerial skill.

$$S_i^n \equiv E[V_{it}^n] \tag{9}$$

Managerial compensation, as defined by Berk and van Binsbergen (2015), is quantified as the product of AUM and the percentage fee the fund charges for active management. This, per definition, is equal to the difference between value added and value added net of managerial compensation. By calculating the difference in managerial compensation for green and brown funds pre and post Covid-19, we can compare the ex-post effect on investors' value added and fund managers' renumeration.

$$\mathrm{MC}_{it} = V_{it}^g - V_{it}^n = q_{i,t-1}f_{i,t-1} \tag{10}$$

4.3 Choice of Benchmarks

When estimating the value a mutual fund adds to investors, it is imperative to compare the return of the fund to the next best investment opportunity available at the time, which is referred to as the benchmark. Berk and van Binsbergen (2015) present two distinct methods of measuring the return of the next best investment alternative. We adopt the same methods as previous literature to estimate the return of the next best investment alternative while simultaneously providing a third benchmark that is relevant for the case of our premium pension data set.

4.3.1 Linear Projection Using 10 Index Funds

By using a set of 10 index funds, we create an alternative investment opportunity set. Similarly, to Berk and van Binsbergen (2015), we depart from the existing literature by ensuring that all 10 index funds were marketed and tradable for the time span of our study, that is from January 2018 to January 2023. By ensuring that all index funds were tradable at the time of our sample, we can be certain that investors had the opportunity to invest in these index funds for the entirety of our sample period.

The 10 index funds that form the alternative investment opportunity are all available in the Premium Pension System. We fully acknowledge that there is a certain degree of arbitrariness in picking such a benchmarking set. We choose these respective index funds based on three primary criterias. First, we wanted each index fund to cover a unique asset class and market segment to create a representative portfolio of index funds for the entire set of equity funds in the Premium Pension System. Thus, none of the index funds track the same index. Second, we wanted to select a set of robust index funds that have a market-leading position in the index fund space in Sweden. Finally, all 10 index funds had to have been tradeable for the entire duration of our sample period, from January 2018 to January 2023.

Table 3: Overview of Index Funds

Index	Fund Name	Asset Class	Inception date
1	Länsförsäkringar Global Index	Developed Market Equities	11/06/2013
2	Länsförsäkringar Sverige Index	Swedish Large-Cap Blend	17/11/2008
3	Länsförsäkringar USA Index	USA Large-Cap Blend	10/06/2009
4	Länsförsäkringar Europa Index	European Large-Cap Blend	19/05/2009
5	Länsförsäkringar Tillväxtmarknad Index A	Emerging Market Equities	13/06/2014
6	Länsförsäkringar Japan Index	Japan Large-Cap Blend	03/01/1996
7	PLUS Småbolag Sverige Index	Swedish Small-Cap/Mid-Cap Blend	29/09/2017
8	Avanza Zero	Swedish Large-Cap Blend	22/05/2006
9	Swedbank Robur Access Asien A	Asian Market Equities ex. Japan	23/09/2015
10	Swedbank Robur Access Global A	Developing Countries Equities	12/10/2015

The table reports the set of index funds we use to calculate the Linear Projection Benchmark and to estimate the expected market return in the CAPM benchmark. Note that the index is the number we have assigned to each index fund.

Moving forward, we define the benchmark as the closest portfolio in that set to the mutual fund. Here, it is imperative to acknowledge that all weights of the 10 index funds must add up to 1 to represent the total investment. As previously detailed, R_{it}^B denotes the net return of the tradeable benchmark at time t. We let β_i^j represent the weight of the jth index fund, where $j = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ according to the numbering of the index funds in Table 1. Furthermore, R_t^j corresponds to the net return of the jth index fund at time t. The benchmark net return for a given mutual fund (R_{it}^B) at time t is given by the following linear projection.

$$R_{it}^B = \sum_{j=1}^{10} \beta_i^j R_t^j \tag{11}$$

The linear regression model is iterated 231 times, for all 231 mutual funds in the data set. For each iteration of the loop, the code creates a constraint matrix 'A' and a constraint vector 'B' to impose the restriction that the coefficients of the independent variables, i.e the weights of each index fund, add up to 1. We also impose the condition that β_i^j can take on both positive and negative values to allow for short sales. Correspondingly, the constraint and condition set up for β_i^j can be summarized as follows:

$$\sum_{j=1}^{10} \beta_i^j = 1 \quad and \quad \beta_i^j \in \mathbb{R} \tag{12}$$

The weights for each index fund that are retrieved to mimic the return for each mutual fund are multiplied with the corresponding net return of that index fund for each month. The sum of the return for these index funds, with their respective weights, corresponds to the benchmark return R_{it}^B. An example of a linear projection is provided in Figure 4 (see Appendix).

4.3.2 Capital Asset Pricing Model (CAPM)

The second benchmarking method employed is the traditional risk-return approach given by the Capital Asset Pricing Model (CAPM). This one-factor model establishes a linear relationship between the expected return of the mutual fund and its risk exposure to the market (Berk and DeMarzo, 2020).

$$R_{it}^B = E[R_i] = r_f + \beta_i^{mkt}(E[R_{mkt}] - r_f) \tag{13}$$

In the equation above, r_f is the risk-free rate, $E[R_{mkt}]$ is the expected return of the market and β_i^{mkt} is the correlation of the ith fund with the market. We collected the daily 10-year treasury rate in Sweden from January 2018 to January 2023. By calculating the arithmetic average of the daily risk-free rate

for every month, we arrive at the monthly risk-free rate. The 5-year market betas, for each fund, are retrieved from Refinitiv Eikon by scanning their respective ISIN code. When estimating the expected return of the market, we use the average monthly net return from the 10 index funds in Table 3 as a proxy for the market portfolio.

While previous literature has criticized CAPM for its simplifying assumptions, it remains widely used by practitioners to estimate the cost of capital and to evaluate managed portfolios (Fama and French, 2004). For example, Graham and Harvey (2001) found that 73,5% of the 392 surveyed CFOs always or almost always use CAPM to calculate the cost of equity when evaluating projects. Moreover, Climent and Soriano (2011) and Nofsinger and Varma (2014) have used CAPM to calculate the excess return for green and brown funds over time.

We depart from Berk and van Binsbergen (2015) by using CAPM as a theoretical representation of the next best investment alternative instead of the multiple risk factors identified by Fama and French (1992) and Carhart (1997), known as the Fama-French-Carhart four-factor model (FFC). We were forced to divert from the FFC risk model since the Swedish House of Finance only provides FFC factors up until 2019 and no alternative source proved to have the same consistency, robustness, universe, and methodology as that of the Swedish House of Finance. The work required to derive new FFC factors is thus out of the scope of this thesis.

Moving forward, we are aware of the inherent limitations of CAPM. However, given that we use two other benchmark techniques to extend previous research on value added, we deem CAPM to constitute a valuable benchmark when estimating the funds' excess return gross and net of fees.

4.3.3 AP7 Equity Fund

Using the AP7 Equity Fund, the state's default equity fund, as the next best investment alternative is an appropriate extension to the benchmarking methods that we provide in this paper as it will yield insight into how the mutual funds available in the Premium Pension System have performed relative to the state's default option. R_{it}^{B} is thus determined as the net return of the AP7 Equity Fund in a given month.

$$R_{it}^{B} = R_{AP7,t}^{n} \tag{14}$$

As the most popular fund within the Premium Pension System, the AP7 Equity Fund serves as a valuable benchmark to other available options for investors. The use of AP7 Equity Fund as a benchmarking method enables us to explore whether other funds within the Premium Pension System possess the necessary skills to surpass the performance of the state-default option. In such a scenario, our findings would suggest that investors should consider exploring other funds available in the PPS, rather than allocating their premium pension in AP7 Såfa and the AP7 Equity Fund.

4.4 Difference-in-Difference Model

To observe the difference in the outcome variables between green and brown funds pre and post Covid-19, we employ a difference-in-difference model with time-fixed effects because we introduce dummy variables in the time series dimension. In addition, we incorporate a control variable to capture the geographical scope of a fund's investments. This variable takes on the value 1 if the fund solely invests in Swedish equities and 0 if the fund also invests in foreign equities. We control for the geographical reach of a fund because it is in line with the findings in Coval and Moskowitz (2001), which is discussed in Berk and van Binsbergen (2015). Coval and Moskowitz (2001) find that funds investing a greater portion of their assets locally perform better. The model can be summarized as follows.

$$Y_{it} = a_0 + \beta_1[\text{Green}_i] + S_t + \beta_2[\text{Green}_i \times \text{Post}] + \sigma X_i + \epsilon_{it} \tag{15}$$

In this model, [Green$_i$] is a treatment dummy variable that takes on the value 1 if the fund belongs to the treatment group, i.e if the fund is green, and the value 0 if the fund belongs to the control group, i.e if the fund is brown. The coefficient β_1 measures the difference in the outcome variable between the treatment and control group before the outbreak of Covid-19. The variable S_t is a vector with time-fixed effects. Note that we exclude the base period, i.e the first month, to avoid the dummy variable trap. The variable [Post] is a time dummy variable that takes on the value 1 in the post Covid-19 period and the value 0 in the pre Covid-19 period. Subsequently, the coefficient β_2 is the interaction term of the model. In addition, X_i is a vector with the control variable and a_0 is the intercept of the regression model.

4.4.1 Treatment- and Control group

To identify the treatment group in our sample, we observe the median Morningstar ESG-rating in our sample. The Morningstar ESG-rating is a scale from 1 to 100 where a lower value corresponds to a more cautious ESG profile, implying that the fund is more considerate of ESG factors. As such, we define the treatment group, i.e the green funds in our sample, as the group of funds that have a Morningstar ESG-rating below the median (Pensionsmyndigheten, 2023). The control group constitutes the rest of the sample, and these funds are considered to be brown funds since they are less considerate of ESG factors according to their rating.

4.4.2 Pre- and Post-period

The World Health Organization (WHO) declared Covid-19 as pandemic in March of 2020 (World Health Organization, 2020). Thus, we consider the period after March of 2020 as the post period in our sample, and the period before March of 2020 as the pre-period. March of 2020 is removed from the data set. By removing the period in which Covid-19 was announced as a global pandemic, we can reduce the likelihood that any pre-existing differences between the treatment and control groups will confound the estimates of the interaction term. This is because we can assume that any differences in outcomes between the two groups prior to Covid-19 are due to random variation, rather than systematic differences related to the period in which Covid-19 was announced as a pandemic.

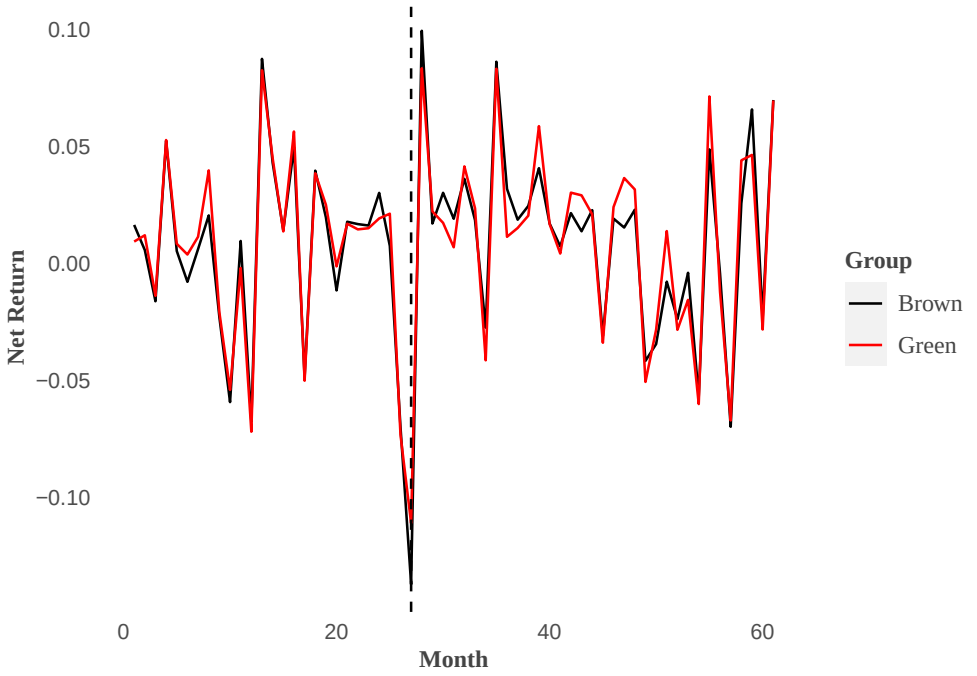
4.4.3 Analyzing Violations of the Parallel Trends Assumption

The difference-in-difference model relies on the parallel trends assumption, implying that before the exogenous shock to the economy, both the treatment and control groups should have the same trend. If this assumption is violated, the difference-in-difference model will produce biased estimates. Consequently, in the counterfactual case that no exogenous shock strikes the economy, the treatment and control group would develop on a similar trajectory. The parallel trends assumption is thus pivotal in establishing a causal effect of the pandemic.

Testing if the parallel trends assumption holds can be done through visual inspection and by conducting a t-test on the difference between the trend lines of green and brown funds pre Covid-19. We test if the parallel trend assumption holds for the net return and assets under management since these are the two key components that influence all other outcome variables. The conclusions drawn from this analysis are used to assume that the parallel trends assumption holds. In addition, it is important to consider the conceptual reasons why the parallel trends assumption might be valid. The Covid-19 pandemic led to turbulence in financial markets, which, according to Ortmann, Pelster, and Wengerek (2020), led to noticeable changes in investment behavior. Furthermore, there are well-documented discrepancies in

performance between green and brown funds under uncertain market conditions (Climent and Soriano, 2011; Nofsinger and Varma, 2014). This argument would further suggest that Covid-19 would impact the relative performance of green and brown funds more significantly than in the counterfactual case.

Figure 2: Average Net Return Pre and Post Covid-19



The figure illustrates the average net return of green and brown funds by month pre and post Covid-19. The red line shows the net return of green funds and the black line shows the net return for brown funds. Note that the dashed line marks the outbreak of Covid-19 in March 2020.

By observing Figure 2, it appears that the net returns for green and brown funds appear stationary, and they seem to develop on a similar trajectory. To test if the parallel trends assumption holds, we conduct a t-test on the difference in trends between green and brown funds before the outbreak of Covid-19. Here, the null hypothesis constitutes the existence of parallel trends and a result that is statistically significant from zero would imply a rejection of the null hypothesis.

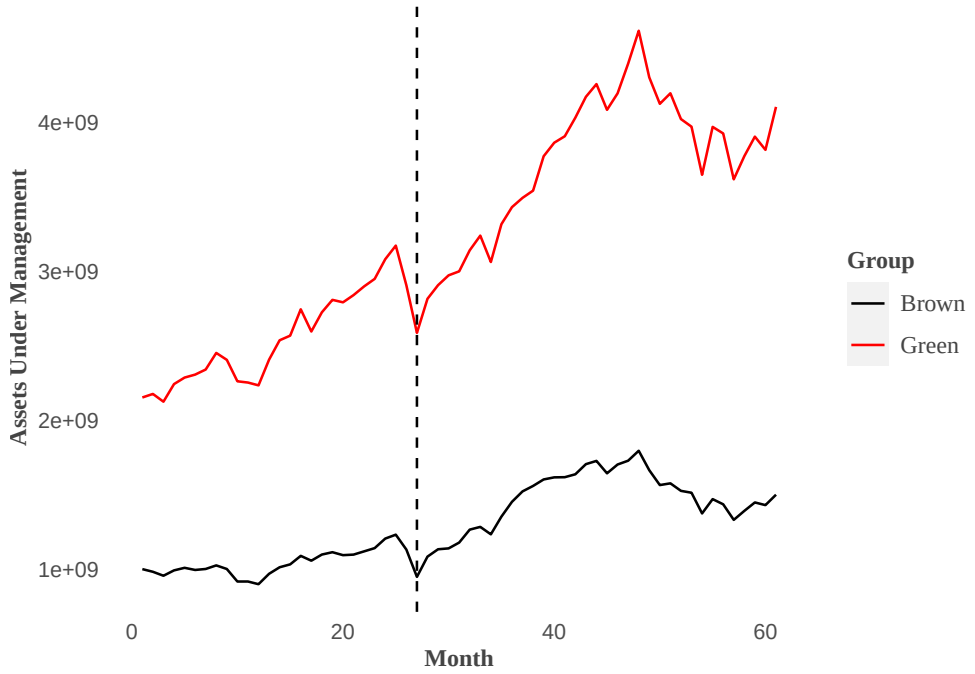
Table 4: Testing the Parallel Trends Assumption for Net Return

Net Return	
Difference in trends pre Covid-19	-0,0001
Standard Error	(0,0002)
t-statistic	-0,8419
p-value	0,3993

The table reports the t-statistic from testing the null hypothesis that there is not a significant difference in trends between green and brown funds before the outbreak of Covid-19. Consequently, the null hypothesis can not be rejected. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1.

Moving forward, we also test if the parallel trends assumption holds for assets under management. However, the trends of the green and brown funds appear to be a bit more ambiguous, and it is hard to tell whether they followed the same trend before Covid-19 or not (see Figure 3). As with net returns, we, therefore, conduct a t-test on the difference in trends between green and brown funds pre Covid-19.

Figure 3: Assets Under Management Pre and Post Covid-19



The figure illustrates the average size of green and brown funds by month pre and post Covid-19. The orange line shows the assets under management of green funds and the black line shows the assets under management for brown funds. Note that the dashed line marks the outbreak of Covid-19 in March 2020.

By observing Table 5, it is apparent that, when we observe the entire sample period before the outbreak of Covid-19, the parallel trends assumption appears to be violated. However, testing if the parallel trends assumption holds or not is heavily reliant upon the number of periods in the sample period. Thus, we conduct a sensitivity analysis by removing the first months in our data set to see if the parallel trends assumption holds closer to Covid-19. We find that, by removing the first 5 months of the sample period, we can not reject the null hypothesis, which implies that the parallel trends assumption holds (see Table 5). In conjunction with the conceptual reasons for why the parallel trends assumption holds, we thus conclude that the parallel trends assumption holds for net returns and AUM.

Table 5: Testing the Parallel Trend Assumption for Assets Under Management

Assets Under Management (MSEK)	
Difference in trends pre Covid-19	$29,48^{**}$
Standard Error	(14,91)
t-statistic	1,9778
p-value	0,04805
Difference in trends pre Covid-19 by removing the first 5 months	30,50
Standard Error	(20,96)
t-statistic	1,4552
p-value	0,1457

The table reports the t-statistic from testing the null hypothesis that there is not a significant difference in trends between green and brown funds before the outbreak of Covid-19. We reject the null hypothesis. However, when removing the first five months, we can not reject the null. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1.

4.4.4 Outcome variables

We employ the difference-in-difference model on a set of outcome variables to observe the difference in the evolution of green and brown funds for our sample period. In addition to regressing value added, value added net of managerial compensation, assets under management, and managerial compensation, we also regress conventional metrics of measuring skill, i.e gross and net alpha. This is to provide a more comprehensive analysis in our discussion. Note that the number of observations for value added, value added net of managerial compensation, and managerial compensation amounts to 13,629 whereas the number of observations for assets under management, gross alpha, and net alpha amounts to 13,860. The apparent difference in the number of observations stems from the fact that we can not calculate value added, value added net of managerial compensation, and managerial compensation, for the first month in our data set, that is January of 2018.

Table 6: Outcome Variables in the Difference-in-Difference Model

Outcome Variables (Y_{it})
Assets Under Management (AUM)
Managerial Compensation (MC)
Gross Alpha
Net Alpha
Value Added
Value Added Net of Managerial Compensation

The table reports the outcome variables that are regressed in the following section. Note that Gross and Net Alpha, as well as Value Added and Value Added Net of Managerial Compensation, are regressed for each individual benchmarking method.

5 Empirical Results

In this section, we present the results from our difference-in-difference model pre and post Covid-19. Table 7 is the regression of assets under management and managerial compensation. Tables 8 and 9 is the regression of gross and net alpha for the three different benchmarking methods. Finally, Tables 10 and 11 illustrate the regression of value added and value added net of managerial compensation for the three different benchmarking methods. Note that we first regress the outcome variables without incorporating the control variable in our model. This is done to observe the effect of having the control variable in our more robust model. Conclusions are based on the model that incorporates a control variable. In addition, the number of observations for value added and value added net of managerial compensation amounts to 13,629, whereas the number of observations for assets under management, gross alpha, and net alpha amounts to 13,860. The apparent difference in the number of observations stems from the fact that we can not calculate value added gross and net of managerial compensation, as well as managerial compensation, for the first month in our data set.

Table 7: Output from regressing Assets Under Management (q) and Managerial Compensation (MC). All values are denoted in MSEK.

Output	Assets Under Management	Managerial Compensation
Pre-treatment difference (β_1)	1.503,64**	4,31***
	(140,54)	(1,48)
Interaction term (β_2)	767,71***	4,61*
	(186,71)	(1,95)
Control Variable	×	×
Pre-treatment difference (β_1)	685,33***	−2,95*
	(135,19)	(1,45)
Interaction term (β_2)	767,71***	4,61*
	(177,38)	(1,88)
Control Variable	✓	✓
Number of observations	13.860	13.629
Adjusted R^2	0,13	0,08

The table reports the pre-treatment difference in assets under management (AUM) and managerial compensation (MC) between green and brown funds and the average treatment effect in AUM and MC for green funds compared to brown funds after the outbreak of Covid-19. There are 13860 observations for AUM and 13629 observations for MC. Standard errors are in parenthesis. Adjusted R^2 ranges from 8-13%. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1

From Table 7, it can be inferred that the difference in assets under management between green and brown funds was positive, and statistically significant at a 1% level, before the outbreak of Covid-19. According to the first model, the average green fund in the PPS managed 1.503,64 MSEK more in assets compared to the average brown fund. When controlling for the geographical scope of the fund, it is evident that the pre-treatment difference is reduced. This, in turn, implies that much of the cross-sectional variation in AUM between green and brown funds pre Covid-19 is captured by the domestic control variable. In the second model, which includes the control variable, it is observable that green funds in the PPS, on average, had 685,33 MSEK more in AUM compared to their conventional counterparts before the exogenous shock. In a similar fashion, the pre-treatment difference in managerial compensation between green and brown funds decreases when the control variable is included. The pre-treatment difference in managerial compensation is negative and statistically significant at a 10% level in the second model. This must stem from the fact that, in our data set, brown funds charge higher fees relative to green funds (see Table 1 and 2). Given that managerial compensation is a function of assets under management and fees, and green funds posits more assets under management relative to brown funds before Covid-19, the relative difference in fees appears to be greater than the relative difference in capital, thus leading to the presumption that brown funds were retrieving 2,95 MSEK more in managerial compensation than green funds before the outbreak of Covid-19.

The positive, and statistically significant, interaction term for assets under management suggests that green funds saw a greater increase of 767,71 MSEK in AUM after Covid-19, relative to brown funds. Similarly, we can observe that the interaction term for managerial compensation is positive and statistically significant at a 10% level in the robust model, implying that compensation for green fund managers, on average, increased by 4,61 MSEK more relative to that of brown fund managers. Since fees are kept constant for the entire duration of our sample period, the positive interaction term for managerial compensation must be attributed to the influx of assets that green funds experienced after Covid-19, as illustrated in Table 7. The influx of capital appears to have made the difference in assets under management between green and brown funds greater relative to the difference in fees charged.

Table 8: Output from regressing Gross Alpha (α_{it}^{g}) using the three different benchmarking methods: Linear Projection, CAPM, and AP7 Equity Fund. All values appear in percentages.

Output	Linear Projection	CAPM	AP7 Equity Fund
Pre-treatment difference (β_1)	$-0{,}30^{***}$	$-0{,}23^{*}$	$-0{,}24^{**}$
	(0,06)	(0,09)	(0,09)
Interaction term (β_2)	-0,12	-0,14	-0,14
	(0,08)	(0,12)	(0,12)
Control Variable	×	×	×
Pre-treatment difference (β_1)	$-0{,}18^{**}$	-0,15	-0,15
	(0,06)	(0,09)	(0,09)
Interaction term (β_2)	-0,12	-0,14	-0,14
	(0,08)	(0,12)	(0,12)
Control Variable	✓	✓	✓
Number of observations	13.860	13.860	13.860
Adjusted R^2	0,04	0,03	0,11

The table reports the pre-treatment difference in gross alpha (α_{it}^{g}) between green and brown funds and the average treatment effect in gross alpha for green funds compared to brown funds after the outbreak of Covid-19. There are 13860 observations across all three benchmarking methods. Standard errors are in parenthesis. Adjusted R^2 ranges from 3-11%. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1

From Table 8, when controlling for the geographical coverage of a fund, it is apparent that the pre-treatment difference in gross alpha is negative for all respective benchmarking methods in both models and statistically significant at a 5% level for the linear projection benchmark. In the second model, we can observe a reduction in the size effect of the pre-treatment difference in gross alpha for green and brown funds. This must be attributed to the fact that the domestic control variable explains part of the cross-sectional variation in gross alpha before the outbreak of Covid-19. Based on our second model, these findings implicitly suggests that brown funds generated approximately 0,15% to 0,18% more in gross alpha before the outbreak of Covid-19 relative to green funds. If we compare these results with Table 7, we can conclude that green funds managed more assets prior to the pandemic, thus facing decreasing returns to scale in NPV positive investment opportunities. It is not self-evident, but brown funds may posit superior stock-picking skills, market timing ability, and differential information, all of which may have contributed to the negative pre-treatment difference in gross alpha. However, these aspects are most likely captured by the higher fees that brown funds charge.

The interaction term is negative, but not statistically significant, for all respective benchmarking methods in both models, which would suggest that gross alpha decreased for green funds relative to brown funds after the pandemic. Since fees are kept constant, the reason for the negative interaction term can be two-fold. First, the fact that green funds experienced an influx of assets under management after Covid-19 would imply that they have even more capital than they had before the pandemic relative to brown funds. Building on the concept that larger funds face diminishing returns to scale in relation to NPV positive investment opportunities, the greater increase in capital could have made it even more difficult for green funds to find undervalued securities after Covid-19 in comparison to brown funds. What also may have contributed to the negative interaction term for gross alpha is the fact that green funds are limited by their self-imposed restrictions, which forces them to only invest in equities that comply with their ESG standards. This factor may also have contributed to the inability of green funds to produce a higher gross alpha than brown funds.

Table 9: Output from regressing Net Alpha (α_{it}^n) using the three different benchmarking methods; Linear Projection, CAPM, and AP7 Equity Fund. All values appear in percentages.

Output	Linear Projection	CAPM	AP7 Equity Fund
Pre-treatment difference (β_1)	0,11	0,18*	0,17
	(0,06)	(0,09)	(0,09)
Interaction term (β_2)	-0,12	-0,14	-0,14
	(0,08)	(0,12)	(0,12)
Control Variable	×	×	×
Pre-treatment difference (β_1)	0,11	0,14	0,14
	(0,06)	(0,06)	(0,09)
Interaction term (β_2)	-0,12	-0,14	-0,14
	(0,08)	(0,12)	(0,12)
Control Variable	✓	✓	✓
Number of observations	13.860	13.860	13.860
Adjusted R^2	0,02	0,02	0,11

The table reports the pre-treatment difference in net alpha (α_{it}^n) between green and brown funds and the average treatment effect in net alpha for green funds compared to brown funds after the outbreak of Covid-19. There are 13860 observations across all three benchmarking methods. Standard errors are in parenthesis. Adjusted R^2 ranges from 2-11%. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1

From Table 9, we can expand on the conclusions drawn from the previous tables. When applying the difference-in-difference model on net alpha, we observe that the pre-treatment difference, although not statistically significant, is positive for all respective benchmarking methods. Comparing the two models, it is apparent that the domestic control variable captures some of the cross-sectional variation in the CAPM and the AP7 Equity Fund benchmarks pre Covid-19. The positive coefficients of the pre-treatment difference implies that the negative pre-treatment difference in gross alpha, (see Table 8), does not stem from the fact that green funds manage more capital, thus facing decreasing returns to scale in NPV positive investment opportunities, but rather because green funds charge lower fees than brown funds. It remains likely that the superior stock-picking skills, market-timing ability, and asymmetry of information of brown funds is captured by the high fee they charge. Thus, when we neglect the fee with net alpha, it is apparent that the green funds generated a higher net alpha than brown funds before the outbreak of Covid-19.

Similarly to Table 8, the interaction term, although not statistically significant, appears to be negative for all respective benchmarking methods. Since fees are kept constant for the entire duration of our sample period, this must stem from the fact that green funds experienced an influx of assets in the aftermath of Covid-19 (see Table 7) and that brown funds were thus more capable of finding and investing their capital in undervalued securities.

Table 10: Output from regressing Value Added (V_{it}^{g}) using the three different benchmarking methods; Linear Projection, CAPM, and AP7 Equity Fund. All values are denoted in MSEK.

Output	Linear Projection	CAPM	AP7 Equity Fund
Pre-treatment difference (β_1)	7,71**	9,55*	7,76
	(2,44)	(4,25)	(4,24)
Interaction term (β_2)	2,39	4,21	-1,88
	(3,21)	(5,60)	(5,58)
Control Variable	×	×	×
Pre-treatment difference (β_1)	0,76	2,02	2,55
	(2,44)	(4,28)	(4,28)
Interaction term (β_2)	2,39	4,21	-1,88
	(3,18)	(5,57)	(5,57)
Control Variable	✓	✓	✓
Number of observations	13.629	13.629	13.629
Adjusted R^2	0,03	0,02	0,04

The table reports the pre-treatment difference in value added (V_{it}^{g}) between green and brown funds and the average treatment effect in value added for green funds compared to brown funds after the outbreak of Covid-19. There are 13629 observations across all three benchmarking methods. Standard errors are in parenthesis. Adjusted R^2 ranges from 2-4%. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1

From Table 10, the three benchmarking methods in the second model suggests that, although not highly significant, the pre-treatment difference in value added is positive. This suggests that green funds were able to extract more capital from financial markets than brown funds before the outbreak of Covid-19. Recall that value added is the product of gross alpha and AUM. We have previously concluded, from Table 8, that the pre-treatment difference for gross alpha was negative. This must imply that the positive pre-treatment difference observed in Table 10 is compensated for by the statistically significant and positive pre-treatment difference in assets under management inferred from Table 7. If one uses conventional methods of measuring managerial skill, such as gross alpha, one would conclude that brown funds performed better than green funds before Covid-19 (see Table 8). However, by looking at value added in Table 10, we get a conclusion that contradicts that of the conventional skill measure. This ties back to Berk and van Binsbergen (2015), and their argument as to why an absolute measure, as opposed to a ratio, is preferred when measuring managerial skill. Recall from Table 7 that, since green funds had considerably higher assets under management compared to brown funds, they are more inclined to face diminishing returns to scale in relation to NPV positive investment opportunities. To account for this natural consequence of becoming a large fund, Berk and van Binsbergen (2015) applies the value added measure to make funds of different sizes more comparable to one another. By applying the difference-in-differnce model on value added, we thus arrive at a different conclusion regarding whether green or brown funds were more skilled before Covid-19. Judging from the pre-treatment difference in value added, we can conclude that green funds appears to have been more capable of extracting capital from financial markets than brown funds in the pre-treatment period. Green funds are thus, according to Berk and van Binsbergen (2015), considered more skilled in the pre-treatment period. Note that the pre-treatment difference is not statistically significant for any of the benchmarking methods, but the argument for using value added as a measure of skill still holds.

The contradictory results in measuring managerial skill using a ratio or an absolute measure are further reinforced by examining the interaction term. From Table 8, we could observe that the interaction term for gross alpha was negative for all three benchmarking methods, thus suggesting that green funds underperformed relative to brown funds following the Covid-19 outbreak. However, when taking the size

of the fund into account (see Table 10), we can draw a contradicting conclusion. Although not statistically significant, the linear projection benchmark suggests that green funds have been able to generate 2,39 MSEK in excess of brown funds and we obtain even more economically significant results when using CAPM to calculate gross alpha, i.e. a value added of 4,21 MSEK after Covid-19. However, green funds generate a negative value added of 1,88 MSEK compared to brown funds when using the AP7 Equity Fund as a benchmark.

Table 11: Output from regressing Value Added Net of Managerial Compensation (V_{it}^n) using the three different benchmarking methods; Linear Projection, CAPM, and AP7 Equity Fund. All values are denoted in MSEK.

Output	Linear Projection	CAPM	AP7 Equity Fund
Pre-treatment difference (β_1)	3,40	5,24	3,45
	(1.98)	(3,95)	(4,07)
Interaction term (β_2)	-2,23	-0,41	-6,50
	(2,61)	(5,20)	(5,36)
Control Variable	×	×	×
Pre-treatment difference (β_1)	3,71	4,97	5,50
	(2,00)	(4,00)	(4,20)
Interaction term (β_2)	-2,23	-0,41	-6,50
	(2,23)	(5,20)	(5,36)
Control Variable	✓	✓	✓
Number of observations	13,629	13,629	13,629
Adjusted R^2	0,01	0,02	0,04

The table reports the pre-treatment difference in value added net of managerial compensation (V_{it}^n) between green and brown funds and the average treatment effect in value added net of managerial compensation for green funds compared to brown funds after the outbreak of Covid-19. There are 13629 observations across all three benchmarking methods. Standard errors are in parenthesis. Adjusted R2 ranges from 1-4%. $^{***}p$-value < 0.01, $^{**}p$-value < 0.05, $^{*}p$-value < 0.1

From Table 11, the pre-treatment difference in value added net of managerial compensation is positive for all respective benchmarking methods, both including and excluding the control variable. Judging from the more robust model, the pre-treatment difference in value added net of managerial compensation appears to range from 3,71 to 5,50 MSEK. Value added net of managerial compensation denotes the capital that the fund is able to extract from financial markets and deliver to its investors after fund managers are reimbursed for active management. Consequently, recall from eq. (10) that the relationship between managerial compensation and value added gross and net of managerial compensation can be established as follows:

$$MC_{it} = V_{it}^g - V_{it}^n = q_{i,t-1} f_{i,t-1} \tag{16}$$

By subtracting the pre-treatment difference in value added with the pre-treatment difference in value added net of managerial compensation for each respective benchmark, one will obtain the pre-treatment difference in managerial compensation that can be observed in Table 7. The same relationship holds for the interaction term. The positive pre-treatment difference in value added net of managerial compensation suggests that green funds extracted more capital for their investors relative to their peers before Covid-19. By comparing the pre-treatment difference in value added in Table 11, one can observe that the pre-treatment difference in value added net of managerial compensation is larger than that of value added. This must stem from the fact that brown funds charge higher fees, and although green funds posit more capital before the outbreak of Covid-19, brown funds appear to retrieve more managerial

compensation (see Table 7). Once fees are neglected, the pre-treatment difference in value added net of managerial compensation increases, implying that green funds generate more value to investors relative to brown funds.

The interaction term, although not statistically significant, is negative for all respective benchmarks, which suggests that value added net of managerial compensation decreased for green funds relative to brown funds in the wake of Covid-19. This relates to our previous discussion, that green funds experienced an influx of assets under management after Covid-19 (see Table 7), which presumably reduced their ability to find NPV positive investment opportunities ex-post Covid-19. Consequently, brown funds' ability to find undervalued securities after Covid-19 seemed to have produced more value to their investors relative to the green funds.

6 Discussion

6.1 Analysis of Results

By comparing our results with previous literature and our hypotheses, a number of insightful conclusions can drawn. From Table 7, it could be inferred that green funds manage more capital relative to brown funds prior to the outbreak of Covid-19. The relative difference in AUM between green funds and brown funds increases following the pandemic, thus implying that there is a significant increase in assets under management in green funds during periods of financial crisis. The substantial inflows in green funds available in the PPS is in line with the argumentation by Nofsinger and Varma (2014) and it reaffirms the findings in Albuquerque et al. (2020) and Pástor and Vorsatz (2020) that investors' demand for sustainable responsible investing increases during periods of financial distress. Given the statistically significant interaction term, we find support for our first hypothesis.

Despite large cross-sectional differences in AUM between green and brown funds before and after the outbreak of Covid-19, the same pattern is not applicable to managerial compensation. As illustrated in Table 7, when controlling for the geographical scope of the fund, green funds, on average, generate less compensation for fund managers relative to brown funds before the outbreak of Covid-19. Given that brown funds charge higher fees compared to green funds in the PPS, and managerial compensation is a function of fees and AUM, the positive difference in size between green and brown funds does not appear to compensate for the difference in percentage fees. These results also contend previous literature suggesting that investors are willing to pay a higher price for SRI (Nofsinger and Varma, 2014). However, we caution that a larger sample size might lead to different conclusions. Following the pandemic, we can observe a significant increase in managerial compensation, which is line with previous discussion on the substantial increase in inflows to green funds relative to brown funds. This suggests that green compensation in the PPS has soared in the wake of Covid-19.

When examining the difference in gross alpha for green and brown funds pre and post Covid-19, we observe that green funds generated a lower gross alpha relative to brown funds before the outbreak of Covid-19, which is in line with the findings on the opportunity costs of investing in green funds outlined by Adler and Kritzman (2008). The negative difference in gross alpha also persists after the pandemic across all three benchmarking methods. This following from the decreasing returns to scale managers of green funds face as inflows in SRI spike during the pandemic, as discussed in Berk and van Binsbergen (2015). The fact that green funds generate a smaller gross alpha pre and post Covid-19 could also be attributable to the superior stock-picking, market-timing ability, and asymmetry of information of brown funds since brown funds do not have self-imposed restrictions. However, such superior attributes are probably captured by the high fees that brown funds charge. The results are not statistically significant for gross alpha, so we can not confirm our second hypothesis. Nonetheless, the negative coefficients

support our second hypothesis since it entails that, although not highly significant, brown funds are capable of generating a higher gross alpha than green funds in unfavorable market conditions.

By neglecting the fees using net alpha, we can see from Table 9 that green funds generated higher net alpha relative to brown funds before the outbreak of Covid-19, while brown funds experienced a greater increase in net alpha relative to green funds after the pandemic. Contrary to the findings in Nofsinger and Varma (2014) green funds seem to have outperformed brown funds under normal market conditions. While Nofsinger and Varma (2008) found evidence of positive alphas for sustainable funds relative to their conventional counterparts in tougher market conditions, we find no such support. Based on the reasoning in Berk and van Binsbergen (2015), one could argue that the reduction in net alpha for green funds relative to brown funds after Covid-19 is attributable to the diminishing returns to scale fund managers face as the size of the fund increases, which could be observed in Table 7. The fact that the pre-treatment difference in net alpha is positive, across all benchmarks, implies that brown funds' ability to generate a higher gross alpha stems from the higher fees they charge. Thus, the superior stock-picking skills, market-timing ability, and asymmetry of information must be captured by the higher fees brown funds charge. We also observe that the high fees brown funds charge does not generate a higher net alpha than that of green funds, suggesting that the high fees are not justifiable. Given that the results, although not statistically significant, indicate that net alpha decreased more rapidly for green funds relative to brown funds after Covid-19, we find support for our second hypothesis. Altogether, our results, although statistically significant, suggest that both gross and net alpha decreased for green funds relative to brown funds as the inflows in SRI during the pandemic surged.

Quantifying the performance of green and brown funds as an absolute value rather than a ratio leads to novel insights. As seen in Table 10 value added is higher for green funds relative to brown funds before the outbreak of Covid-19. This, according to Berk and van Binsbergen (2015), suggests that fund managers of green funds are more skilled compared to managers of conventional funds under normal market conditions. The relative difference in value added between green and brown funds increases after the pandemic for the tradeable and theoretical benchmarks. Since the interaction term for gross alpha is negative for green funds, this suggests that it must be attributable by the increase in AUM that green funds experienced after the outbreak. Interestingly enough, brown funds seem to have extracted more money from financial markets compared to green funds when benchmarking the excess return using the AP7 Equity Fund. The reason for this is rather ambiguous, but a possible explanation is that the state-default fund, in contrast to our other benchmarks, which were computed using index funds, is actively managed and thus able to rebalance the portfolio in direct response to stock market fluctuations. Nevertheless, the results from the linear projection and CAPM benchmarks, although not statistically significant, indicate that the increase in size for green funds following the onset of Covid-19 dominates the ex-post effect on value added.

When excluding the compensation fund managers receive in return for active management, value added net of managerial compensation is higher for green funds relative to brown funds prior to the outbreak of Covid-19. This, although not highly significant, implies that green funds generated more value to investors than brown funds prior to the pandemic. These results are also consistent with the pre-pandemic estimates for net alpha. Despite the significant increase in assets under management for green funds after Covid-19, growth in value added net of managerial compensation is lower for green funds relative to brown funds following the crisis. Following the line of reasoning in Berk and van Binsbergen (2015), the decrease in value added net managerial compensation following the outbreak is attributable to the fact that the interaction term for net alpha, for all benchmarks, is negative which stems from the fact that larger funds face a challenge in investing their capital in NPV positive investment opportunities. The negative interaction term for value added net of managerial compensation can thus be attributed to cross-sectional differences in AUM ex-post Covid-19, previously described in Table 7. These findings are

not statistically significant, but they indicate that diminishing returns to scale has a more substantial impact on the value green fund managers generate to investors compared to the increase in AUM.

6.2 Limitations

The most apparent issue at hand is the sample size of our data set. Given that our panel includes 231 funds over 61 months, it may not be large enough to suffice that the t-statistic of the pre-treatment and interaction estimates follow a t-distribution. To address this concern, we have analyzed other databases, besides the Swedish Pension Agency, to investigate if our data set can be complemented. However, when retrieving a Nordic sample of mutual funds from Refinitiv Eikon, we ended up with an even smaller data set of actively managed funds after cleaning and filtering the data. The five-year study period might also not be long enough to capture the permanent effect of Covid-19 on green and brown funds, but future studies will be able to expand this research further. By using mutual fund data from the Swedish Pension Agency, we are able to analyze green and brown funds two years prior and two years after the outbreak of Covid-19. The decision to use Swedish pension data is further guided by the generalizability of using mutual fund data from a database that includes all working citizens in Sweden.

Although the sample of green and brown funds we have chosen is representative of all actively managed green and brown mutual funds in the pension system, all funds in the PPS are subject to a sample selection bias since these comply with financial and regulatory criteria required for a fund company to be listed on the premium pension fund market. Given that we compare value added for green and brown funds within the PPS, this selection bias does not significantly affect the comparability between our treatment and control group. For this reason, we deem our difference-in-difference methodology to still be of high relevance.

Furthermore, we are aware of the the possibility of survivorship bias in our data. This arises from removing funds that have been added or removed from the PPS between January 2018 and January 2023. This was done, however, to create a balanced sample of green and brown funds over time to test for the ex-post effect of Covid-19. When faced with this dilemma, we found support in existing literature for constructing a balanced panel data set, referencing to the reduction in noise inferred by unit heterogeneity in unbalanced panels (Aptech, 2019). Since mutual funds in the PPS were not assigned an ESG-Morningstar rating prior to 2020, we would not have been able to categorize these funds into a treatment and control group. This is, however, an apparent limitation in our study and it is something that future research can account for.

When trying to obtain the counterfactual to estimate a causal effect, there is a risk of omitted variable bias. In our case, there might be factors we have not controlled for that influence both the choice of investment in green or brown funds and the subsequent returns that these funds generate. This could make it difficult to attribute any differences in value added solely to the green or brown investment strategy of these funds. To reduce the risk of omitted variable bias associated with value added for green and brown funds, we incorporate a vector with a control variable for the geographical scope of the fund. While we could have controlled for the specific social and environmental aspects each fund considers or the perceived risk profile of the fund, these characteristics are presumably already captured by the ESG-Morningstar ratings and the market betas in CAPM. Consequently, we opted to use only one control variable, the geographical scope of the fund, as discussed extensively in Berk and van Binsbergen (2015).

Lastly, as evident from the Breusch-Pagan test (see Table 14 in Appendix), a challenge we encounter is the prevalence of heteroskedasticity in our regression models. Our tests show that we can reject the null hypothesis of homoskedasticity for all our models. The issue of heteroskedasticity is a common concern in cross-sectional regressions and the matter arises due to the substantial differences in assets under management and monthly returns across the green and brown funds we are studying. Consequently,

future research may take such fund characteristics into consideration.

7 Conclusion

This paper studies the ex-post effect of Covid-19 on the value green and brown funds generate. This is referred to as a fund's value added. We empirically document that, prior to the outbreak of Covid-19, green funds in the Swedish Premium Pension System (PPS) managed more money relative to brown funds. Managers of green funds, on the other hand, were being compensated less compared to their conventional counterparts. Our findings tie back to the argument put forward by Berk and van Binsbergen (2015), regarding the reasoning as to why an absolute measure of managerial skill is more accurate compared to conventional skill measures such as gross and net alpha. We find that, although not statistically significant, the pre-treatment difference in gross alpha between green and brown funds was negative. Using conventional measures of skill, the results thus point to the conclusion that brown funds are more skilled in favorable market conditions. However, by accounting for the size of the fund using value added, we arrive at contradicting results because the pre-treatment difference in value added was positive, yet not statistically significant. The contradicting conclusions can be drawn from observing the interaction term for gross alpha and value added as well. Our empirical findings, in line with Berk and van Binsbergen (2015), suggest that value added is a more comprehensive measure of managerial skill.

To analyze the ex-post effect of Covid-19 on the outcome variables, we extend the concept of value added developed by Berk and van Binsbergen (2015). More specifically, we introduce the AP7 Equity Fund as a third benchmarking method in addition to the theoretical risk-factor model and tradeable benchmark obtained when projecting the net returns of 10 index funds against the mutual funds available in the PPS. Furthermore, we divide value added into the part that is generated to investors and the part that fund managers take out as compensation to examine the changing dynamics that follow from the growing demand for green investments. Lastly, our findings are further nuanced by comparing the estimates for value added pre and post Covid-19 with the results using gross and net alpha, thus adding another dimension to the debate on why conventional measures do not accurately measure managerial skill.

We show that the value fund managers generate for investors does not differ between green and brown funds during periods of financial distress since our results are not statistically significant. Yet, the robustness inferred from using three benchmarking methods and their mutual consensus implies that value added increased for green funds relative to brown funds after the outbreak of Covid-19. As explained in Berk and van Binsbergen (2015), the ex-post difference in value added is primarily attributable to the fact that the value added measure, in contrast to conventional alpha measures, takes the size of the fund into account. While gross alpha decreases for green funds relative to brown funds during the pandemic, our findings indicate a relative increase in the value managers of green funds generates. By accounting for decreasing returns to scale as a fund accumulates more assets, managers of green funds can be considered more skilled.

Fruitful avenues for future research on this topic could also entail investigating the effect of the Russo-Ukrainian war on value added for green and brown funds. This would allow for further analysis of the trade-off between sustainability and financial performance following a macroeconomic crisis. While this study found green funds in the Swedish pension system to generate more value relative to brown funds in response to the pandemic, an examination of Russia's war on Ukraine might provide more insights into the dynamics that govern value added. Another option would be to conduct the same methodology but by using a larger sample size so that one may be able to find statistically significant results for the pre-treatment difference and interaction term of value added. It would also be of interest to examine the same research questions using data from a country where environmental consciousness is not as prevalent

in the public eye as in Sweden. As evidenced in this report, mutual fund performance is a broad subject and there are many areas in which it can be applied.

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Appendix

List of Funds

Table 12: List of Green Funds

Fund Number	Fund Name	Fund Number	Fund Name
118000	BL - Equities Dividend B	520759	SEB Dynamisk Aktiefond
122432	SEB Europafond	521104	Ålandsbanken Norden Aktie S Placeringsfond
123679	Handelsbanken Global Tema A1	523050	NN (L) Global Equity Impact Opportunities P
152835	Lärarfond 21-44 år	528133	Länsförsäkringar Sverige Vision A
158261	SEB Sverige Expanderad	538462	AMF Aktiefond Europa
167643	Pareto Global B	538751	Allianz Europe Small Cap Equity AT
170423	Enter Sverige A	541235	Didner & Gerge Global
182584	Aktia Capital Placeringsfond B	563965	Länsförsäkringar Global Vision A
184119	Storebrand Global Solutions A	564849	Nordea European Stars
189258	Pictet Water R	570044	Evli Finland Select Placeringsfonden B
191676	DNB Teknologi A	570630	Öhman Marknad Europa A
194092	SEB Teknologifond	596429	Nordea Generationsfond 90-tal
203067	Nordea Swedish Stars	635623	Länsförsäkringar Sparmål 2040
215996	Nordea Generationsfond 80-tal	642298	Öhman Marknad Pacific A
220244	Celina Sverige Aktiv Hållbarhet A	645952	AMF Aktiefond Världen
237834	Fondita Nordic Small Cap Placeringsfond B	666495	Templeton European Opportunities Fund A
238832	Ålandsbanken Europa Aktie B Placeringsfond	671453	Länsförsäkringar Sparmål 2035
243022	Handelsbanken Pension 80 A12	678128	Öhman Marknad USA A
278853	Handelsbanken Pension 70 A12	681783	AMF Aktiefond Sverige
280867	Odin Europa C	690693	Pictet Global Megatrend Selection R
282517	Nordea Global	721035	C WorldWide Sweden Small Cap 1A
283408	Swedbank Robur Technology A	747899	Swedbank Robur Transfer 80
286294	Nordea Småbolagsfond Norden	755033	Pictet Timber R
287656	Nordea Generationsfond 70-tal	755090	S-Banken Europa Aktie A
300996	BL - Equities America B	771030	Lannebo Teknik
301580	SEB Aktiesparfond	783720	Swedbank Robur Transfer 70
309492	CB European Quality Fund A Cap	785022	Swedbank Robur Aktiefond Pension
313742	Länsförsäkringar Fastighetsfond A	792697	C WorldWide Sweden 1A
320176	Carnegie Fastighetsfond Norden A	793109	Evli Global Placeringsfonden B
320358	BL - Global Equities B	810465	Pictet Quest Europe Sustainable Equities R
320762	Swedbank Robur Transfer 90	811117	Handelsbanken Norden Tema A1
324665	S-Banken Fenno Aktie A	820852	Swedbank Robur Nordenfond
336826	BL - Equities Europe B	832360	Länsförsäkringar Sparmål 2045
339184	Spiltan Aktiefond Stabil	840033	Handelsbanken Amerika Tema A1
344739	Aktie-Ansvar Sverige A	844522	SPP Generation 80-tal
350512	Handelsbanken Pension 60 A12	848770	NN (L) EURO Equity P
367698	Aberdeen Standard SICAV I - European Sustainable Equity Fund A	861757	Nordea Nordic
384107	Franklin U.S. Opportunities Fund A	865063	Aberdeen Global - European Equity (Ex UK) Fund
393314	Carnegie Sverigefond A	887497	Pictet Clean Energy R
401695	NN (L) Smart Connectivity P	887901	UB Global REIT Placeringsfond A
422709	Coeli - Global Select Fund R	899773	NN (L) European Equity P
439471	Skandia Time Global	904904	Öhman Sverige A
446088	BlackRock - World Technology A2	908277	AMF Aktiefond Global
450981	Odin Sverige C	912220	Storebrand Global Low Volatility A
456475	Länsförsäkringar USA Aktiv A	916122	BlackRock - Euro Markets A2
475301	Skandia Världen	916189	Handelsbanken Sverige Tema A1
479550	Seligson & Co Global Top 25 Brands A	923383	Pictet Premium Brands R
484923	SEB Nordenfond	941096	Folksam LO Världen
484980	Simplicity Norden	968420	Swedbank Robur Fastighet A
487108	Prior & Nilsson Realinvest A	968891	Pictet Security R
492306	Länsförsäkringar Europa Aktiv A	973263	Danske Invest SICAV - Sverige SI
498972	SPP Generation 70-tal	976506	CB Save Earth Fund RC
511139	Skandia USA	976928	Folksam LO Sverige
515676	Länsförsäkringar Småbolag Sverige Vision A	984187	SKAGEN Global E
520692	AMF Aktiefond Nordamerika	989491	Ålandsbanken Global Aktie B Placeringsfond

The table reports all 110 green funds that form the treatment group in the study. The fund number is the number each fund is assigned in the PPS.

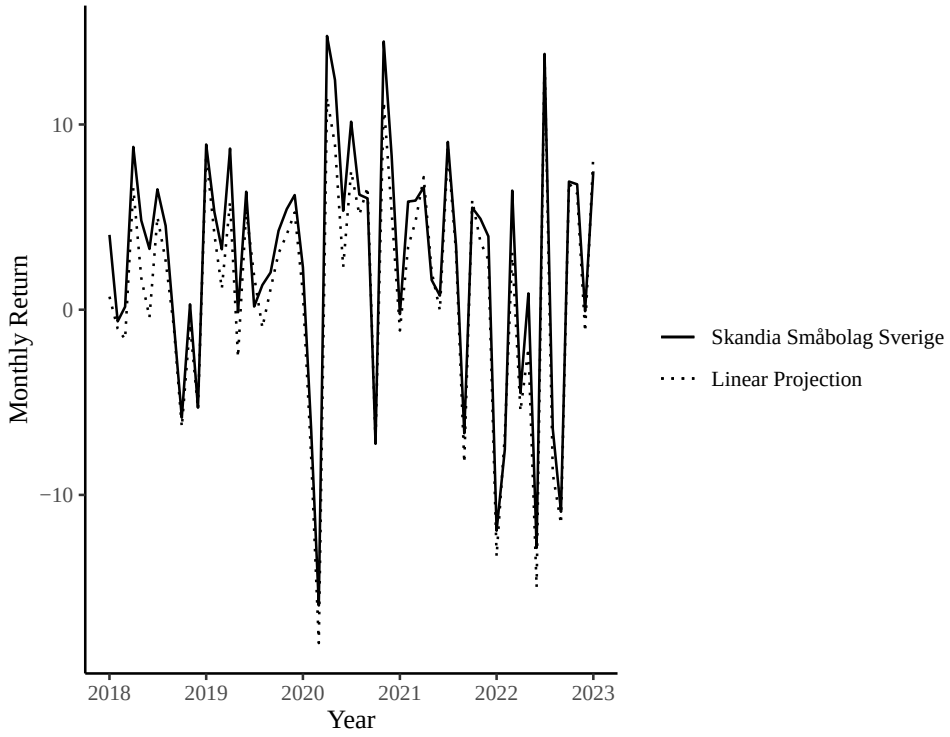
Table 13: List of Brown Funds

Fund Number	Fund Name	Fund Number	Fund Name
103606	Skandia Småbolag Sverige	502922	Allianz Global Metals and Mining A
140491	Didner & Gerge Småbolag	504100	Handelsbanken Asien Tema A1
147348	Alfred Berg Aktiv C	505586	Carnegie Indienfond A
152181	Spiltan Småbolagsfond	517748	BlackRock - World Energy A2
159442	BlackRock - Japan Small & MidCap A2	553578	BlackRock - Sustainable Energy A2
170894	Franklin India Fund A	556589	SEB Europafond Småbolag
174490	Amundi Funds Japan Equity Value A2	562421	Odin Global C
183178	Alfred Berg Norge C	562728	Odin Norge C
184416	Celina Småbolagsfond A	571695	Delphi Europe Acc
191080	Baring Global Emerging Markets A	571695	Delphi Europe Acc
192146	Aberdeen Standard SICAV I - Japanese Smaller Companies Fund A	584912	Carnegie Småbolagsfond A
202002	Fondita Global Megatrends Placeringsfond B	598557	Odin Norden C
206250	Länsförsäkringar Tillväxtmarknad Aktiv A	616797	AXA IM US Equity QI B
229922	SEB Läkemedelsfond	617670	Handelsbanken Kina Tema A1
231100	BlackRock - Emerging Markets A2	625236	BlackRock - US Mid-Cap Value Fund A2
233585	JPMorgan China A	644005	Handelsbanken Hälsovård Tema A1
235291	Baring Latin America A	652628	Axa Rosenberg Japan Small Cap Alpha Fund B
242495	DNB Fund - Nordic Equities Retail A	653097	Nordea Kinafond
250878	Allianz Emerging Asia Equity A	661066	BlackRock - Latin American A2
260919	Pictet Biotech R	666370	NN (L) Greater China Equity P
262741	Baring Global Resources A	668269	Evli Nordic Placeringsfonden B
269357	AMF Aktiefond Småbolag	670091	S-Banken Emerging Markets ESG Aktie A
271478	Indecap Guide 2 C	679837	Handelsbanken Latinamerika Impact Tema A1
272898	Spiltan Aktiefond Småland	687442	DNB SMB A
282632	Holberg Global A	687509	Handelsbanken Hållbar Energi A1
291906	Didner & Gerge Aktiefond	688986	Pictet Health R
294322	AXA IM Globlal Equity QI B	694539	Öhman Småbolagsfond A
295857	Öhman Emerging Markets A	696898	BlackRock - European Value A2
296749	Pictet Digital R	717496	Franklin Mutual Global Discovery Fund A
305243	JPMorgan Emerging Markets Equity A	751495	Handelsbanken Nordiska Småbolag A1
318469	Holberg Norge	753731	Allianz China Equity A
328021	Prior & Nilsson Sverige Aktiv A	757575	Aberdeen Standard SICAV I - Japanese Sustainable Equity Fund A
334409	Baring Hong Kong China A	764951	Evli Europa Placeringsfonden B
338590	BlackRock - World Gold A2	768499	BlackRock - India A2
339473	Aktia Nordic Small Cap Placeringsfond B	768556	BlackRock - US Basic Value A2
341362	Carnegie Listed Private Equity A	780411	UB Infra Placeringsfond A
354290	Holberg Norden	785493	Fondita Nordic Micro Cap Placeringsfond B
356063	Fondita European Small Cap Placeringsfond B	804385	BlackRock - US Flexible Equity A2
360495	S-Banken USA Aktie A	806869	Lannebo Sverige
362327	DNB Fund - Asian Mid Cap Retail A	825109	Swedbank Robur Östeuropafond A
374421	BlackRock - World Healthscience A2	834788	East Capital Russian A SEK
385401	Länsförsäkringar Asienfond A	838383	Carnegie Asia A
388298	Delphi Nordic Acc	842690	Lannebo Småbolag
391896	BlackRock - China A2	848069	Aberdeen Standard SICAV I - Global Innovation Equity Fund A
395434	Allianz Thailand Equity A	856682	Swedbank Robur Småbolagsfond Sverige A
401810	AXA IM Pacific Ex-Japan Equity QI B	874271	Pictet Indian Equities R
404236	Pictet Emerging Markets R	882126	Pictet China Equities R
407775	Aberdeen Standard - American Focused Equity Fund A	896761	Swedbank Robur Småbolagsfond Europa A
410258	BlackRock - World Financials A2	910109	Pictet Japanese Equity Opportunities R
416867	Öhman Sweden Micro Cap	914945	SEB Asienfond ex Japan
416982	Seligson & Co Global Top 25 Pharmaceuticals A	917955	Pictet Asian Equities Ex Japan R
419101	Odin Emerging Markets C	920439	NN (L) Japan Equity P
420463	Evli Sverige Småbolag	928341	Swedbank Robur Healthcare A
442483	East Capital Eastern Europe A SEK	950774	SEB Emerging Marketsfond
449090	SEB Östeuropafond	952010	Handelsbanken Svenska Småbolag A1
469692	Nordea Indienfond	964767	Öhman Global A
477729	Baring Asia Growth A	987784	BlackRock - Emerging Europe A2
481911	BlackRock - World Mining A2	987842	Handelsbanken Tillväxtmarknad Tema A1
490292	Lannebo Sverige Plus	992099	NN (L) Asia Income P
494427	Nordea Asian Stars	995571	Nordea Globala Tillväxtmarknader
501981	SKAGEN Kon-Tiki F	–	—

The table reports all 121 brown funds that form the control group in the study. The fund number is the number each fund is assigned in the PPS.

Example Linear Projection

Figure 4: Linear Projection of Skandia Småbolag Sverige



The figure compares the net return of Skandia Småbolag with its linear benchmark. The set of 10 index funds mimic the net return of Skandia Småbolag for each month.

Heteroskedasticity Results

Table 14: Breusch-Pagan Test

Variable	Test Score
Assets Under Management	$587,91^{***}$
Managerial Compensation	$213,04^{***}$
Gross Alpha	
Linear Projection	$90,55^{**}$
CAPM	$144,69^{***}$
AP7 Equity Fund	$146,77^{***}$
Net Alpha	
Linear Projection	$93,85^{***}$
CAPM	$149,76^{***}$
AP7 Equity Fund	$152,00^{***}$
Value Added	
Linear Projection	$101,10^{***}$
CAPM	$140,66^{***}$
AP7 Equity Fund	$195,81^{***}$
Value Added Net of Managerial Compensation	
Linear Projection	$98,98^{***}$
CAPM	$167,65^{***}$
AP7 Equity Fund	$243,08^{***}$

The table reports the Breusch-Pagan heteroskedasticity results for all regressions with three benchmarking methods. Significant results indicate that we can reject the null hypothesis of homoskedasticity.