Online Appendix for

"Retail Financial Innovation and Stock Market Dynamics: The Case of Target Date Funds"

by

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Appendix A: Additional Tables and Figures

Figure A.1: Size of assets in TDFs by target retirement year

This figure plots the sum of total net assets (TNA) of TDFs during 2000Q1-2021Q4 broken down by target retirement years. TDFs with target retirement years at the middle of a decade (20x5) are grouped together with TDFs with target retirement years at the beginning of the decade (20x0). The TD2010- category in this figure includes TD2000 and TD2010. The TD2050+ category includes TD2050 and TD2060.

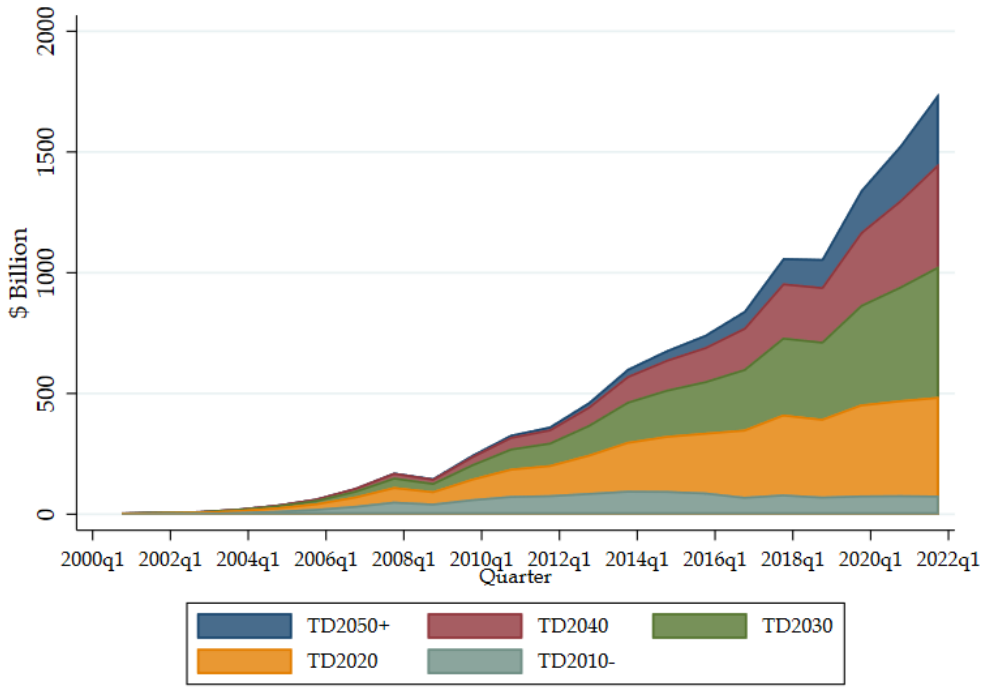
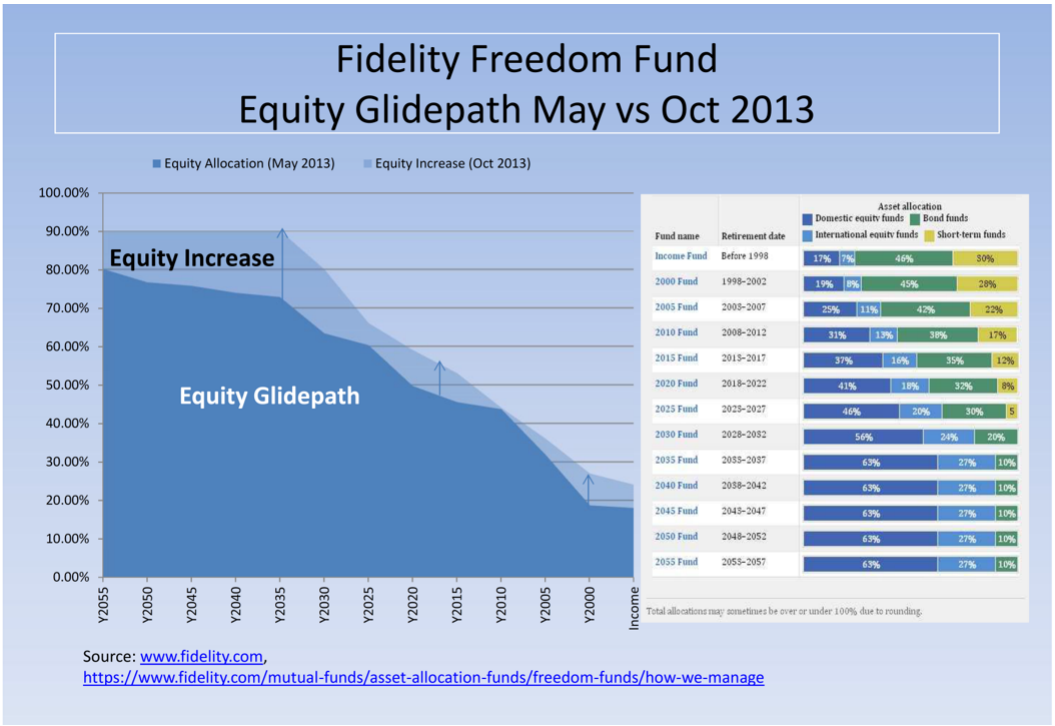


Figure A.2: Example of glide path adjustment

This figure shows the adjustment to the glide path of Fidelity Freedom Fund in September 2013. Graph source experientialwealth.com and www.chaoco.com.

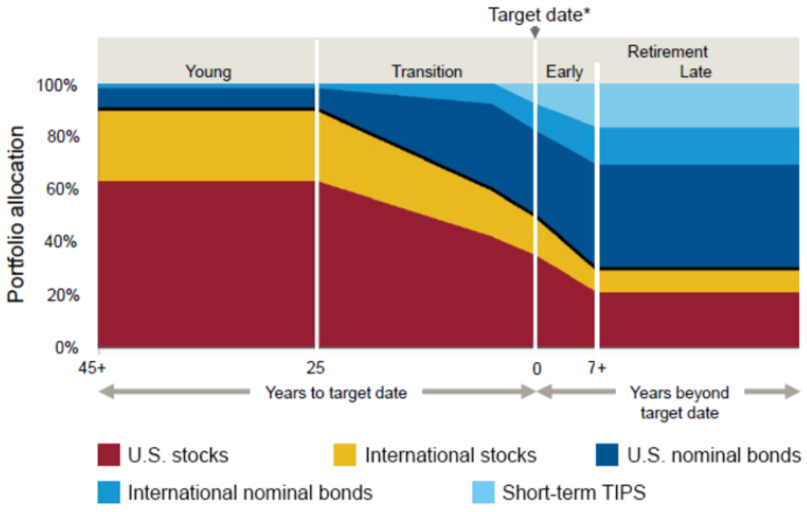


Source: www.fidelity.com,
https://www.fidelity.com/mutual-funds/asset-allocation-funds/freedom-funds/how-we-manage

Figure A.3: Glide path examples

This figure shows the asset allocations of Vanguard Target Retirement Funds in panel A and of T.Rowe Price as a function of years to retirement. Source is the fund's prospectus.

A. Glide path of Vanguard TDFs



B. Glide path of T. Rowe Price TDFs

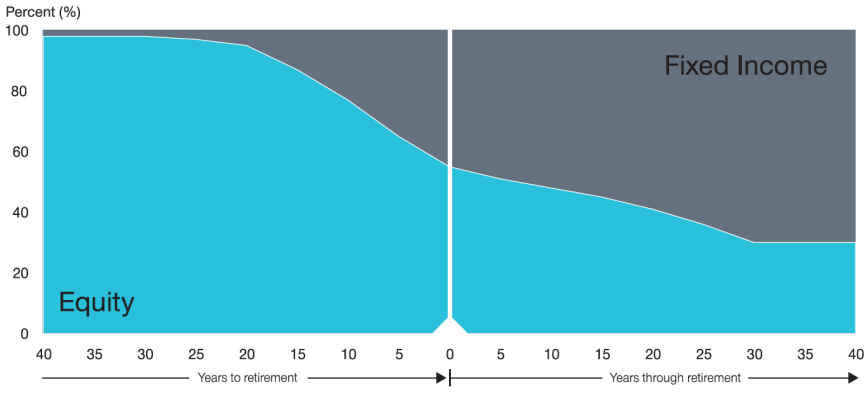


Figure A.4: Cash holding by TDFs as a function of years to retirement

This figure plots average cash holdings as fractions of total assets at active and passive TDFs as a function of years to the target retirement year grouped into 5-year bins.

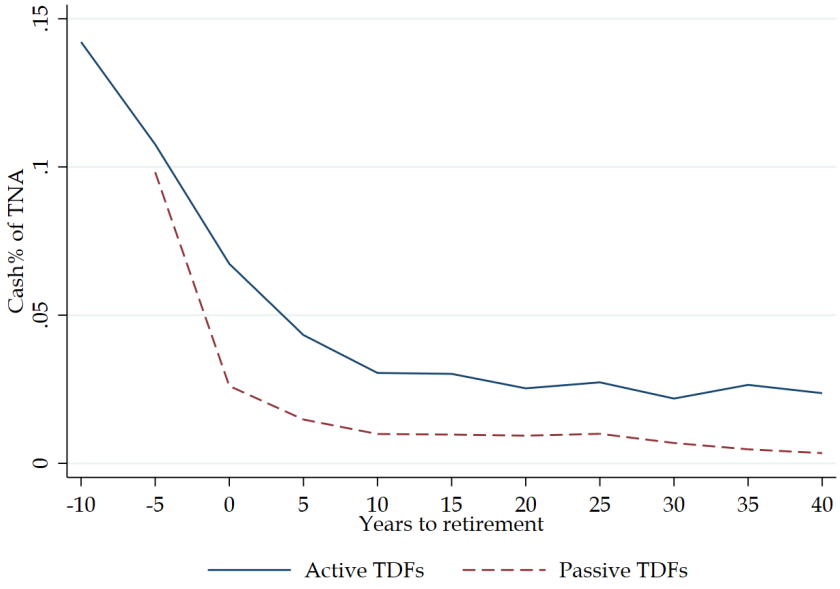


Figure A.5: Distributions of passive and active TDF ownership

This figure shows the mean decile number of passive TDF ownership for each combination of size group (based on NYSE market capitalization breakpoints) and and active TDF ownership decile. Deciles of active TDF ownership and passive TDF ownership are ranked in each cross section among all stocks in sample.

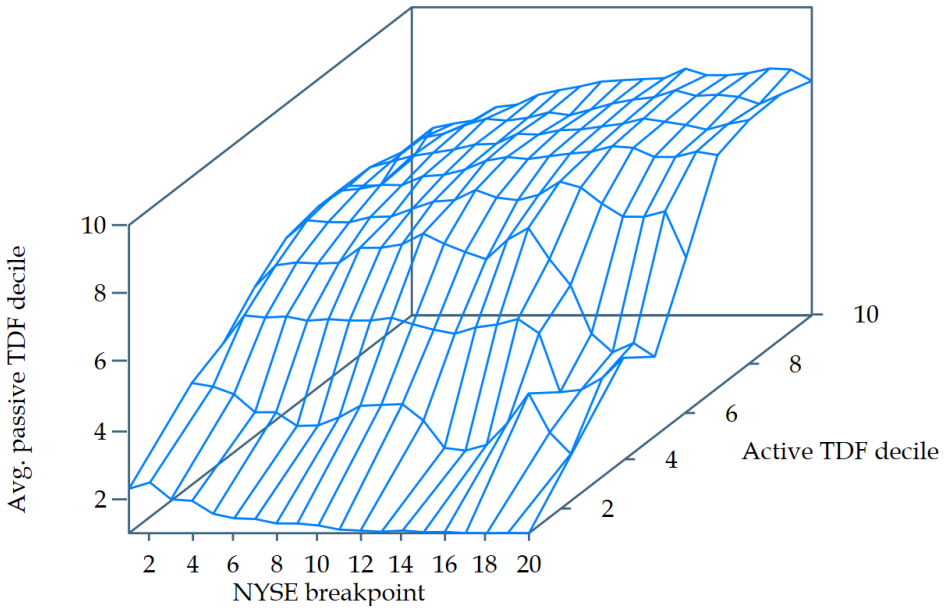


Figure A.6: TDF overweighting of S&P 500 stocks

This figure shows by year the difference between (1) the weight of S&P 500 stocks in the aggregate TDF portfolio and (2) the weight of S&P 500 stocks in the market portfolio.

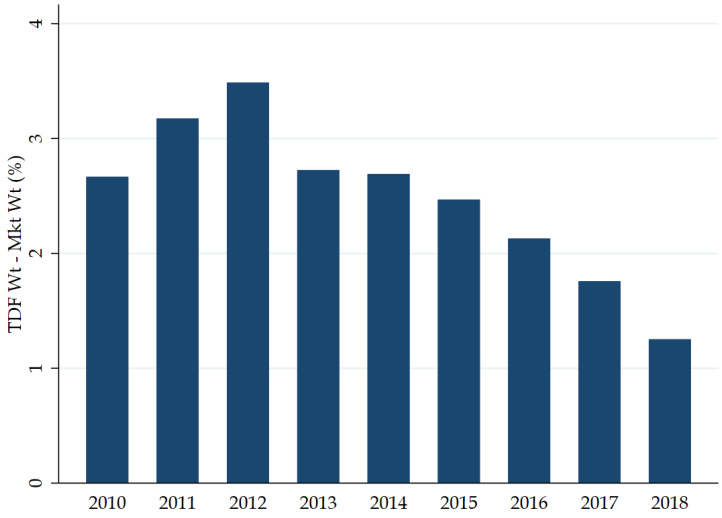


Figure A.7: Returns from simple market-contrarian trading strategy

This figure shows the cumulative returns from buying the total U.S. stock market when the excess stock market return over the bond market return in the previous month is negative, and the reverse when the excess stock market return is positive.

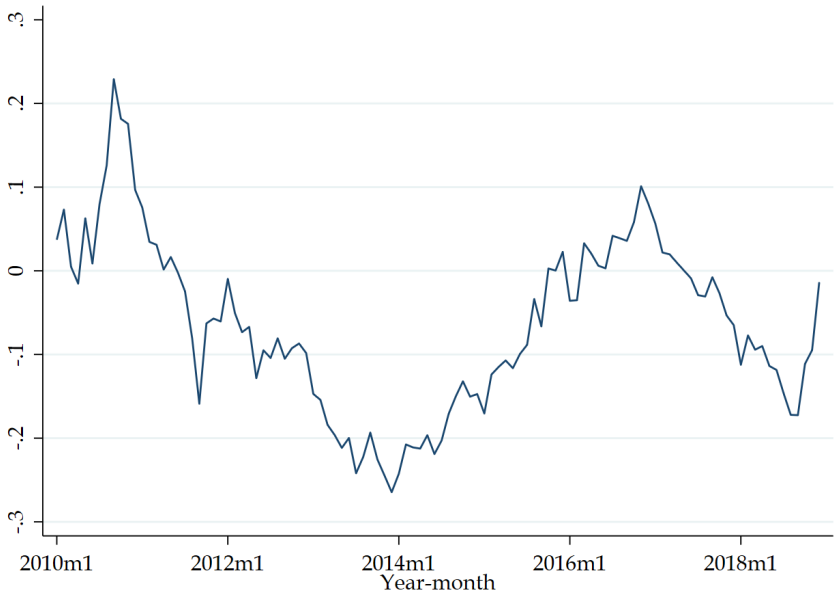


Figure A.8: Estimated fractions of the U.S. stock market held by TDFs, CITs, and BFs

This figure shows the ratios of domestic equity holdings of TDFs, CITs, and BFs to the total stock market capitalization. The calculation is a conservative estimate based on these funds holding 40% of their assets in U.S. equity, which is relatively low because BFs typically have lower equity shares than TDFs, and because of some holdings of foreign equity.

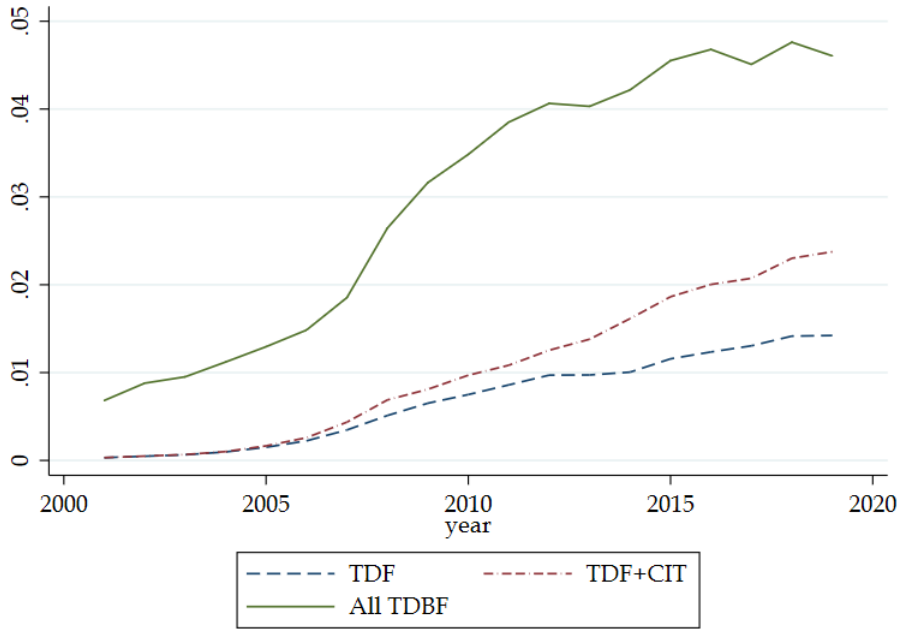


Table A.1: Summary statistics on mutual funds and stocks

This table presents statistics on equity mutual funds and stocks. The mutual fund sample contains retail/institutional domestic equity funds which are held by TDFs during 2009.01-2018.12 and with lagged asset size above $10 million. The stock sample includes NYSE-, NASDAQ-, and AMEX-traded stocks with market capitalization above the fifth percentile on the NYSE and with beginning-of-month prices above five dollars during 2010.1-2018.12. *Fund flow rate* is the quarterly growth rate in assets in excess of that implied by net fund return. *Index fund* indicator is from CRSP. *Fund size* is the total net assets of a fund. *Fraction held by TDFs* is the total value of TDF holdings of a fund divided by *Fund size*. *Fund family size* is the total size of funds managed by a management company. *Fund age* is the years since inception of the oldest share class of a fund. *Expense ratio* is the weighted-average net expense ratio across share classes. *Return volatility* is the one-year standard deviation in the monthly returns. *Monthly return* is the monthly total return of a stock. *7-Factor market beta, pre-window (rolling)* is the factor loading on the market factor estimated using a 7-factor model that includes Market-rf, SMB, HML (Fama and French, 1993), momentum (Carhart, 1997), liquidity (Pástor and Stambaugh, 2003), profitability, and investment (Fama and French, 2015) in the pre-PPA window of 1996-2005 (using 36-month rolling windows). *7-Factor alpha, pre-window (rolling-window)* is the monthly return adjusted for factor returns using betas estimated with the pre-window (rolling-window). *TDF ownership* refers to the fraction of a stock owned indirectly by TDFs through mutual funds. *Mutual fund ownership* is the fraction of a stock owned by equity mutual funds that have no investment from TDFs. *Market capitalization* is total shares outstanding times the share price. *Monthly volume/Shares out.* is monthly trading volume normalized by the number of shares outstanding. *Market-to-book ratio* is the ratio between market value and book value of common shares. *Dividend yield 12m* is the trailing-12-month cash dividend per share divided by the share price. *ROE* is calculated as quarterly revenue minus COGS, SG&A and interest expense, divided by lagged book value of common shares. *Investment* measures the quarterly growth rate in total assets. *Illiquidity* is the quarterly average of square root of the daily ratio between absolute return and trading volume measured in millions (Amihud, 2002). *Return m-6 to m-2* is the cumulative return from month $m-6$ to $m-2$.

A. Equity mutual fund monthly, N=33,537	Mean	p25	p50	p75	SD
Fund flow rate (%)	0.02	-1.18	-0.22	0.88	2.93
Index fund	0.21	0.00	0.00	0.00	0.40
Fund size ($ billion)	8.3	0.5	1.5	4.3	31.8
Frac. held by TDFs (%)	9.91	0.00	0.39	5.79	22.68
Fund family size ($ billion)	436.6	51.0	165.2	433.9	703.3
Fund age (year)	18.3	9.0	15.0	22.0	14.8
Expense ratio (%)	0.79	0.54	0.84	1.05	0.38
Return volatility (%)	3.90	2.74	3.65	4.89	1.56

B. Stock monthly, N=136,518	Mean	p25	p50	p75	SD
Monthly return (%)	1.28	-3.82	1.15	6.05	9.39
7-Factor market beta, pre-window	1.02	0.65	0.99	1.34	0.62
7-Factor market beta, rolling-window	1.01	0.63	0.97	1.34	0.61
7-Factor alpha, pre-window (%)	0.33	-4.40	0.15	4.69	8.82
7-Factor alpha, rolling-window (%)	0.33	-4.37	0.19	4.73	9.04
TDF ownership (%)	0.64	0.26	0.49	0.78	0.65
Mutual fund ownership (%)	25.13	18.00	24.93	32.05	10.15
Market capitalization ($ billion)	11.09	0.67	1.95	6.68	36.50
Monthly volume/Shares out.	0.18	0.09	0.14	0.22	0.17
Market-to-book ratio	3.53	1.43	2.19	3.68	5.31
Dividend yield 12m (%)	1.78	0.00	1.08	2.38	6.61
ROE (%)	6.03	2.47	5.72	9.16	10.74
Investment (%)	2.28	-1.01	1.04	3.45	10.33
Illiquidity	0.05	0.01	0.03	0.06	0.07
Return m-6 to m-2 (%)	7.61	-3.53	7.06	17.84	20.32

Table A.2: TDF rebalancing: actual vs. predicted by quarter

This table estimates the relationship between actual rebalancing by TDFs in quarter q and the predicted values of rebalancing given the TDFs' equity shares and realized differential asset-class returns during quarters q and $q-1$. $Rebal(E)_q$ / TNA_{q-1} ($Rebal(FI)_q$ / TNA_{q-1}) in panel A (B) is TDF-level rebalancing trade in quarter q with respect with equity (bond), divided by $TDF\ TNA$ in quarter $q-1$ and winsorized at 1% and 99%. $Pred.rebal_q$ stands for predicted rebalancing in response to the realized return of quarter q and is calculated as $-S(1-S)(R^E-R^B)_q$ in panel A and $S(1-S)(R^E-R^B)_q$ in panel B, where S is the TDF's equity share in $q-1$ and $(R^E-R^B)_q$ stands for the quarterly excess return of the equity market over the bond market in quarter q. $Pred.rebal_{q-1}$ stands for the value of predicted rebalancing in response to the realized return of quarter $q-1$. R^E is approximated by the weighted average between total U.S. and foreign equity market return in columns 1-4, where the weights follow the proportions of domestic and foreign equity in a TDF's equity holdings in quarter $q-1$, and by the U.S. only equity market return in columns 5-8. The sample is restricted to TDF-quarters during 2008Q3-2018Q4 where the value of available holdings (including cash) is larger than 90% of fund assets, the equity share does not change by more than 5% from the previous quarter (to exclude glide path adjustments), and the fund assets do not grow by more than 50% from the previous quarter (to exclude fund mergers). Control variables include lagged quarter's log $TDF\ TNA$, log *Series size*, *Cash share*, and current quarter's $TDF\ flow\ rate$, *TDF quarterly return*, and *Years to retirement*. Standard errors are clustered two ways by TDF and quarter. *p $<$ .1; **p $<$ .05; ***p $<$ .01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A.	$Rebal(E)_q$ / TNA_{q-1}							
	US+Foreign R^E				US R^E			
	All		Passive	Active	All		Passive	Active
$Pred.rebal_q$	0.665***	0.695***	0.741***	0.671***	0.616***	0.577***	0.667***	0.534***
	(0.097)	(0.100)	(0.071)	(0.127)	(0.080)	(0.063)	(0.064)	(0.069)
$Pred.rebal_{q-1}$	0.148	0.147	0.066	0.190	0.154	0.158	0.104	0.185
	(0.112)	(0.118)	(0.064)	(0.152)	(0.109)	(0.114)	(0.066)	(0.143)
Controls	no	yes	yes	yes	no	yes	yes	yes
TDF FE	yes	yes	yes	yes	yes	yes	yes	yes
Observations	4,670	4,670	1,539	3,131	4,670	4,670	1,539	3,131
R-squared	0.226	0.234	0.429	0.213	0.219	0.227	0.421	0.206
B.	$Rebal(FI)_q$ / TNA_{q-1}							
	US+Foreign R^E				US R^E			
	All		Passive	Active	All		Passive	Active
$Pred.rebal_q$	0.529***	0.457***	0.675***	0.364***	0.505***	0.409***	0.578***	0.330***
	(0.072)	(0.065)	(0.132)	(0.067)	(0.067)	(0.058)	(0.111)	(0.062)
$Pred.rebal_{q-1}$	0.115	0.098	0.304	-0.007	0.144	0.125	0.343	0.011
	(0.090)	(0.092)	(0.230)	(0.060)	(0.097)	(0.096)	(0.236)	(0.063)
Controls	no	yes	yes	yes	no	yes	yes	yes
TDF FE	yes	yes	yes	yes	yes	yes	yes	yes
Observations	4,670	4,670	1,539	3,131	4,670	4,670	1,539	3,131
R-squared	0.248	0.255	0.414	0.221	0.245	0.254	0.407	0.221

Table A.3: Rebalancing model fit by TDF series

This table estimates the relationship between TDF rebalancing with respect to equity and the predicted values of rebalancing estimated for the largest 12 TDF series based on average AUM during the sample period. The sample is restricted to TDF-quarters where the value of available holdings (including cash) is larger than 90% of fund assets, the equity share does not change by more than 5% from the previous quarter (to exclude glide path adjustments), and the fund assets do not grow by more than 50% from the previous quarter (to exclude fund mergers). Regression specifications follow Table A.2, panel A, column 2. The dependent variable is TDF-level rebalancing trade in quarter q calculated as the sum of changes in positions in equity mutual funds minus TDF flow-driven trades in equity funds, divided by the TDF asset size in quarter $q-1$ and winsorized at 1% and 99%. Predicted rebalancing is calculated as $-S(1-S)(R^E-R^B)_q$ and $-S(1-S)(R^E-R^B)_{q-1}$, for quarter q and $q-1$ respectively, where S is the fraction of a TDF portfolio invested in equity in $q-1$. R^E is approximated by the weighted average between total U.S. and foreign equity market return, where the weights follow the proportions of domestic and foreign equity in a TDF's equity holdings in quarter $q-1$. Control variables include lagged quarter's log of TDF fund size, log of TDF series size, cash share, and current quarter's net flow rate to the TDF, TDF raw return, and years to retirement. Standard errors are clustered two ways by TDF and quarter. *p $<$ .1; **p $<$ .05; ***p $<$ .01.

	Series name	Passive	Coef, q	Coef, q-1	R-squared	N
1	Vanguard Target Retirement	1	0.965***	0.001	0.877	391
			(0.068)	(0.022)		
2	Fidelity Freedom	0	0.969**	0.492	0.161	576
			(0.415)	(0.376)		
3	T Rowe Price Retirement	0	0.415***	0.637***	0.556	308
			(0.113)	(0.216)		
4	American Funds Target Date Retirement	0	0.238***	0.012	0.481	38
			(0.055)	(0.698)		
5	JPMorgan SmartRetirement	0	0.042	0.681	0.175	93
			(0.618)	(0.746)		
6	TIAA-CREF Lifecycle	0	1.682***	0.250	0.685	154
			(0.455)	(0.205)		
7	Principal LifeTime	0	-0.008	0.198*	0.259	194
			(0.070)	(0.110)		
8	Fidelity Freedom Index	1	0.616***	0.020	0.487	301
			(0.138)	(0.161)		
9	Fidelity Advisor Freedom	0	0.893***	0.706	0.262	250
			(0.153)	(0.452)		
10	American Century One Choice	0	1.088***	-0.337***	0.762	128
			(0.195)	(0.072)		
11	TIAA-CREF Lifecycle Index	1	0.575***	-0.090	0.310	225
			(0.179)	(0.126)		
12	KP Retirement Path	0	0.037	0.987*	0.525	101
			(0.249)	(0.538)		

Table A.4: Fit of TDF rebalancing model with three-asset-class model

This table estimates the relationship between actual rebalancing by TDFs in quarter q with respect to domestic equity, foreign equity, and fixed income positions, and the predicted values of rebalancing in those asset classes given the TDFs' sub-asset-class shares and realized sub-asset-class returns during quarters q and $q-1$. Dependent variables $Rebal_q$ / TNA_{q-1} in columns 1-3 (4-6 and 7-9) is TDF-level rebalancing trade in quarter q with respect with domestic equity (foreign equity and fixed income), divided by $TDF\ TNA$ in quarter $q-1$ and winsorized at 1% and 99%. $Pred.rebal_q$ ($Pred.rebal_{q-1}$) stands for predicted rebalancing in response to the realized return of quarter q and is calculated as follows. Suppose the share of domestic equity, foreign equity, and bond are a, b, and $1-a-b$, predicted rebalancing in columns 1-3 is calculated as $-a(1-a)(R^{DE}-R^B)+ab(R^{FE}-R^B)$ where a and b are measured in quarter $q-1$, and R^{DE} and R^{FE} denote total returns of the U.S. equity market and foreign equity market respectively. Predicted rebalancing in columns 4-6 is calculated as $-b(1-b)(R^{FE}-R^B)+ba(R^{DE}-R^B)$, and predicted rebalancing in columns 7-9 is calculated as zero minus the sum of the predicted rebalancing amounts in DE and FE, so that rebalancing trades sum up to zero. $Pred.rebal_{q-1}$ stands for the value of predicted rebalancing in response to the realized return of quarter $q-1$. The sample is restricted to TDF-quarters during 2008Q3-2018Q4 where the value of available holdings (including cash) is larger than 90% of fund assets, the equity share does not change by more than 5% from the previous quarter (to exclude glide path adjustments), and the fund assets do not grow by more than 50% from the previous quarter (to exclude fund mergers). Control variables include lagged quarter's log $TDF\ TNA$, log *Series size*, *Cash share*, and current quarter's $TDF\ flow\ rate$, *TDF quarterly return*, and *Years to retirement*. Standard errors are clustered two ways by TDF and quarter. *p $<$ .1; **p $<$ .05; ***p $<$ .01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Rebal(DE)_q$ / TNA_{q-1}			$Rebal(FE)_q$ / TNA_{q-1}			$Rebal(FI)_q$ / TNA_{q-1}		
	All	Passive	Active	All	Passive	Active	All	Passive	Active
$Pred.rebal_q$	0.456***	0.734***	0.329**	0.380***	0.648***	0.252***	0.446***	0.626***	0.379***
	(0.087)	(0.060)	(0.125)	(0.071)	(0.092)	(0.086)	(0.071)	(0.132)	(0.073)
$Pred.rebal_{q-1}$	0.113	0.136**	0.092	0.033	0.011	0.040	0.101	0.278	0.002
	(0.075)	(0.054)	(0.100)	(0.061)	(0.076)	(0.083)	(0.089)	(0.198)	(0.056)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
TDF FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	4,670	1,539	3,131	4,670	1,539	3,131	4,670	1,539	3,131
R-squared	0.172	0.367	0.148	0.196	0.272	0.191	0.252	0.380	0.222

Table A.5: TDF rebalancing: actual vs. predicted by fund size

This table estimates the relationship between actual rebalancing by TDFs in quarter q and the predicted values of rebalancing given the TDFs' equity shares and realized differential asset-class returns during the third, second, and first months of quarter q and during $q-1$ in subsamples of small, medium, and large TDFs. $Rebal(E)_q$ / TNA_{q-1} ($Rebal(FI)_q$ / TNA_{q-1}) in panel A (B) is TDF-level rebalancing trade in quarter q with respect with equity (bond), divided by $TDF\ TNA$ in quarter $q-1$ and winsorized at 1% and 99%. Fund size groups small, medium and large are based on cross-sectional sorting of TDF fund size into terciles. $Pred.rebal_{q,m=t}$ stands for predicted rebalancing in response to the realized return of the tth month of quarter q, and is calculated as $-S(1-S)(R^E-R^B)_{q,m=t}$ in panel A and $S(1-S)(R^E-R^B)_{q,m=t}$ in panel B, where S is the TDF's equity share in $q-1$ and $(R^E-R^B)_{q,m=t}$ stands for the monthly excess return of the equity market over the bond market in month t. $Pred.rebal_{q-1}$ stands for the value of predicted rebalancing in response to the realized return of quarter $q-1$. R^E is approximated by the weighted average between total U.S. and foreign equity market return, where the weights follow the proportions of domestic and foreign equity in a TDF's equity holdings in quarter $q-1$. The sample is restricted to TDF-quarters during 2008Q3-2018Q4 where the value of available holdings (including cash) is larger than 90% of fund assets, the equity share does not change by more than 5% from the previous quarter (to exclude glide path adjustments), and the fund assets do not grow by more than 50% from the previous quarter (to exclude fund mergers). Control variables include lagged quarter's log $TDF\ TNA$, log *Series size*, *Cash share*, and current quarter's $TDF\ flow\ rate$, *TDF quarterly return*, and *Years to retirement*. Standard errors are clustered two ways by TDF and quarter. *p < .1; **p < .05; ***p < .01.

	(1)	(2)	(3)	(4)	(5)	(6)
A.			$Rebal(E)_q$ / TNA_{q-1}			
		Passive			Active	
	Small	Medium	Large	Small	Medium	Large
$Pred.rebal_{q,m=3}$	0.842***	0.207	0.611***	0.150	0.467	0.425
	(0.220)	(0.145)	(0.158)	(0.308)	(0.293)	(0.447)
$Pred.rebal_{q,m=2}$	0.582***	0.863***	0.879***	0.701**	0.355	1.275**
	(0.170)	(0.158)	(0.092)	(0.330)	(0.232)	(0.558)
$Pred.rebal_{q,m=1}$	1.025***	0.783***	0.832***	0.728***	0.680**	1.060***
	(0.136)	(0.149)	(0.102)	(0.242)	(0.260)	(0.238)
$Pred.rebal_{q-1}$	0.217**	0.130	0.041	0.355	-0.040	0.477**
	(0.090)	(0.080)	(0.061)	(0.265)	(0.194)	(0.233)
Controls	yes	yes	yes	yes	yes	yes
TDF FE	yes	yes	yes	yes	yes	yes
Observations	515	530	474	1,014	1,000	1,067
R-squared	0.434	0.407	0.717	0.277	0.285	0.191
B.			$Rebal(FI)_q$ / TNA_{q-1}			
		Passive			Active	
	Small	Medium	Large	Small	Medium	Large
$Pred.rebal_{q,m=3}$	0.634***	1.032***	0.802**	-0.037	0.527***	0.565***
	(0.140)	(0.175)	(0.311)	(0.216)	(0.126)	(0.138)
$Pred.rebal_{q,m=2}$	0.785***	1.443***	0.873**	0.439	0.555***	0.280*
	(0.148)	(0.383)	(0.364)	(0.268)	(0.125)	(0.152)
$Pred.rebal_{q,m=1}$	0.315*	0.221	0.075	0.325	0.164	0.459***
	(0.172)	(0.343)	(0.353)	(0.234)	(0.115)	(0.149)
$Pred.rebal_{q-1}$	0.185	0.348*	0.216	-0.178	0.155**	-0.014
	(0.125)	(0.176)	(0.258)	(0.154)	(0.064)	(0.089)
Controls	yes	yes	yes	yes	yes	yes
TDF FE	yes	yes	yes	yes	yes	yes
Observations	515	530	474	1,014	1,000	1,067
R-squared	0.462	0.443	0.526	0.271	0.291	0.241

Table A.6: TDF rebalancing: actual vs. predicted under small and large return shocks

This table estimates the relationship between actual rebalancing by TDFs in quarter q and the predicted values of rebalancing given the TDFs' equity shares and realized differential asset-class returns during the third, second, and first months of quarter q and during $q-1$ in subsamples of small and large differential asset class return shocks. $Rebal(E)_q$ / TNA_{q-1} ($Rebal(FI)_q$ / TNA_{q-1}) in panel A (B) is TDF-level rebalancing trade in quarter q with respect with equity (bond), divided by $TDF\ TNA$ in quarter $q-1$ and winsorized at 1% and 99%. Small (large) shocks are those where $R^E - R^B$ is less (more) than one standard deviation from the mean. $Pred.rebal_{q,m=t}$ stands for predicted rebalancing in response to the realized return of the tth month of quarter q, and is calculated as $-S(1-S)(R^E - R^B)_{q,m=t}$ in panel A and $S(1-S)(R^E - R^B)_{q,m=t}$ in panel B, where S is the TDF's equity share in $q-1$ and $(R^E - R^B)_{q,m=t}$ stands for the monthly excess return of the equity market over the bond market in month t. $Pred.rebal_{q-1}$ stands for the value of predicted rebalancing in response to the realized return of quarter $q-1$. R^E is approximated by the weighted average between total U.S. and foreign equity market return, where the weights follow the proportions of domestic and foreign equity in a TDF's equity holdings in quarter $q-1$. The sample is restricted to TDF-quarters during 2008Q3-2018Q4 where the value of available holdings (including cash) is larger than 90% of fund assets, the equity share does not change by more than 5% from the previous quarter (to exclude glide path adjustments), and the fund assets do not grow by more than 50% from the previous quarter (to exclude fund mergers). Control variables include lagged quarter's log $TDF\ TNA$, log *Series size*, *Cash share*, and current quarter's $TDF\ flow\ rate$, *TDF quarterly return*, and *Years to retirement*. Standard errors are clustered two ways by TDF and quarter. *p $<$ .1; **p $<$ .05; ***p $<$ .01.

	(1)	(2)	(3)	(4)
A.	$Rebal(E)_q$ / TNA_{q-1}			
	Small shock		Large shock	
	Passive	Active	Passive	Active
$Pred.rebal_{q,m=3}$	0.545**	0.713	0.509***	0.402*
	(0.211)	(0.585)	(0.105)	(0.211)
$Pred.rebal_{q,m=2}$	0.969***	0.890**	0.826***	0.829***
	(0.183)	(0.398)	(0.109)	(0.273)
$Pred.rebal_{q,m=1}$	0.937***	1.023***	0.953***	0.973***
	(0.131)	(0.346)	(0.094)	(0.164)
$Pred.rebal_{q-1}$	0.118	0.191	0.045	0.097
	(0.101)	(0.168)	(0.068)	(0.165)
Controls	yes	yes	yes	yes
TDF FE	yes	yes	yes	yes
Observations	1,239	2,479	1,415	2,868
R-squared	0.315	0.176	0.420	0.212
B.	$Rebal(FI)_q$ / TNA_{q-1}			
	Small shock		Large shock	
	Passive	Active	Passive	Active
$Pred.rebal_{q,m=3}$	0.420**	0.078	0.018	0.295**
	(0.153)	(0.286)	(0.288)	(0.140)
$Pred.rebal_{q,m=2}$	0.828***	0.083	1.168***	0.336**
	(0.129)	(0.251)	(0.219)	(0.140)
$Pred.rebal_{q,m=1}$	0.806***	0.171	0.981***	0.375***
	(0.106)	(0.140)	(0.165)	(0.132)
$Pred.rebal_{q-1}$	-0.066	0.169*	0.366	0.031
	(0.076)	(0.088)	(0.227)	(0.097)
Controls	yes	yes	yes	yes
TDF FE	yes	yes	yes	yes
Observations	1,239	2,479	1,415	2,868
R-squared	0.288	0.201	0.449	0.214

Table A.7: Flow sensitivity of funds without TDF investments

This table estimates the flow-performance relationship in mutual funds without TDF investment during 2008.7-2018.12. Observations are at the mutual fund monthly level. The sample in columns 1-3 (4-6) includes domestic equity funds (corporate bond funds) which are not held by any TDF during the sample period. The dependent variable $Fund\ flow$ is the monthly fund flow rate, defined as the growth rate in fund assets in excess of the realized net fund return. Observations where the lagged asset size is less than $10 million or where the dependent variable is below 1% or above 99% are dropped. $R^E - R^B$ is the excess return of the U.S. total stock market over the U.S. total bond market. $Index\ fund$ equals one if a mutual fund is an index fund. Control variables include the lagged month's log *Fund size*, log *Fund family size*, current month's log *Fund age*, *Expense ratio*, and lagged *Return volatility*. Standard errors are clustered two ways by time and fund. *p $<$ .1; **p $<$ .05; ***p $<$ .01.

	(1)	(2)	(3)	(4)	(5)	(6)
	$Fund\ flow_t$					
	Domestic equity funds			Bond funds		
	All	Index	Active	All	Index	Active
$(R^E - R^B)_t$	0.068***	0.106***	0.067***	0.041***	0.018	0.041***
	(0.022)	(0.016)	(0.022)	(0.013)	(0.018)	(0.013)
$(R^E - R^B)_t \times Index\ fund$	0.034*			-0.024		
	(0.018)			(0.018)		
$(R^E - R^B)_{t-1}$	0.040***	0.077***	0.040***	0.013	-0.020	0.013
	(0.014)	(0.017)	(0.014)	(0.011)	(0.020)	(0.011)
$(R^E - R^B)_{t-1} \times Index\ fund$	0.034**			-0.035*		
	(0.015)			(0.019)		
Controls	yes	yes	yes	yes	yes	yes
Fund FE	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no
Observations	301,026	52,203	248,823	183,329	12,270	171,059
R-squared	0.176	0.118	0.191	0.197	0.185	0.184

Table A.8: TDF ownership and foreign equity fund flows

Columns 1-3 estimate the effect of TDF ownership on the mutual fund flow-performance relationship in the foreign-equity fund sample. Columns 4-6 estimate the flow-performance relationship in mutual funds without TDF investment. Observations are at the mutual fund monthly level during 2008.7-2018.12. The dependent variable *Fund flow* is the monthly fund flow rate, defined as the growth rate in fund assets in excess of the realized net fund return. Observations where the lagged asset size is less than $10 million or where the dependent variable is below 1% or above 99% are dropped. $R^E - R^B$ is the excess return of the U.S. total stock market over the U.S. total bond market. *Frac.by TDFs* is measured as the fraction of fund assets held by TDFs, measured at the end of the previous quarter. *Index fund* equals one if a mutual fund is an index fund. Control variables include the lagged month's log *Fund size*, log *Fund family size*, current month's log *Fund age*, *Expense ratio*, and lagged *Return volatility*. Standard errors are clustered two ways by time and fund. *p < .1; **p < .05; ***p < .01.

	(1)	(2)	(3)	(4)	(5)	(6)
	$Foreign\ equity\ fund\ flow_t$					
	TDF-invested			Non-TDF-invested		
	All	Index	Active	All	Index	Active
$(R^E - R^B)_t \times Frac.by\ TDFs_{q-1}$	-0.174***	-0.386***	-0.143***			
	(0.049)	(0.119)	(0.048)			
$(R^E - R^B)_{t-1} \times Frac.by\ TDFs_{q-1}$	-0.127**	-0.172	-0.123**			
	(0.059)	(0.107)	(0.057)			
$(R^E - R^B)_t$	0.060***	0.163***	0.057***	0.097***	0.123***	0.097***
	(0.016)	(0.029)	(0.016)	(0.020)	(0.022)	(0.020)
$(R^E - R^B)_t \times Index\ fund$	0.092***			0.028		
	(0.032)			(0.018)		
$(R^E - R^B)_{t-1}$	0.028*	0.016	0.029*	0.070***	0.106***	0.070***
	(0.015)	(0.035)	(0.015)	(0.018)	(0.025)	(0.018)
$(R^E - R^B)_{t-1} \times Index\ fund$	-0.014			0.034*		
	(0.030)			(0.018)		
$Frac.by\ TDFs_{q-1}$	0.005	-0.004	0.007			
	(0.005)	(0.011)	(0.005)			
Controls	yes	yes	yes	yes	yes	yes
Fund FE	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no
Observations	19,559	5,731	13,828	117,284	23,927	93,357
R-squared	0.158	0.125	0.174	0.195	0.130	0.223

Table A.9: Market betas by TDF quintile

This table reports means and standard deviations of market betas in pre- and post-PPA periods by quintiles of TDF ownership. Observations are collapsed to the stock level and TDF quintiles are ranked based on the average TDF ownership during 2010-2018. Market betas are estimated using a seven-factor risk-adjustment model, where the factors include Market-rf, SMB, HML (Fama and French, 1993), momentum (Carhart, 1997), liquidity (Pástor and Stambaugh, 2003), profitability, and investment (Fama and French, 2015), and are estimated twice for each stock using all available monthly returns during 1996-2005 (pre-PPA period) and 2010-2019 (post-PPA period) respectively. Statistics of difference tests on means between pre and post are reported for each TDF quintile.

Beta on (Mkt-Rf)		High TDF (quint.=5) N=326	quint.=4 N=457	quint.=3 N=460	quint.=2 N=355	Low TDF (quint.=1) N=232
Pre 96.01-05.12	Mean	1.189	1.136	1.027	1.005	0.998
	Std. dev	(0.638)	(0.576)	(0.527)	(0.656)	(0.593)
Post 10.01-19.12	Mean	1.077	1.060	0.985	1.003	0.951
	Std. dev	(0.487)	(0.387)	(0.437)	(0.576)	(0.553)
Diff (post - pre)	Mean	-0.112**	-0.076**	-0.042	-0.002	-0.047
	Std. err	(0.044)	(0.032)	(0.032)	(0.046)	(0.053)

Table A.10: TDF ownership and stock return sensitivity to market performance in sub-periods

This table examines the relationship between TDF ownership and monthly stock return sensitivity to differential asset class performance during two sub-periods 2010-2014 and 2015-2018. The dependent variable *7-factor alpha* is the risk-adjusted return winsorized at 1% and 99%, where the factors include Market-rf, SMB, HML (Fama and French, 1993), momentum (Carhart, 1997), liquidity (Pástor and Stambaugh, 2003), profitability, and investment (Fama and French, 2015). Beta loadings are estimated using 1996-2005 (36-month rolling windows) in panel A (panel B). TDF (%) is the percentage of a stock indirectly owned by TDFs measured at the end of the previous quarter. $Return_{m-1}$ and $Return_{m-6\,to\,m-2}$ are raw returns in month $m-1$ and cumulative raw returns during months $m-6$ to $m-2$, respectively. The pre-PPA period (falsification test) includes 1987-2005 and factor betas for that test use the window 1977-1986 in panel A and 36-month rolling windows in panel B. TDF(%) in the falsification test is measured as averages during 2010-2018. The sample includes NYSE-, NASDAQ-, and AMEX-traded stocks with market capitalizations that are above the fifth percentile on the NYSE and with beginning-of-month prices above five dollars. Control variables include log of lagged values of *Market capitalization*, *Monthly volume/Shares out.*, *Market-to-book ratio*, and lagged values of *Dividend yield 12m*, *ROE*, *Investment*, *Illiquidity*, and *Mutual fund ownership*. Standard errors in this table are clustered two ways by time and stock.

	(1)	(2)	(3)	(4)	(5)	(6)
A.			*7-Factor alpha pre-window$_m$*			
		2010-2014			2015-2018	
$(R^E - R^B)_m \times TDF_{q-1}(\%)$	-0.037	-0.057*	-0.039	-0.040**	-0.042**	-0.062***
	(0.033)	(0.034)	(0.033)	(0.019)	(0.020)	(0.022)
$(R^E - R^B)_{m-1} \times TDF_{q-1}(\%)$ (%)	0.008	-0.005	-0.020	-0.012	-0.018	-0.023
	(0.019)	(0.023)	(0.024)	(0.019)	(0.020)	(0.019)
$TDF_{q-1}(\%)$	-0.002***	-0.001	-0.001	-0.002***	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Return_{m-1}$		-0.032***	-0.032***		-0.023**	-0.025**
		(0.011)	(0.011)		(0.010)	(0.010)
$Return_{m-6\,to\,m-2}$		-0.008	-0.008*		-0.000	-0.000
		(0.005)	(0.005)		(0.007)	(0.007)
Control for characteristics	no	yes	yes	no	yes	yes
Characteristics $\times$ $(R^E - R^B)$	no	no	yes	no	no	yes
Time-by-industry FE	yes	yes	yes	yes	yes	yes
Observations	85,527	69,744	69,744	63,056	57,597	57,597
R-squared	0.204	0.212	0.214	0.235	0.250	0.251
B.			*7-Factor alpha rolling-window$_m$*			
		2010-2014			2015-2018	
$(R^E - R^B)_m \times TDF_{q-1}(\%)$	-0.031	-0.028	-0.037	-0.013	-0.013	-0.019
	(0.022)	(0.025)	(0.025)	(0.013)	(0.012)	(0.013)
$(R^E - R^B)_{m-1} \times TDF_{q-1}(\%)$	0.016	-0.001	-0.011	-0.029**	-0.023*	-0.018
	(0.018)	(0.022)	(0.022)	(0.014)	(0.014)	(0.015)
$TDF_{q-1}(\%)$	-0.002**	-0.001	-0.001	-0.002***	-0.001**	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Return_{m-1}$		-0.020	-0.021		-0.006	-0.007
		(0.012)	(0.013)		(0.016)	(0.015)
$Return_{m-6\,to\,m-2}$		-0.000	-0.000		-0.008	-0.008
		(0.005)	(0.005)		(0.007)	(0.007)
Control for characteristics	no	yes	yes	no	yes	yes
Characteristics $\times$ $(R^E - R^B)$	no	no	yes	no	no	yes
Time-by-industry FE	yes	yes	yes	yes	yes	yes
Observations	109,618	89,758	89,758	96,168	86,818	86,818
R-squared	0.181	0.185	0.186	0.151	0.160	0.160

Table A.11: Stock-level TDF rebalancing and quarterly return

This table examines the relationship between stock-level TDF rebalancing and quarterly returns during 2010-2018.The dependent variable *Quarterly 7-factor alpha* is the quarterly risk-adjusted return winsorized at 1% and 99%, where the factors include Market-rf, SMB, HML (Fama and French, 1993), momentum (Carhart, 1997), liquidity (Pástor and Stambaugh, 2003), profitability, and investment (Fama and French, 2015). Beta loadings are estimated using 1996-2005 (36-month rolling windows) in panel A (panel B). $TDF\ rebalancing_q$ represents the quarterly TDF rebalancing trades allocated to the stock level, by i) distributing TDF rebalancing trades to the underlying mutual funds according to lagged portfolio weights of the funds in the TDF portfolio, followed by aggregating up the trades by different TDFs to the fund level, and ii) allocating mutual fund level TDF-induced rebalancing flows to the stock level according to lagged weights of stocks in mutual fund portfolios, followed by summing up the trades at the stock level. The sample includes NYSE-, NASDAQ-, and AMEX-traded stocks with market capitalizations that are above the fifth percentile on the NYSE and with beginning-of-quarter prices above five dollars. Control variables include log of lagged values of *Market capitalization*, *Monthly volume/Shares out.*, *Market-to-book ratio*, and lagged values of *Dividend yield 12m*, *ROE*, *Investment*, *Illiquidity*, and *Mutual fund ownership*. Standard errors in this table are clustered two ways by time and stock.

	(1)	(2)	(3)
A.	*Quarterly 7-factor alpha (pre-window)$_q$*		
$TDF\ rebalancing_q$	7.189**	6.440*	6.313*
	(3.459)	(3.273)	(3.171)
Controls	no	yes	yes
Characteristics $\times$ $(R^E - R^B)$	no	no	yes
Time-by-industry FE	yes	yes	yes
Observations	172,200	139,389	139,389
R-squared	0.317	0.353	0.354
B.	*Quarterly 7-factor alpha (rolling-window)$_q$*		
$TDF\ rebalancing_q$	5.512	4.530	4.855
	(3.495)	(3.615)	(3.939)
Controls	no	yes	yes
Characteristics $\times$ $(R^E - R^B)$	no	no	yes
Time-by-industry FE	yes	yes	yes
Observations	172,200	139,389	139,389
R-squared	0.310	0.342	0.342

Table A.12: Mean test of monthly return of trading strategies

This table shows the p-values of mean tests for the monthly returns from investing in a portfolio of stocks with the highest TDF ownership and shorting a portfolio with the lowest TDF ownership when the excess stock market return in the current month (columns 1-4) or previous month (columns 5-8) is negative, and the reverse when the excess stock market return is positive. A graphical representation of the cumulative profits are shown in Figure 5. The sample includes NYSE-, NASDAQ-, and AMEX-traded stocks with market capitalizations that are above the fifth percentile on the NYSE and with beginning-of-month prices above five dollars. In each quarter and within each size group based on market capitalization (the size groups are defined according to NYSE size breakpoints that are at 5-percentile increments), stocks are sorted two-ways into quintiles, first by mutual fund ownership (calculated as the sum of ownership by mutual funds which are not held by TDFs), and second by TDF ownership. The trading strategy in columns 1-4 (columns 5-8) invests in the highest TDF portfolio and shorts the lowest TDF portfolio in month t if $R^E - R^B, m < 0$ ($R^E - R^B, m-1 < 0$) and takes the reverse positions (long the lowest TDF portfolio and short the highest TDF portfolio) if $R^E - R^B, m > 0$ ($R^E - R^B, m-1 > 0$). Columns 1-2 and 5-6 test the mean of the monthly 7-factor (Market-rf, SMB, HML, momentum, liquidity, profitability and investment) alphas where betas are estimated using the pre-PPA window of 1996-2005, and columns 3-4 and 7-8 test the mean of the rolling-window 7-factor alphas of the respective strategies.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Current return strategy				Lagged return strategy			
7-Factor alpha (%)	pre-window		rolling-window		pre-window		rolling-window	
	EW	VW	EW	VW	EW	VW	EW	VW
Mean	0.458	0.501	0.438	0.455	0.338	0.214	0.437	0.385
SD	1.549	1.594	1.524	1.542	1.580	1.657	1.524	1.561
Ho: Mean=0, p-value	0.003	0.002	0.004	0.003	0.028	0.182	0.004	0.012

Table A.13: Breakdown of TDF holdings of bond funds

This table shows the breakdown of TDF holdings of bond funds. Observations are at TDF-quarterly frequency. The fraction in each category is calculated as the value of TDF holdings in that category divided by the total value of the TDF's bond fund holdings.

TDF quarterly, N=13,110	Mean	Median	SD
Corporate	0.671	0.735	0.295
Government	0.141	0.066	0.207
Foreign	0.090	0.015	0.137
Other	0.099	0.000	0.211

Appendix B: TDF and BF holding data quality

TDFs are identified in the CRSP Mutual Fund Database by fund names containing target retirement years of 2000, 2005, 2010, . . . , or 2065. Balanced funds are identified using Lipper classifications including B (balanced funds), MTAA/MTAC/MTAG/MTAM (mixed-asset target allocation aggressive/conservative/growth/moderate), MTRI (retirement income), and MATJ (mixed-asset target today).

Figure B.1 suggests several quarters have lower coverage of holdings data, mainly 2010Q2, 2010Q3, and 2015Q2. Results in this paper are similar whether we include or drop these quarters. We also assessed the quality of holdings data of the balanced funds. Figure B.2 panel B suggests that the coverage of BF holdings is worse than that of TDFs, which is another reason we do not include the BFs in our main analyses, but results on BFs are available upon request.

Figure B.1: TDF holding data quality

This figure plots the values of available TDF holdings from the CRSP Mutual Fund Database against the total asset values of TDFs over 2003-2018. The solid line represents the total AUM of TDFs. The dotted line shows the total values of TDF holdings that can be matched to mutual funds.

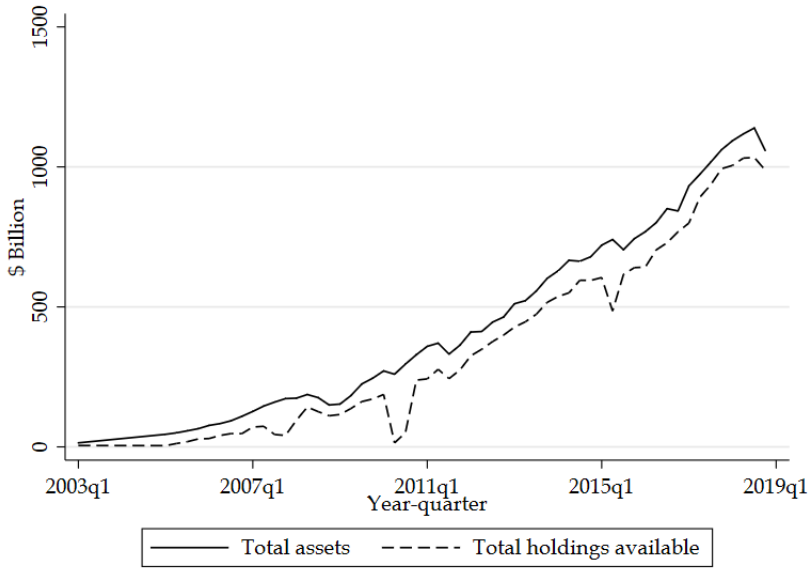
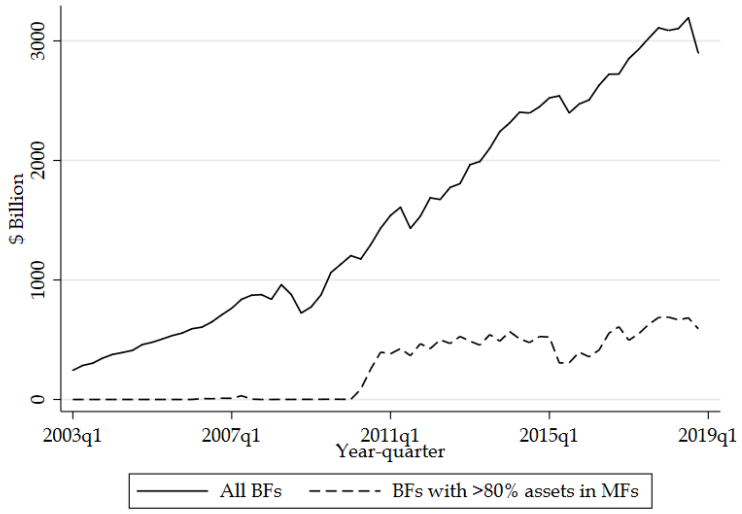


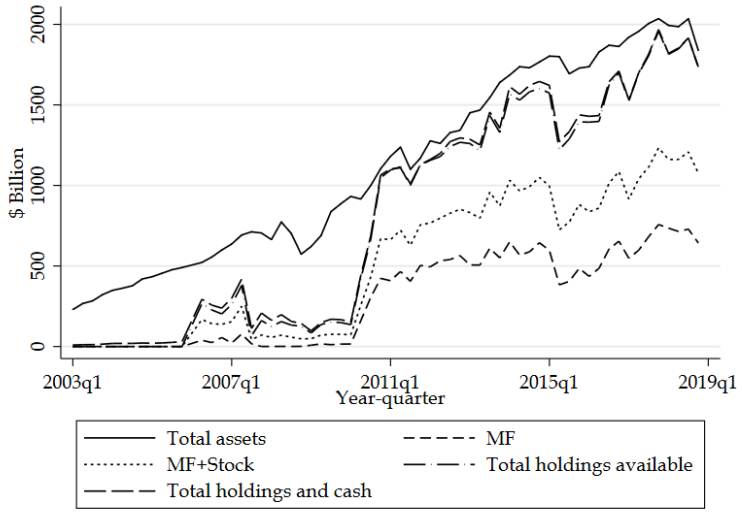
Figure B.2: Balanced fund holding data quality

Panel A plots the values of available balanced fund holdings from the CRSP Mutual Fund Database against the total asset values of balanced funds over 2003-2018. The solid line represents the total AUM of balanced funds. The line MF represents the total values of BF holdings that can be matched to mutual funds. MF+Stock shows the total values that can be matched to mutual funds and stocks. Total holdings available represents values of all holdings including those where the CUSIPs cannot be matched to mutual funds or stocks (possibly holdings of individual bonds). Total holdings and cash add cash to holdings of mutual funds and securities. Panel B shows the value of balanced funds-of-funds in the dashed line. Balanaced funds-of-funds are defined as the balanced funds with at least 80% of assets invested in mutual funds.

A. Size of balanced funds-of-funds



B. Available holdings of balanced funds



Appendix C: Calculation of price elasticity of demand

We rely on the estimated price effect in Table 7 (the coefficient -0.04 on $R^E - R^B, m \times TDF(\%)$), and scale this coefficient to -0.01 to account for holdings of all TDFs, CITs, and BFs. Suppose the ownership of stock i by these funds is $X_i\%$. Let the aggregate TDF, CIT, and BF portfolio value be A and its target equity share be S^*. Further, let w_i be the weight out of the equity portion that is allocated to stock i. Then $X_i\% \equiv w_i S^* A / M_i$, where M_i is the market capitalization of stock i. S^* in the representative TDF portfolio is roughly 70% in the data.

To calculate $\Delta\%Price$, we take the adjusted coefficient -0.01 which measures the incremental return (or change in price) due to each 1% of representative TDF ownership. Consider a 10% increase in the U.S. equity market in month m. The coefficient of -0.01 implies that the return of stock i is $0.01 \times 10\% \times X_i = 0.001 X_i$ lower in month m due to TDF-type trading by these funds.

For $\Delta\%Demand$, we estimate that for the same increase in the equity market, the representative TDF (including CITs and BFs) sells equity at $-0.7 \times 0.3 \times 10\% = -2.1\%$ of its portfolio value according to the rebalancing formula. The dollar amount of equity sold by the aggregate is therefore $-0.021A$. Assume this representative TDF fund sells all the stocks in its portfolio in proportion to portfolio weights, and all rebalancing is implemented in the same month as the return shock, then it sells $0.021Aw_i$ dollar value of stock i, or fraction $0.021Aw_i/M_i = (0.021/0.7) \times X_i\% = 0.0003X_i$ of stock i's market capitalization in month m. The elasticity is therefore $-0.0003X_i/0.001X_i = -0.3$.

Appendix D: S&P 500 index inclusion details and tables

The S&P inclusion rule is based on a set of eligibility criteria, including domicile, stock exchange, years since IPO, financial viability, market capitalization, and liquidity. After the eligibility criteria are satisfied, the "index committee" at S&P Global has discretion over the composition of the index, and in particular, considers a "sector balance."[1]

We construct a group of control stocks for stocks in the S&P 500, following the methodology in Denis et al. (2003). First, based on the eligibility criteria, we screen the full sample of stocks and restrict to stocks that are domiciled in the U.S., traded on the eligible exchanges, at least one year from the IPO, and have positive sum of earnings in the recent four quarters as well as positive earnings in the most recent quarter. Second, in each of the 12 Fama-French industry portfolios, we first divide the stocks into 3 groups based on terciles of market capitalization, with equal numbers of stocks in each group, and then further divide each industry and size group into another three based on liquidity (defined as the annual trading volume divided by the number of shares outstanding). This way we obtain 108 portfolios. Third, we map the S&P 500 stocks to the 108 portfolios (multiple S&P stocks can be mapped to the same portfolio) and use the other stocks in the corresponding portfolios that are not included in the index as a control for the index-included stocks. Throughout the sample period, 53 out of the 108 portfolios can be matched with S&P 500 stocks.

In addition to the results discussed in the main paper, Table 9 also shows that stocks included in the S&P 500 have lower market momentum than otherwise similar stocks due to higher ownership by TDFs. Consistent with the variation around index inclusion being driven primarily by *active* TDFs which rebalance at a slower pace, the speed of the impact on stock returns is slower than that found in Table 7.

As noted in the main paper, index inclusion leads to an increase in price (Harris and Gurel, 1986; Shleifer, 1986; Wurgler and Zhuravskaya, 2002; Chang, Hong, and Liskovich, 2015), to excess daily return volatility due to exchange-traded fund (ETF) trading (Ben-David, Franzoni, and Moussawi (2018)), and to more co-movement with other stocks in the index (Barberis, Shleifer, and Wurgler, 2005; Boyer, 2011). Our analysis focuses on a different dimension of returns than these papers. Our analysis of the sensitivity of stock return to the lagged market returns would be unaffected by any return-level effect of inclusion in the index. Thus, our results are unlikely to be driven by a general increase in demand for a stock on inclusion in the index. Our results are also quite distinct from the ETF-induced excess volatility. Our conversations with practitioners suggest that TDFs

[1] See https://us.spindices.com/documents/methodologies/methodology-sp-us-indices.pdf .

rebalance at much lower frequency than the trading strategies of ETFs, motivating our choice of monthly rather than daily returns. Finally, co-movement concerns the correlation between contemporaneous stock return and market performance, while we focus on the relation with lagged market returns. Obviously, if the market return follows a random walk, co-movement does not generate any prediction on the effect of index inclusion on the stock-level market momentum. If the market return were serially positively correlated, then co-movement would predict an increase in the sensitivity to market momentum in index-included stocks rather than the negative effect we find. However, we find, only in the recent period with TDFs, that the S&P index has negative serial correlation, as we discuss in the next section.

We conduct a two-stage least squares analysis to try to estimate the effect of TDF ownership using S&P 500 index inclusion as an instrument. Specifically, the second-stage equation is:

$$\begin{aligned} Alpha_{ipm} = \gamma_1 (R^E - R^B)_m \times TDF(\%)_{im} + \gamma_2 (R^E - R^B)_{m-1} \times TDF(\%)_{im} \\ + \eta TDF(\%)_{im} + \xi X_{im} + \delta_1 X_{im} \cdot (R^E - R^B)_m + \delta_2 X_{im} \cdot (R^E - R^B)_{m-1} \\ + \theta_{pm} + Return_{im-1} + Return_{i,m-6 \text{ to } m-2} + \epsilon_{ipm} \end{aligned} \tag{D.1}$$

where $TDF(\%)_{im}$ is predicted TDF ownership obtained from the first-stage regression following equation (6). In some specifications, we allow the relationship between S&P index inclusion and TDF(%) to vary over time (consistent with the growth of TDFs and their use of different indexes), but within each period, all variation in TDF(%) is just that driven by S&P inclusion.

Table D.2 presents the results of this analysis. The point estimates are an order of magnitude larger than those in our main analysis, and the standard errors are roughly the same size as the coefficients, so that one cannot reject any hypothesis of interest.

Table D.1: Summary statistics: S&P 500 stocks and control group

This table presents summary statistics of the matched sample of S&P 500 stocks with the control group. Observations are at stock-by-month level during 2010-2018 and include S&P 500 stocks and control stocks matched on industry, size, and liquidity, following Denis et al. (2003). *Monthly return* is the monthly total return of a stock. *7-Factor market beta, pre-window (rolling)* is the factor loading on the market factor estimated using a 7-factor model that includes Market-rf, SMB, HML (Fama and French, 1993), momentum (Carhart, 1997), liquidity (Pástor and Stambaugh, 2003), profitability, and investment (Fama and French, 2015) in the pre-PPA window of 1996-2005 (using 36-month rolling windows). *7-Factor alpha, pre-window (rolling-window)* is the monthly return adjusted for factor returns using betas estimated with the pre-window (rolling-window). *TDF ownership* refers to the fraction of a stock owned indirectly by TDFs through mutual funds. *Mutual fund ownership* is the fraction of a stock owned by equity mutual funds that have no investment from TDFs. *Market capitalization* is total shares outstanding times the share price. *Monthly volume/Shares out.* is monthly trading volume normalized by the number of shares outstanding. *Market-to-book ratio* is the ratio between market value and book value of common shares. *Dividend yield 12m* is the trailing-12-month cash dividend per share divided by the share price. *ROE* is calculated as quarterly revenue minus COGS, SG&A and interest expense, divided by lagged book value of common shares. *Investment* measures the quarterly growth rate in total assets. *Illiquidity* is the quarterly average of square root of the daily ratio between absolute return and trading volume measured in millions (Amihud, 2002). $Return_m$ is the lagged raw monthly return. $Return_{m-6\,to\,m-2}$ is the cumulative return from month $m-6$ to $m-2$. p-values of difference tests on means are reported.

	S&P 500 stocks N=8,289		Control group N=7,620		
	Mean	SD	Mean	SD	p-value
$Monthly\ return_m$ (%)	0.963	7.722	1.344	8.370	0.00
7-Factor market beta pre-window	1.269	0.551	1.126	0.653	0.00
$7\text{-}Factor\ market\ beta\ rolling_{m-1}$	1.018	0.461	1.074	0.518	0.00
$7\text{-}Factor\ alpha\ pre\text{-}window_m$ (%)	0.001	7.381	0.455	8.097	0.00
$7\text{-}Factor\ alpha\ rolling\text{-}window_m$ (%)	0.165	7.205	0.548	7.780	0.00
$TDF\ ownership_{q-1}$ (%)	0.662	0.423	0.740	0.653	0.00
$Mutual\ fund\ ownership_{q-1}$ (%)	22.662	6.548	29.703	8.592	0.00
$Market\ capitalization_{m-1}$ ($ billion)	35.744	85.618	4.350	3.172	0.00
$(Monthly\ volume/Shares\ out.)_{m-1}$	0.220	0.182	0.206	0.151	0.00
$Market\text{-}to\text{-}book\ ratio_{q-1}$	5.226	6.312	4.147	5.703	0.00
$Dividend\ yield\ 12m_{q-1}$ (%)	1.578	6.094	1.177	2.611	0.00
ROE_{q-1} (%)	9.795	8.356	7.808	9.063	0.00
$Investment_{q-1}$ (%)	2.680	8.980	3.160	10.090	0.00
$Illiquidity_{q-1}$	0.009	0.004	0.021	0.011	0.00
$Return_{m-1}$ (%)	0.012	0.075	0.017	0.083	0.00
$Return_{m-6\,to\,m-2}$ (%)	16.490	23.310	20.160	24.812	0.00

Table D.2: 2SLS estimate of stock return sensitivity to lagged market performance

This table estimates the relationship between TDF ownership and stock returns in response to recent market performance using a two-stage least squares procedure. TDF ownership in month m is instrumented by S&P 500 membership in month m. The sample includes the matched sample of S&P 500 stocks with control stocks. The dependent variable is 7-factor-adjusted alpha winsorized at 1% and 99%, where the factors include Market-rf, SMB, HML (Fama and French, 1993), momentum (Carhart, 1997), liquidity (Pástor and Stambaugh, 2003), profitability, and investment (Fama and French, 2015), beta loadings are estimated using 1996-2005 (36-month rolling windows) in columns 1-2 (columns 3-4). The first stage corresponding to columns 1 and 3 estimates an average effect of S&P 500 membership on TDF ownership. The first stage corresponding to columns 2 and 4 allows the effect of S&P 500 membership on TDF ownership to vary month over month. $Pred.TDF_m$ represents predicted TDF ownership from the first stage. $Return_{m-1}$ and $Return_{m-6\ to\ m-2}$ are raw returns in month $m-1$ and cumulative raw returns during months $m-6$ to $m-2$, respectively. Standard errors in this table are block-bootstrapped with clustering by time and stock over 500 repetitions.

	(1)	(2)	(3)	(4)
	7-Factor alpha pre-window$_m$		*7-Factor alpha rolling-window$_m$*	
$(R^E - R^B)_m \times Pred.TDF_m(\%)$	-0.799**	-0.422	-0.212	-0.120
	(0.318)	(0.284)	(0.253)	(0.174)
$(R^E - R^B)_{m-1} \times Pred.TDF_m(\%)$	0.013	-0.005	-0.243	-0.272
	(0.297)	(0.179)	(0.249)	(0.171)
$Pred.TDF_m(\%)$	-0.006	0.010	0.006	0.014
	(0.024)	(0.016)	(0.022)	(0.016)
$Return_{m-1}$	-0.069***	-0.069***	-0.041***	-0.041**
	(0.016)	(0.018)	(0.013)	(0.016)
$Return_{m-6\ to\ m-2}$	-0.008	-0.008	-0.006	-0.006
	(0.008)	(0.011)	(0.007)	(0.008)
Controls	yes	yes	yes	yes
Characteristics $\times$ $(R^E - R^B)$	yes	yes	yes	yes
Time-by-peer group FE	yes	yes	yes	yes
Stock FE	yes	yes	yes	yes
Time variation in first stage	no	yes	no	yes
Observations	12,154	12,154	16,441	16,441
R-squared	0.282	0.281	0.230	0.230

Appendix E: Additional details on bonds

Data on corporate bond mutual funds come from CRSP, and we identify corporate bond funds as those with Lipper classifications of A, BBB, HY, SII, SID, IID, or CRSP objective codes starting in IC. We obtain the holdings of the corporate bond funds from CRSP and map them using CUSIP codes to the corporate bonds in WRDS Bond Returns and the treasury securities in CRSP Treasuries. Following Choi et al. (2020), to reduce the effect of potential data errors, we restrict the sample to bond funds where at least 20% of the fund assets are invested in corporate bonds, and where the quarterly growth rate in fund size is larger than -50% and smaller than 200%. We measure cash as the sum of fractions of assets held in cash, treasuries, and money market funds. The fraction held by TDFs at the bond level follows the analogous formula as that for stocks, i.e., $TDF_{c,q-1} = \Sigma_{jk} a_{cj,q-1} b_{jk,q-1}$ for corporate bond c in the lagged quarter $q-1$, where $a_{cj,q-1}$ is the fraction of bond c held by mutual fund j and $b_{jk,q-1}$ is the fraction of mutual fund j held by TDF k. The two measures of illiquidity are based on Choi et al. (2020): the Roll (1984) measure of effective bid-ask spread based on first-order serial covariance of price changes, and the fraction of zero-trading days during a quarter.

Our regression specification is:

$$\begin{aligned} Return_{cmtr} = \lambda_1 (R^E - R^B)_m \times TDF_{cq-1} + \lambda_2 (R^E - R^B)_{m-1} \times TDF_{cq-1} + \gamma TDF_{cq-1} + \xi X_{cm} \\ + \delta_1 X_{cm} \cdot (R^E - R^B)_m + \delta_2 X_{cm} \cdot (R^E - R^B)_{m-1} + Return_{cm-1} + Return_{c,m-6 \text{ to } m-2} \\ + \theta_{mt} + \sigma_r + \epsilon_{cm} \end{aligned} \tag{E.1}$$

where c indexes the corporate bond, m represents a month, t refers to *Years to maturity* in integer years, and r indicates the credit rating. The regression controls for θ_{mt}, years-to-maturity(integer)-by-time fixed effects, and σ_r, rating fixed effects. X_{cm} is a set of bond characteristics including fraction of the bond held by mutual funds with no TDF investment, amount outstanding, trading volume, Roll (1984) illiquidity measure, and the fraction of zero-trading days in a quarter. Because TDFs buy into bonds when $R^E - R^B > 0$, we expect the coefficients $\hat{\lambda_1}$ and $\hat{\lambda_2}$ to be positive.

Table E.1 presents the estimates of equation (E.1). Column 1 presents the baseline estimate without controlling for bond characteristics and shows no effect of TDFs on bond returns. Column 2 adds in the control variables and suggests that a bond held more by TDFs tend to have higher returns following high excess return of equity, but column 3 shows that the estimated effect goes away when we control for the reversal in bond returns during the short- and medium-term. A possible explanation is that retail/institutional

flows to bond funds drive reversals in bond returns, and our estimated coefficient on $(R^E - R^B) \times TDF$ picks that up. Given that the coefficient on medium-term lagged return is strong, we control for longer lagged returns in columns 4-6 ($m-12$ to $m-2$). Column 5 adds in the interaction between $R^E - R^B$ and bond characteristics, and column 6 adds in rating-by-time fixed effects. While the estimated coefficients of interest are in the expected direction, we fail to reject the hypothesis that TDFs have no effect on corporate bond returns, perhaps because of the use of derivatives and active liquidity management by funds to eliminate cross-bond price differentials.

Table E.1: TDF ownership and corporate bond return sensitivity to differential asset class returns

This table examines the relationship between TDF ownership and monthly corporate bond return sensitivity to differential asset class performance during 2010-2018. The sample includes corporate bonds in the WRDS Bond Database with beginning-of-month ratings in the top three (numerical ratings 1-3, equivalent to S&P ratings AAA, AA+, or AA). The dependent variable $Return_m$ is the monthly raw bond return measured at end of month, winsorized at 1% and 99%. $TDF_{q-1}(\%)$ is the percentage of the amount outstanding of a bond indirectly held by TDFs measured at the end of the previous quarter. Control variables include log of lagged values of *Amount outstanding*, *Monthly volume/amount out*, and lagged values of *Frac. held by mutual funds*, *Roll illiquidity* and ZTD. $Return_{m-1}$, $Return_{m-6\,to\,m-2}$, $Return_{m-12\,to\,m-2}$ are raw returns in month $m-1$, cumulative raw returns in months $m-6$ to $m-2$, and cumulative raw returns in months $m-12$ to $m-2$, respectively. Time-by-TTM FE stands for *Years to maturity*-by-time fixed effects. Standard errors in this table are clustered two ways by time and bond.

	(1)	(2)	(3)	(4)	(5)	(6)
			$Return_m$			
$(R^E - R^B)_m \times TDF_{q-1}(\%)$	0.001	0.017***	0.013	0.012	0.002	-0.001
	(0.010)	(0.006)	(0.008)	(0.009)	(0.009)	(0.008)
$(R^E - R^B)_{m-1} \times TDF_{q-1}(\%)$	0.000	0.008	0.008	0.014**	0.011	0.006
	(0.010)	(0.005)	(0.007)	(0.007)	(0.008)	(0.009)
$TDF_{q-1}(\%)$	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Return_{m-1}$			-0.364***	-0.374***	-0.377***	-0.393***
			(0.036)	(0.032)	(0.029)	(0.025)
$Return_{m-6\,to\,m-2}$			-0.099***			
			(0.024)			
$Return_{m-12\,to\,m-2}$				-0.074***	-0.074***	-0.080***
				(0.016)	(0.015)	(0.013)
Control for characteristics	no	yes	yes	yes	yes	yes
Characteristics $\times (R^E - R^B)$	no	no	no	no	yes	yes
Time-by-TTM FE	yes	yes	yes	yes	yes	yes
Rating FE	yes	yes	yes	yes	yes	n.a.
Rating-by-time FE	no	no	no	no	no	yes
Observations	25,727	19,456	17,090	13,991	13,991	13,991
R-squared	0.624	0.792	0.829	0.836	0.838	0.852