Passive Investing and the Rise of Mega-Firms

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Growth of Passive Investing

- US equity index mutual funds and index ETF in 1993:
  - AUM $23 billion.
  - 3.7% of combined active and passive.
  - 0.44% of US stock market.
- US equity index mutual funds and index ETF in 2021:
  - AUM $8.4 trillion.
  - 53% of combined active and passive.
  - 16% of US stock market.
- 42% of index mutual funds track S&P500 index.
- What are effects on asset prices and the real economy?

This Paper

- Flows into passive funds tracking capitalization-weighed indices:
    - Raise disproportionately prices of *largest* stocks within the indices.
        - Example: Inflows into S&P500 passive funds $\rightarrow$ Higher returns for largest S&P500 stocks than smaller S&P500 stocks.
    - *Raise* largest stocks' return volatility and price sensitivity to cashflow news.
    - If stocks are mispriced because of noise traders $\rightarrow$ Passive flows raise disproportionately prices of *overvalued* stocks within the indices' largest.
- $\rightarrow$ Passive investing is *not neutral*.
    - Reduces primarily cost of capital of largest firms.
    - Makes size distribution of firms more skewed.
- Provide empirical evidence in support of model's predictions.

Passive Flows in CAPM World

- Suppose that index tracked by passive funds is market portfolio.
- If passive flows are due to increased market participation:
  - Market risk premium drops.
  - $\rightarrow$ Stock prices rise, especially for high CAPM beta stocks.
  - Small stocks have higher CAPM beta than large stocks $\rightarrow$ Higher returns for small stocks than for large stocks.
- If passive flows are due to switch from active to passive:
  - No effect on stock prices because active and passive funds hold same portfolio.

Intuition

- CAPM logic fails to account for flows' effect on price volatility.
- Assume:
  - A stock is in high demand by noise traders (return to CAPM world later).
  - Additional demand generated by passive flows induces smart-money investors to short the stock.
- $\rightarrow$ Stock's price rises.
- $\rightarrow$ Stock's price becomes more sensitive to cashflow shocks.
  - Positive shock to stock's cashflows $\rightarrow$ Stock accounts for larger fraction of market movements $\rightarrow$ Smart-money investors buy the stock to reduce risk.
- High price sensitivity $\rightarrow$ High volatility $\rightarrow$ Smart-money investors become even more willing to buy the stock $\rightarrow$ Price and price sensitivity rise $\rightarrow$ ...
- Mechanism is quantitatively significant for large stocks, as their idiosyncratic risk is non-negligible.

Model

Assets

- Continuous time t goes from zero to infinity.
- Riskless asset, exogenous return $r > 0$.
- N stocks $n = 1, .., N$. Stock n is in supply of $\eta_n > 0$ shares and pays dividend flow per share

$$D_{nt} = \bar{D}_n + b_n D^s_t + D^i_{nt}$$

  - $\bar{D}_n \geq 0$: Constant component.
  - $b_n D^s_t$: Systematic component. Systematic factor D^s_t follows square-root process

    $$dD^s_t = \kappa^s \left(\bar{D}^s - D^s_t\right) dt + \sigma^s \sqrt{D^s_t} dB^s_t$$

    with $(\kappa^s, \bar{D}^s, \sigma^s)$ positive and b_n non-negative.
  - D^i_{nt}: Idiosyncratic component, follows square-root process

    $$dD^i_{nt} = \kappa^i_n \left(\bar{D}^i_n - D^i_{nt}\right) dt + \sigma^i_n \sqrt{D^i_{nt}} dB^i_{nt}.$$

    with $\{\kappa^i_n, \bar{D}^i_n, \sigma^i_n\}_{n=1,..,N}$ positive, and $(B^s_t, \{B^i_{nt}\}_{n=1,..,N})$ mutually independent.
  - Normalizations: $\bar{D}^s = 1$ and $\bar{D}_n + b_n + \bar{D}^i_n = 1$.
- Square-root process: Tractable specification that ensures:
  - Positive prices.
  - Volatility of dividend per share *increases* with dividend level.

Agents

- Experts (active investors).
  - Can invest in all stocks without constraints.
  - Maximize $\mathbb{E}_t(dW_{1t}) - \frac{\rho}{2}\mathbb{V}\mathrm{ar}_t(dW_{1t})$ over number of shares $\{z_{1nt}\}_{n=1..,N}$ held in the stocks.
  - Measure μ_1.

- Non-experts (passive investors).
  - Can invest in riskless asset and capitalization-weighted index that includes η'_n shares of stock n, where $\eta'_n = \eta_n$ for $n \in \mathcal{I}$ and $\eta'_n = 0$ for $n \notin \mathcal{I}$.
  - Maximize $\mathbb{E}(dW_{2t}) - \frac{\rho}{2}\mathbb{V}\mathrm{ar}(dW_{2t})$ over fraction λ held in the index.
  - Measure μ_2.

- Noise traders demand inelastically u_n shares of asset n.
  - Noise traders are not essential for main results.

- Model builds on Buffa-Vayanos-Woolley (JPE 2022).
  - Introduce correlation across stocks and a size distribution of stocks.

Equilibrium

Equilibrium Prices

- **Proposition:** Price of stock n is

$$S_{nt} = \underbrace{\frac{\bar{S}_n}{r}}_{\substack{\text{PV of constant}\\ \text{component, } \bar{S}_n}} + \underbrace{b_n a_1^s \frac{\kappa^s + rD_t^s}{r}}_{\substack{\text{PV of systematic}\\ \text{component, } b_n S^s(D_t^s)}} + \underbrace{a_{n1}^i \frac{\kappa_n^i \bar{D}_n^i + rD_{nt}^i}{r}}_{\substack{\text{PV of idiosyncratic}\\ \text{component, } S_n^i(D_{nt}^i)}},$$

where

$$a_1^s = \frac{2}{r + \kappa^s + \sqrt{(r+\kappa^s)^2 + 4\rho\left(\sum_{m=1}^N \frac{\eta_m - \mu_2\lambda\eta_m' - u_m}{\mu_1} b_m\right)(\sigma^s)^2}},$$

$$a_{n1}^i = \frac{2}{r + \kappa_n^i + \sqrt{(r+\kappa_n^i)^2 + 4\rho\frac{\eta_n - \mu_2\lambda\eta_n' - u_n}{\mu_1}(\sigma_n^i)^2}},$$

and $\lambda > 0$ solves scalar equation.

- Price *and* price sensitivity to dividend shocks are decreasing in:
  - Systematic supply $\left(\sum_{m=1}^N \frac{\eta_m - \mu_2\lambda\eta_m' - u_m}{\mu_1} b_m\right)(\sigma^s)^2$.
  - Idiosyncratic supply $\frac{\eta_n - \mu_2\lambda\eta_n' - u_n}{\mu_1}(\sigma_n^i)^2$.

Price Sensitivity and Supply – Intuition

- Positive shock to dividends of stock n
- $\rightarrow$ Expected future dividends rise *and* become riskier (square-root process).
- If supply is positive (experts hold a long position)
  - $\rightarrow$ Experts become more willing to sell stock n to reduce risk
  - $\rightarrow$ Stock price increases less than when supply is zero.
- If supply is negative (experts hold a short position)
  - $\rightarrow$ Experts become more willing to buy stock n to reduce risk
  - $\rightarrow$ Stock price increases more than when supply is zero.
- Difference with standard CARA-normal models.
  - Supply affects price but not price sensitivity.

Calibrated Example

Parameter Values – Active vs. Passive and Size Distribution

- Normalizations:
  - $\mu_1 + \mu_2 = 1$ in baseline case.
  - $\rho = 1$.

- $r = 3\%$.

- μ_1 and μ_2.
  - $\mu_1 = 0.9$, $\mu_2 = 0.1$ in baseline case. Passive 10% of active plus passive.
  - Raise μ_2 to 0.6. Two polar cases:
    - Passive flows due to increase in market participation. $\mu_1 = 0.9$, $\mu_2 = 0.6$.
    - Passive flows due to switch from active to passive. $\mu_1 = 0.4$, $\mu_2 = 0.6$.

- Size distribution of firms.
  - Based on market-cap distribution in US stock market.
  - Ten stocks in supply of $3125 \times \eta$ shares each. Size group 1. (Avg =$1tn)
  - 50 stocks in supply of $625 \times \eta$ shares each. Size group 2. (Avg = $207bn)
  - 250 stocks in supply of $25 \times \eta$ shares each. Size group 3. (Avg = $48.1bn)
  - 1250 stocks in supply of $5 \times \eta$ shares each. Size group 4. (Avg = $6.71bn)
  - 1250 stocks in supply of η shares each. Size group 5. (Avg = $815mn)

Parameter Values – Noise Traders, Index, Dividend Processes

- Noise traders.
  - Absent in baseline case.
  - Alternative: Noise-trader demand equal to zero for half of stocks in each size group and to 40% of shares issued for remaining stocks.

- Index.
  - Includes all stocks in baseline case.
  - Alternative: Includes only stocks in size groups 3, 4 and 5. (S&P500)

- Dividend processes.
  - $\kappa^s = \kappa^i_n \equiv \kappa$ for all n.
  - $\bar{D}^i_n \equiv \bar{D}^i$ and $\sigma^i_n = \sigma^i$ for all n.
  - $\frac{\sigma^i}{\sqrt{\bar{D}^i}} = \frac{\sigma^s}{\sqrt{\bar{D}^s}} = \sigma^s$. Distributions of D^s_t and D^i_{nt} same when scaled by their long-run means.
  - $b_n = \bar{b} - (m-3)\Delta b \geq 0$ for size group m. Size negatively related to CAPM beta when $\Delta b > 0$.

Parameter Values – Dividend Processes and Supply

- $\Delta b = 0.025$. Spread in CAPM betas between size groups 1 and 5 is 0.40.
  - Fama-French (JF 1992): Spread is 0.45.

- $\bar{b} + 2\Delta b + \bar{D}^i = 1$. Minimize constant $\rightarrow$ Maximize return volatility.

- $\bar{b} = 0.85$, $\Delta b = 0.025$, $\bar{D}^i = 0.10$. CAPM R-squared averages to 22.69% across stocks, and to 26.83% when weighted by size.
  - Respective averages for stocks in CRSP universe are 16.7% and 27.1%.

- $\eta = 0.00003$. Expected excess returns across size groups lie between 4-6%.

- σ^s maximizes return volatility.
  - Volatility ranges from 21.12% for size group 1 to 11.58% for size group 5.
  - Not high enough. (Raising σ^s shifts weight to very small or very large values of D_t^s, for which volatilities are low.)
  - Raising volatility strengthens our results.

No Noise Traders

- Return moments in baseline case.

Size Group	Expected Return (%)	Return Volatility (%)	CAPM Beta	CAPM R^2 (%)
1 (Smallest)	5.61	21.12	1.35	22.68
2	4.94	18.19	1.16	22.45
3	4.45	16.01	1.02	22.70
4	4.17	13.98	0.95	25.79
5 (Largest)	4.09	11.58	0.95	37.21

Passive Flows and Stock Prices

- % price change when μ_2 is raised to 0.6. Set $D_t^s = \bar{D}^s = 1$, $D_{nt}^i = \bar{D}^i$.

Size Group	Increase in Market Participation		Switch from Active to Passive	
	All Stocks in Index	Size Groups 3-5 in Index	All Stocks in Index	Size Groups 3-5 in Index
1 (Smallest)	6.51	6.36	0	-0.52
2	5.60	5.32	0	-1.05
3	5.44	5.70	0	1.08
4	6.54	7.62	0	3.97
5 (Largest)	7.71	9.90	0	7.23

- Increase in market participation:
  - Effect is *J*-shaped with size.
  - More so if index includes only medium and large stocks.
- Switch from active to passive:
  - No effect if index includes all stocks.
  - Otherwise:
    - Effect increases with size.
    - Effect is *asymmetric:* aggregate market rises.

Intuition – Present Values

- Assume increase in market participation.

- % price change is

$$\frac{1}{S_{nt}}\frac{\partial S_{nt}}{\partial(\mu_2\lambda)} = \frac{b_n \frac{\partial S^s(\bar{D}^s)}{\partial(\mu_2\lambda)} + \frac{\partial S_n^i(\bar{D}_n^i)}{\partial(\mu_2\lambda)}}{\bar{S}_n + b_n S^s(\bar{D}^s) + S_n^i(\bar{D}_n^i)}$$

- Small and mid-size stocks:
  - Passive flows do not affect PV of idiosyncratic component ($\frac{\partial S_n^i(\bar{D}_n^i)}{\partial(\mu_2\lambda)} \approx 0$).
    - Small and mid-size stocks account for negligible fraction of market movements $\rightarrow$ Idiosyncratic dividends are discounted at riskless rate.
  - Passive flows raise PV of systematic component.
    - More so for higher b_n stocks $\rightarrow$ Decreasing part of J-shape.

- Large stocks:
  - Passive flows raise PV of both systematic and idiosyncratic component.
    - Large stocks account for non-negligible fraction of market movements.
    - $\rightarrow$ Increasing part of J-shape.

Intuition – Effect of Volatility

- Why is effect of passive flows not subsumed into CAPM beta?
- Effect holding price sensitivity constant → Proportional to CAPM beta.
- Effect accounting for change in price sensitivity → Gives greater weight to part of beta caused by idiosyncratic component of dividends.
  - Systematic supply.
    - Passive flows raise price sensitivity to shocks to systematic component.
    - → Volatility increase attenuates price rise caused by reduction in systematic supply.
  - Idiosyncratic supply.
    - Attenuation effect is weaker.
    - Volatility increase pertains to idiosyncratic supply which is smaller than systematic supply.
    - Attenuation effect is zero when idiosyncratic supply is zero, and negative (amplification) when idiosyncratic supply is negative.

Passive Flows and Return Volatility

- Change in return volatility when μ_2 is raised to 0.6.

Size Group	Baseline Return Volatility	Change in Return Volatility			
		Increase in Market Participation		Switch from Active to Passive	
		All Stocks in Index	Size Groups 3-5 in Index	All Stocks in Index	Size Groups 3-5 in Index
1 (Smallest)	21.12	-0.04	-0.04	0	0
2	18.19	0.11	0.11	0	-0.03
3	16.01	0.22	0.23	0	0.06
4	13.98	0.39	0.46	0	0.28
5 (Largest)	11.58	0.65	0.83	0	0.66

- Return volatility rises for large stocks.
- Increase in price sensitivity to idiosyncratic component of dividends.

Noise Traders

- Return moments.

Size Group	Noise-Trader Demand	Expected Return (%)	Return Volatility (%)	Market Beta	CAPM R^2 (%)
1 (Smallest)	Low	5.17	21.10	1.34	24.95
	High	5.17	21.10	1.34	24.93
2	Low	4.58	18.25	1.16	24.78
	High	4.58	18.25	1.16	24.69
3	Low	4.16	16.10	1.03	25.11
	High	4.13	16.16	1.02	24.70
4	Low	3.91	14.10	0.96	28.40
	High	3.84	14.31	0.95	26.88
5 (Largest)	Low	3.86	11.75	0.95	40.06
	High	3.73	12.19	0.94	36.72

- Noise trader demand affects mid-size and large stocks.
- Within each of these size groups, it generates negative risk-return relationship. High noise-trader demand:
  - Low expected return.
  - High volatility. High sensitivity to idiosyncratic component of dividends.

Passive Flows and Stock Prices

- % price change when μ_2 is raised to 0.6. Set $D_t^s = \bar{D}^s = 1$, $D_{nt}^i = \bar{D}^i$.

Size Group	Noise-Trader Demand	Increase in Market Participation		Switch from Active to Passive	
		All Stocks in Index	Size Groups 3-5 in Index	All Stocks in Index	Size Groups 3-5 in Index
1 (Smallest)	Low	6.97	6.83	-0.07	-0.87
	High	6.97	6.83	0.01	-0.80
2	Low	5.98	5.75	-0.18	-1.33
	High	5.97	5.73	0.13	-1.04
3	Low	5.66	5.84	-0.61	-0.18
	High	5.65	5.85	0.64	1.25
4	Low	6.36	7.12	-1.57	0.45
	High	6.72	7.77	2.28	6.78
5 (Largest)	Low	7.13	8.54	-2.09	0.91
	High	8.94	12.17	4.81	31.95

- Larger % price change for stocks in high noise-trader demand (overvalued).
  - Increase in price sensitivity to shocks to idiosyncratic component does not attenuate and can even amplify price increase for these stocks.
- Asymmetric effect. Aggregate market rises even when flows are pure reallocation from active to passive.

Index Additions

- % price change and change in return volatility when a stock is added to the index. Set $\mu_2 = 0.6$.

Size Group	Noise-Trader Demand	Percentage Price Change		Change in Return Volatility	
		All Stocks in Index	Size Groups 3-5 in Index	All Stocks in Index	Size Groups 3-5 in Index
1 (Smallest)	Low	0.04	0.06	0.00	0.00
	High	0.04	0.06	0.00	0.00
2	Low	0.18	0.26	0.01	0.01
	High	0.19	0.26	0.01	0.01
3	Low	0.72	1.03	0.03	0.05
	High	0.77	1.10	0.04	0.05
4	Low	2.03	2.98	0.13	0.20
	High	2.64	3.92	0.17	0.25
5 (Largest)	Low	2.66	4.14	0.23	0.35
	High	5.03	8.42	0.41	0.68

- % price change is larger for larger and overvalued stocks.
- Change in volatility is larger for these stocks.

Empirical Evidence

Data

- Flows into S&P500 index mutual funds and plain-vanilla ETFs (= passive funds).
- Stock prices, returns and index composition are from CRSP.
- S&P500 index mutual fund assets and flows are from ICI. Top three S&P500 index ETFs (account for almost all ETFs).
- Measure passive flows by change in passive fund assets as % of S&P500.
  - Results are similar when using ICI-reported flows into passive funds.
- Sample period is 1996-2020. Periods are quarters.

Returns – Large Stocks vs. Index

	Big–S&P EW	Big–S&P VW	Big–S&P EW	Big–S&P VW
Passive flows	**6.095**	**6.101**	**5.808**	**5.822**
	(3.71)	**(3.04)**	**(3.62)**	**(2.89)**
S&P return			-0.0374	-0.0203
			(-2.06)	(-0.89)
Lagged S&P return			-0.0104	0.00773
			(-0.57)	(0.33)
VIX			0.000266	0.000358
			(1.24)	(1.33)
Constant	-0.00470	-0.00491	-0.00868	-0.0117
	(-2.74)	(-2.35)	(-1.72)	(-1.85)
Observations	99	99	99	99
R-squared	0.124	0.087	0.206	0.123

- Big = Top decile.
- Passive flows are associated with high contemporaneous return of large stocks relative to S&P500.

Index Concentration

	Δtop10	Δstdev	ΔHerf	Δtop10	Δstdev	ΔHerf
Passive flows	**10.50**	**9.484**	**14.30**	**10.08**	**9.254**	**13.95**
	(2.48)	**(2.42)**	**(2.33)**	**(2.41)**	**(2.40)**	**(2.30)**
S&P return				-0.0201	0.000453	0.00508
				(-0.43)	(0.01)	(0.07)
Lagged S&P return				0.0184	0.0182	0.0322
				(0.38)	(0.41)	(0.46)
VIX				0.00122	0.00130	0.00210
				(2.17)	(2.51)	(2.58)
Constant	-0.000463	8.74e-05	0.000503	-0.0250	-0.0267	-0.0430
	(-0.11)	(0.02)	(0.08)	(-1.90)	(-2.20)	(-2.25)
Observations	99	99	99	99	99	99
R-squared	0.060	0.057	0.053	0.121	0.126	0.125

- Passive flows are associated with increases in index concentration.

Return Volatility

	Total vol	Total vol	Idio vol	Idio vol
Lagged passive flows	51.63 (6.12)	20.51 (15.94)	47.36 (4.96)	20.64 (13.58)
Log(weight)	-0.0635 (-12.04)		-0.0749 (-13.12)	
Log(weight) × Lagged passive flows	**4.135** **(3.41)**		**3.495** **(2.50)**	
Big		-0.0354 (-2.70)		-0.0471 (-3.28)
Big × Lagged passive flows		**21.66** **(4.87)**		**19.30** **(4.00)**
Lagged total vol	0.595 (93.97)	0.610 (104.07)		
Lagged idio vol			0.607 (84.85)	0.628 (98.91)
Observations	45737	45737	45737	45737
R-squared	0.571	0.569	0.613	0.609

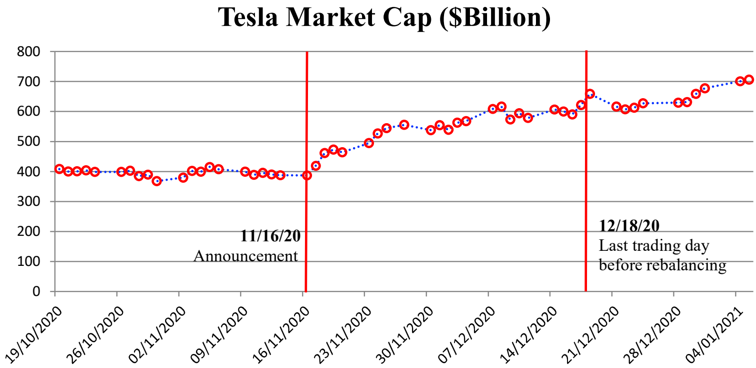
- Firm and quarter fixed effects. Control for S&P return.
- Passive flows raise more the volatility of large stocks.

Index Additions

	Ann to Eff	Eff	Eff+1 to Eff+10
Weight	**27.92**	**8.066**	**-6.234**
	(7.28)	**(2.38)**	**(-2.62)**
Constant	0.0138	0.00388	-0.00610
	(2.84)	(1.19)	(-1.74)
Observations	426	426	426
R-squared	0.094	0.024	0.009

- Index additions raise more the prices of large stocks.

Case Study: Tesla



- Tesla's market capitalization rose by 50% in the month around its addition to the S&P500.

Conclusion

- Passive investing is not neutral.
- Flows into passive funds tracking value-weighed indices:
  - Raise disproportionately prices of largest stocks within the indices.
  - Raise largest stocks' return volatility and price sensitivity to cashflow news.
  - If stocks are mispriced because of noise traders:
    - Prices of overvalued stocks within the indices' largest rise disproportionately.
    - Asymmetric effect: Aggregate market rises even when flows are a pure reallocation from active to passive.
  - Index additions raise more the prices of the largest and most overvalued stocks.
- Provide empirical evidence in support of model's predictions.