What Alleviates Crowding in Factor Investing?

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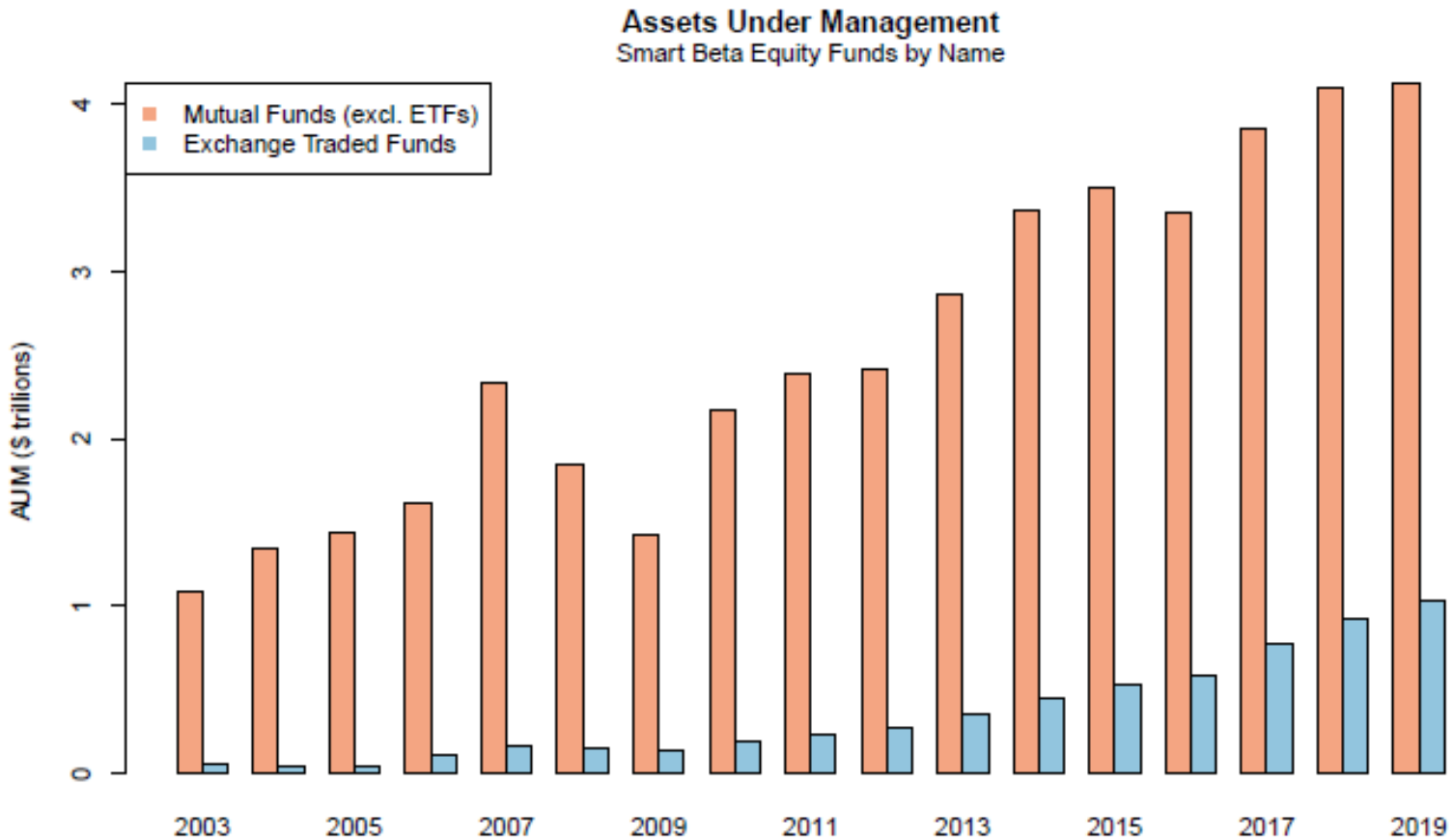
Factor investing growth

- Factor investing: quantitative-investment approach that exploits firm characteristics that predict expected stock returns.
- Assets under management growing fast: Johansson et al. (2020)



Crowding in factor investing

- **Number of factor investors is also growing fast:**
  - Flood (2019): 145 managers launched factor-investing products in 2018.

Crowding in factor investing

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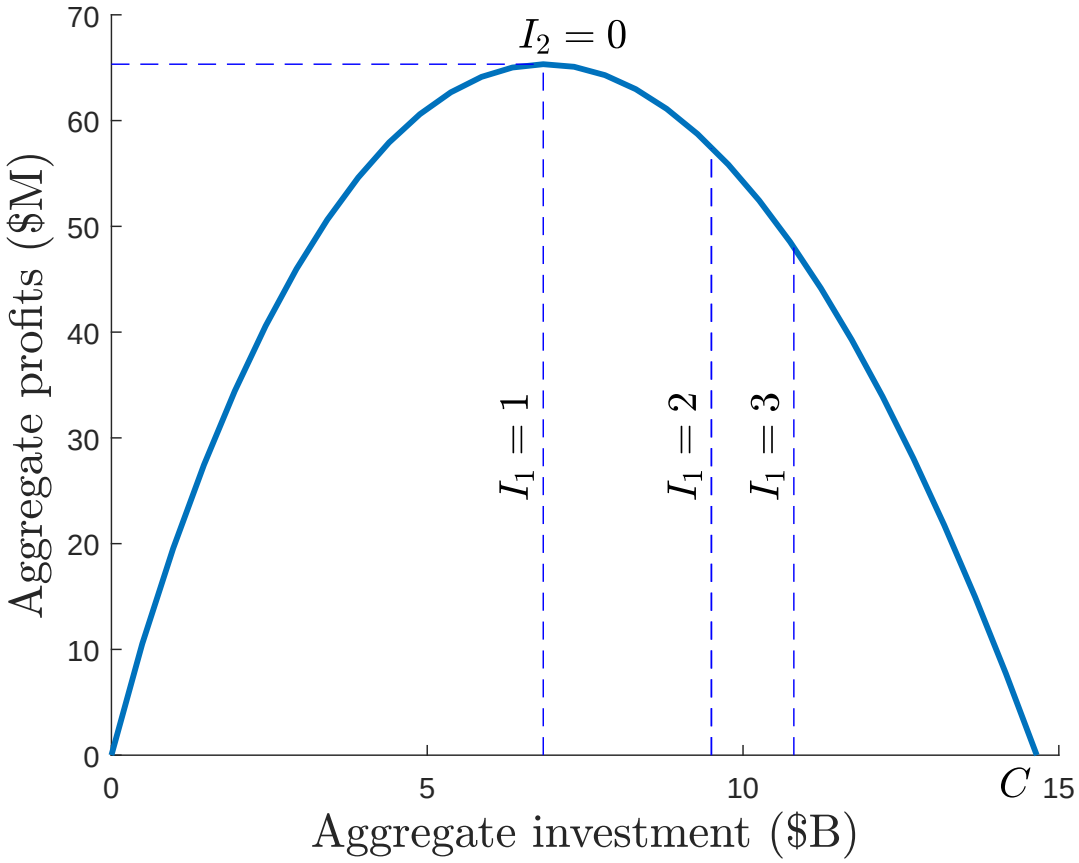
Crowding in factor investing

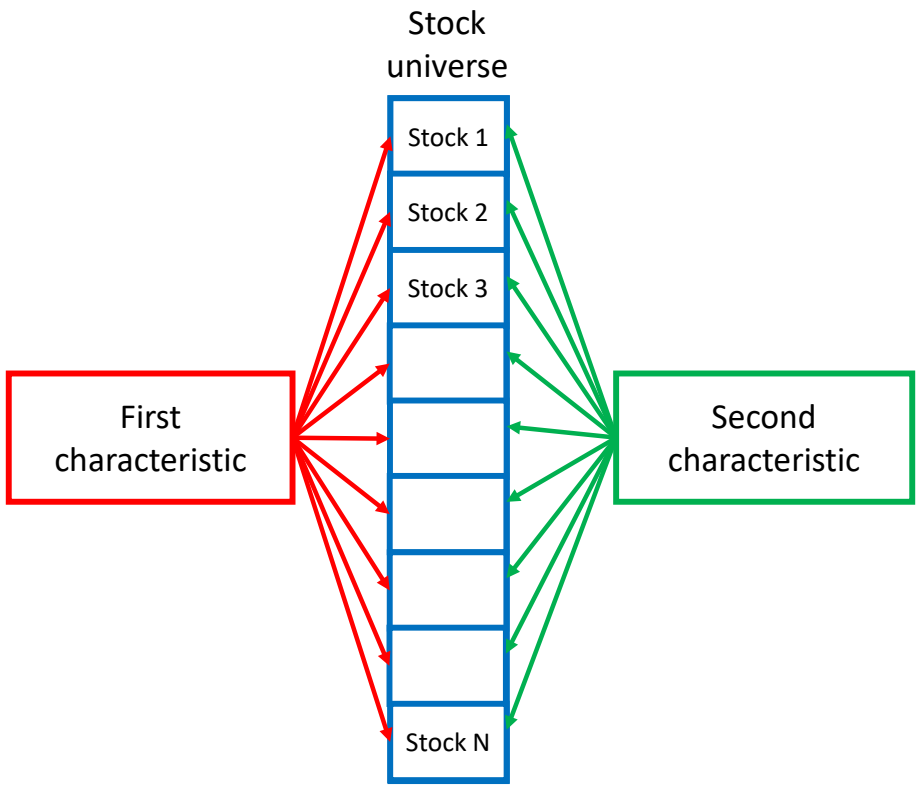
- **Crowding:** as increasing number of institutions exploit the same characteristic
  - competition leads them to overinvest as in Cournot (1838) and
  - price-impact costs erode profits.

Crowding in factor investing



What we do

1. Identify mechanism (trading diversification) that alleviates crowding: institutions exploiting *different* characteristics reduce each other's price-impact costs.
   - Theory: *even when* their trades are not negatively correlated.
   - Empirical: combining 18 characteristics leads to 50% increase in capacity and investment and 25% increase in profits.



What we do

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   - Theory: *even when* their trades are not negatively correlated.
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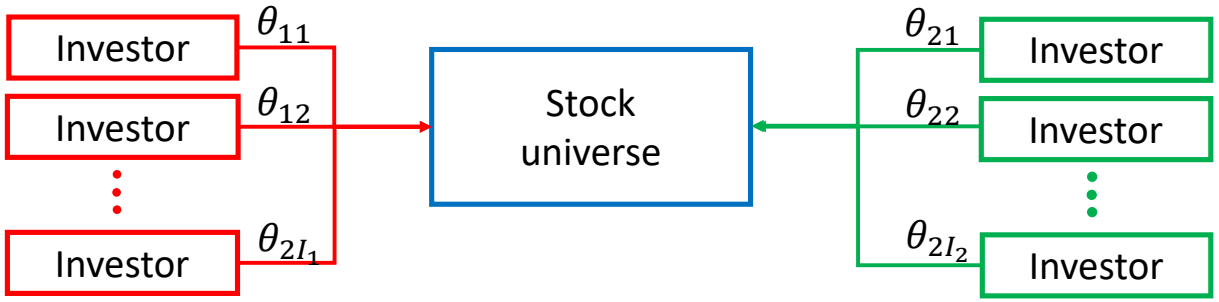
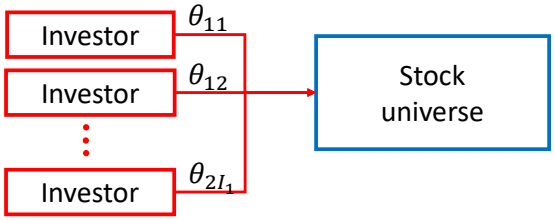
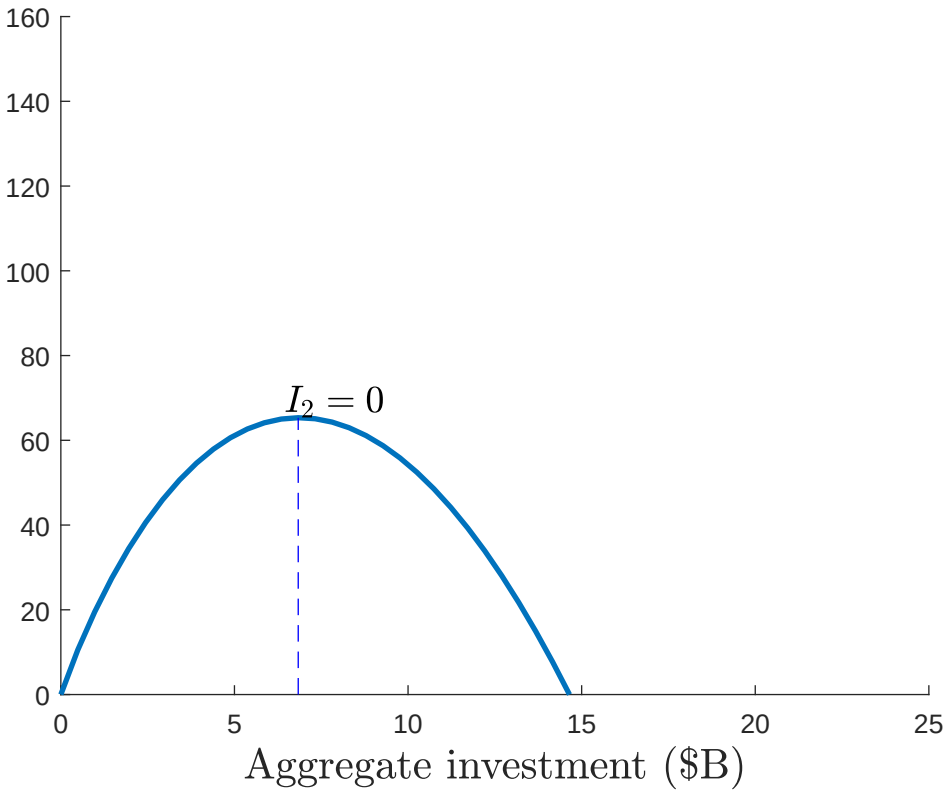
2. Study effect of trading diversification on equilibrium:
   - Develop game-theoretic model with two groups of investors exploiting different characteristics.
   - Characterize equilibrium in closed form and take model to the data.



Effect of trading diversification on equilibrium



- Competition among investors exploiting same characteristic erodes profits because of crowding.



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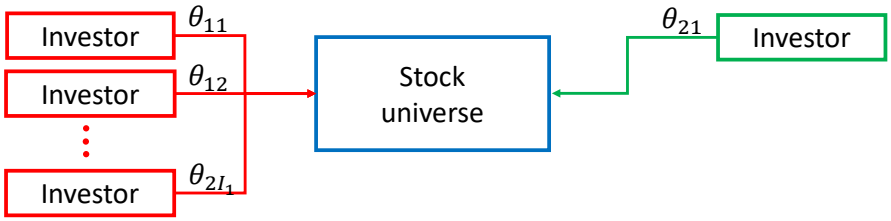
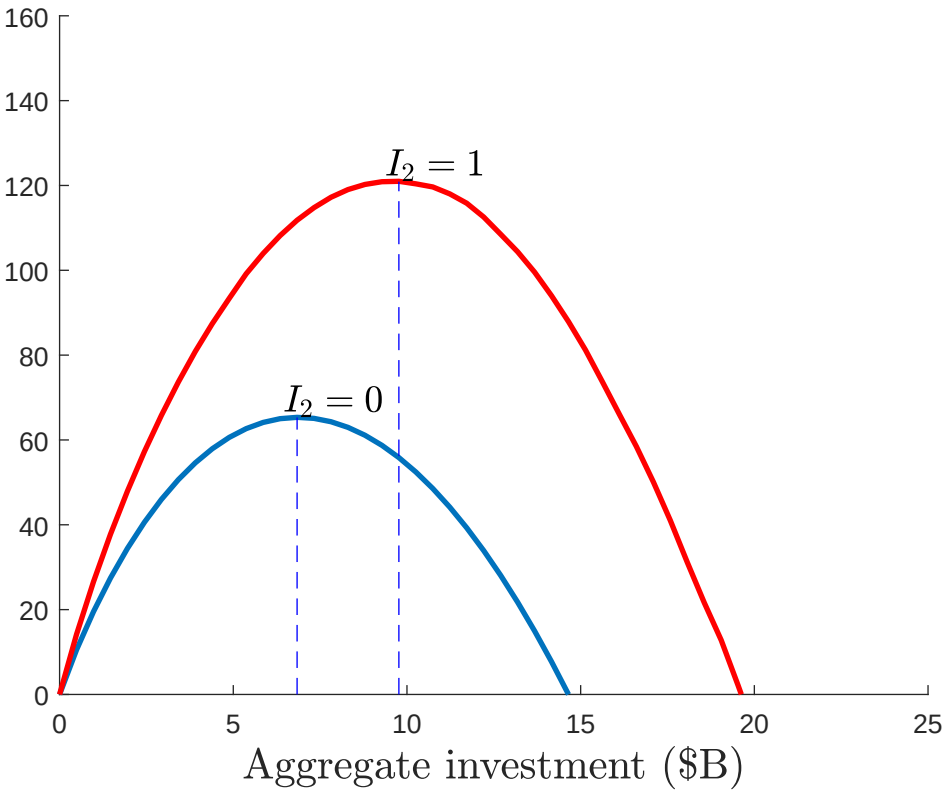
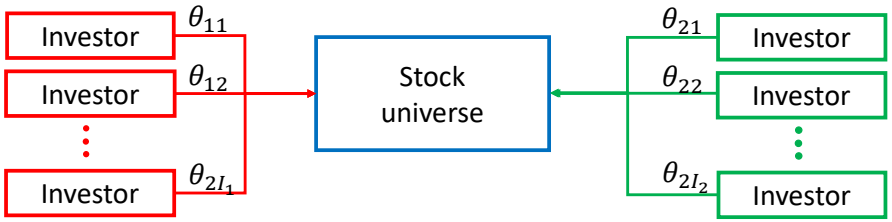
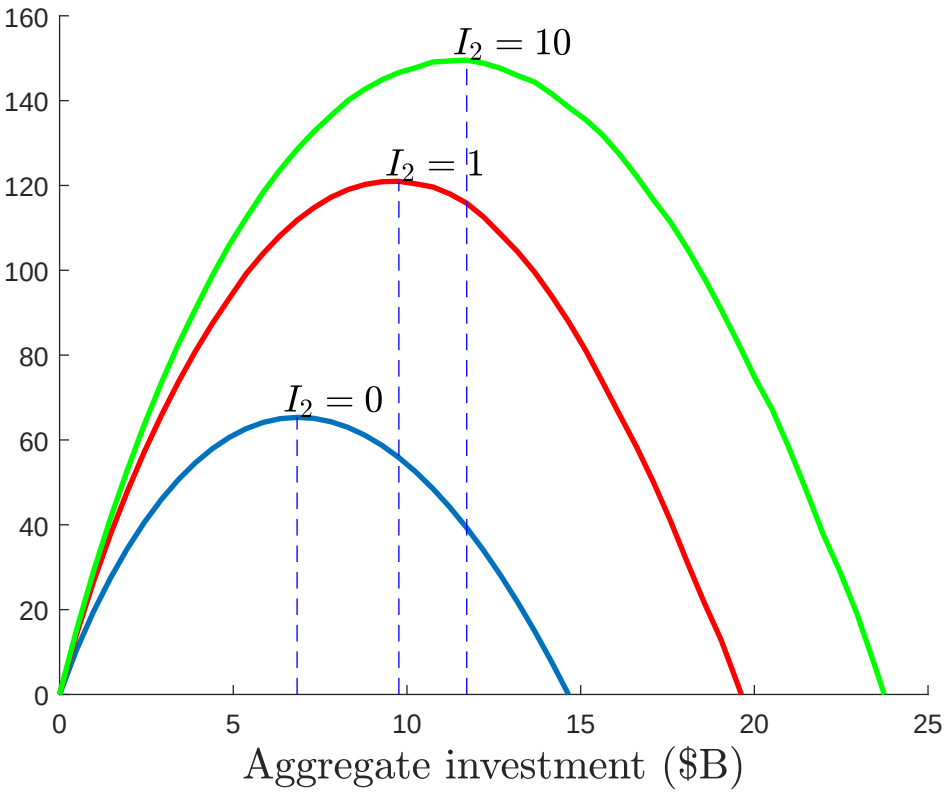




- Competition among investors exploiting same characteristic erodes profits because of crowding.
- Trading diversification increases capacity, investment, and profits of first characteristic, alleviating crowding.

Effect of trading diversification on equilibrium





- Competition among investors exploiting same characteristic erodes profits because of crowding.
- Trading diversification increases capacity, investment, and profits of first characteristic, alleviating crowding.
- Competition among investors exploiting second characteristic further alleviates crowding of first characteristic.

Relation to literature (1/3)

Competition in investment management:

- Bonelli, Landier, Simon, and Thesmar (2019) consider competitive traders and show capacity and profits increase with signal persistence.

- We study how trading diversification affects capacity and profits when competing investors exploit different characteristics.

Relation to literature (2/3)

Competition in the mutual-fund industry, Berk and van Binsbergen (2017)

- Berk and Green (2004): diseconomies of scale at fund level. Thus, rational fund flows chase past performance and fund net returns are zero in equilibrium.
- Pástor and Stambaugh (2012); Pástor, Stambaugh, and Taylor (2015): diseconomies of scale at industry level.
- Edelen, Evans, and Kadlec (2007): trading costs primary source of diseconomies of scale.
- In contrast, we consider diseconomies of scale at the characteristic level, but show competition among investors exploiting *different* characteristics alleviates diseconomies due to trading diversification.

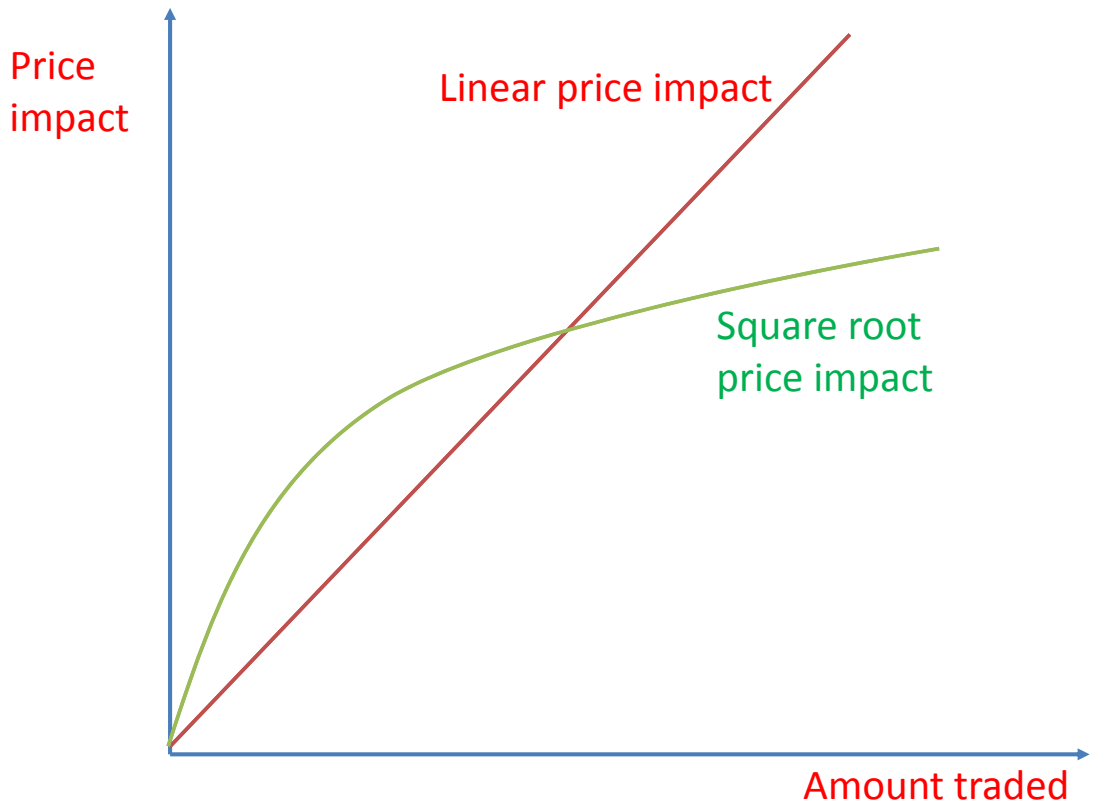
Relation to literature (3/3)

Capacity of quantitative strategies

- Korajczyk and Sadka (2004); Novy-Marx and Velikov (2016); Bonelli et al. (2019) study strategy capacity; capital allocated before price impact erodes gains.
- Ratcliffe et al. (2017); Frazzini et al. (2018) show strategy capacity is much larger for large money managers because they can trade cheaply.
- Barroso and Santa-Clara (2015); Novy-Marx and Velikov (2016); Frazzini et al. (2015); DeMiguel et al. (2020): combining characteristics reduces transaction costs.
- We show how the strategic interactions among financial institutions alleviate crowding in factor investing due to trading diversification.

Trading diversification

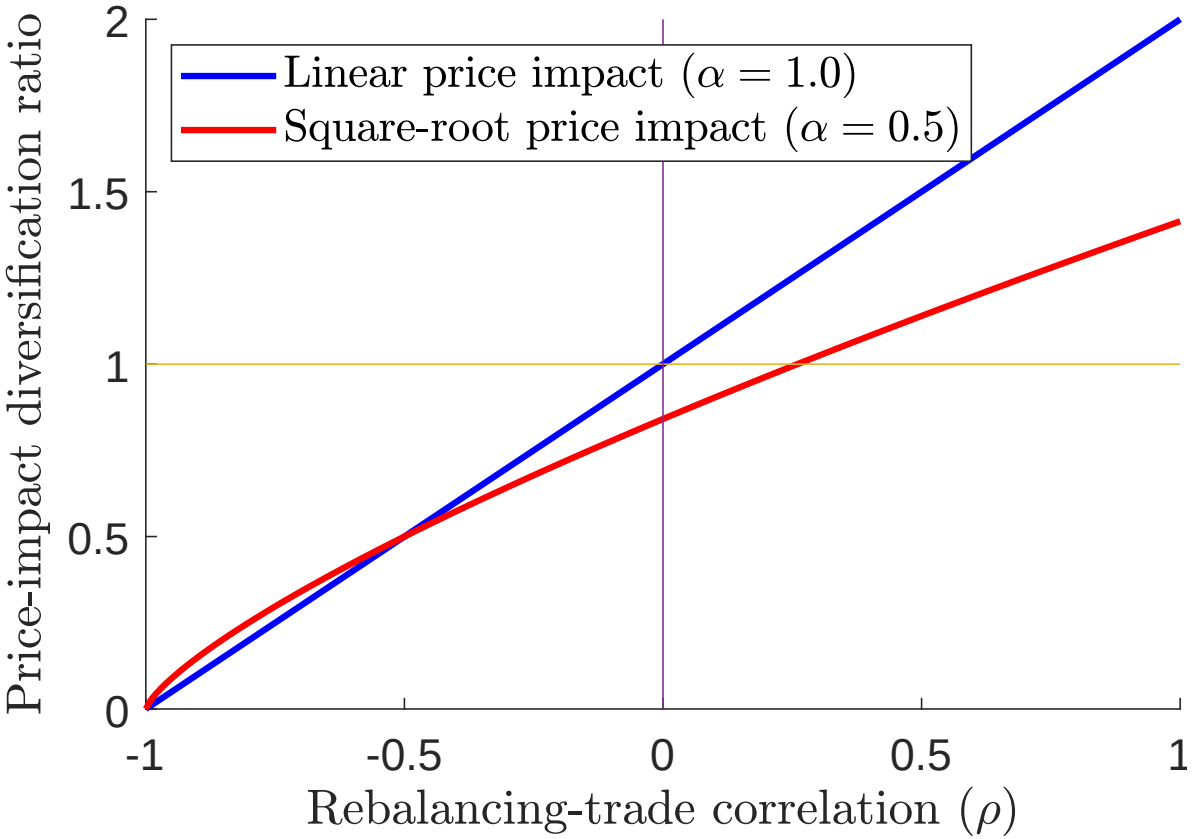
Modelling price-impact costs



- Several papers assume linear price impact, but empirically price impact grows with square root of amount traded; Torre and Ferrari (1997); Grinold and Kahn (2000); Almgren et al. (2005); Ratcliffe et al. (2017); Frazzini et al. (2018).
- For game-theoretic model we use linear model, but for empirics we use model of Frazzini et al. (2018) with linear and square-root terms.

Theoretical results

$$\textbf{Ratio} = \frac{\text{Cost of trading } K \text{ char.'s } \textbf{combined}}{\text{Cost of trading } K \text{ char.'s } \textbf{in isolation}} = \frac{\left[K(1+(K-1)\rho)\right]^{\frac{1+\alpha}{2}}}{K}$$



Two characteristics:

- Linear price impact: combining characteristics reduces costs only when $\rho < 0$.
- Square-root price impact: combining characteristics reduces costs even for moderately positive ρ.

Theoretical results

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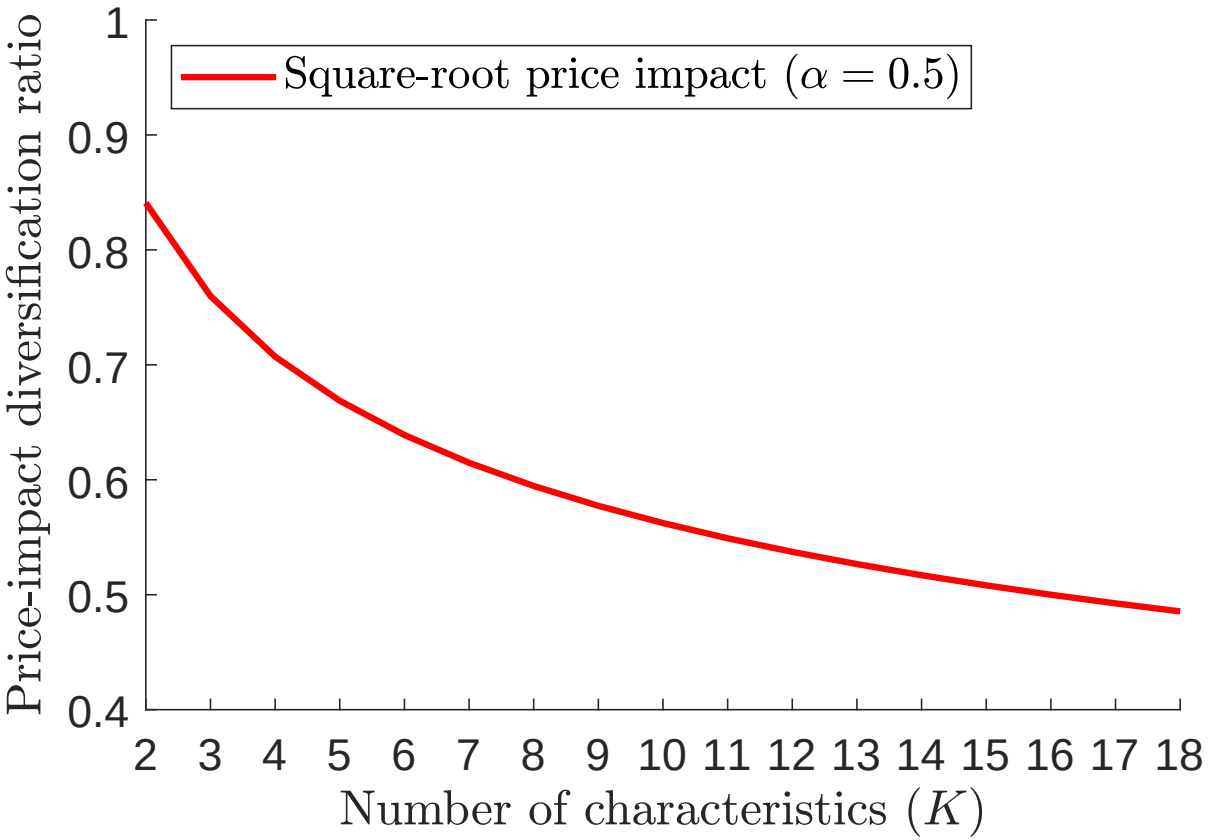


K characteristics:

- Combining multiple characteristics further reduces costs.

Empirical results: Data

- Collect monthly data on 18 firm-specific characteristics:
  - Size, value, and momentum plus the 15 characteristics that DeMiguel et al. (2020) find jointly significant.
  - We combine data from CRSP, Compustat, and I/B/E/S from January 1980 to December 2017.
  - Form value-weighted long-short portfolios for each characteristic using the 30th and 70th percentiles as thresholds.
- Use characteristic data to estimate rebalancing trades $\tilde{x}_{kt}$.
- Use price-impact model of Frazzini et al. (2018):
  - Captures linear and square-root price impact, stock market capitalization and idiosyncratic volatility, market variance, and time trend.
  - Calibrated running a panel regression on trade-execution data from large money manager covering a 19-year period.

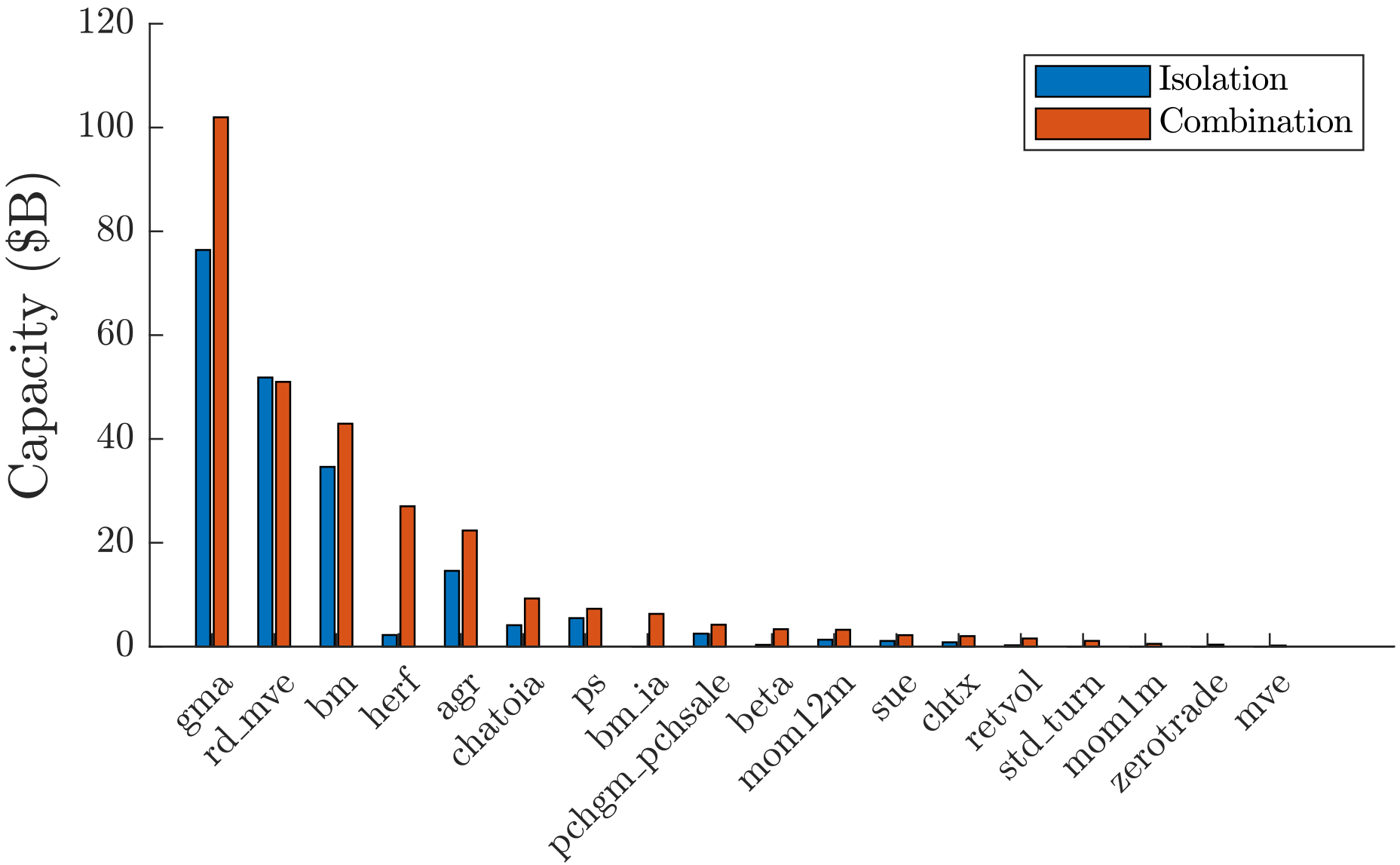
Empirical results: Capacity, Investment, and Profit

Exploiting 18 characteristics in combination rather than isolation results in:

- **50% increase in capacity and optimal investment** and
- **25% increase in optimal profit**.

	Capacity			Investment			Profit		
Characteristic	Isol. ($bill.)	Comb. ($bill.)	Incr. (%)	Isol. ($bill.)	Comb. ($bill.)	Incr. (%)	Isol. ($mill.)	Comb. ($mill.)	Incr. (%)
gma	76.410	101.973	33	36.665	49.690	36	208.80	308.65	48
rd_mve	51.836	51.001	−2	25.918	24.852	−4	686.08	681.92	−1
bm	34.617	42.938	24	16.474	20.923	27	163.61	215.18	32
herf	2.225	27.024	1115	1.025	13.168	1184	0.44	13.03	2878
agr	14.586	22.358	53	6.863	10.895	59	65.33	119.91	84
chatoia	4.117	9.257	125	1.925	4.511	134	9.91	31.08	214
ps	5.478	7.285	33	2.542	3.550	40	15.54	25.91	67
bm_ia	0.000	6.296	-	0.000	3.068	-	0.00	1.32	-
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
Total	195.564	286.859	47	94.312	139.782	48	1165.89	1465.15	26

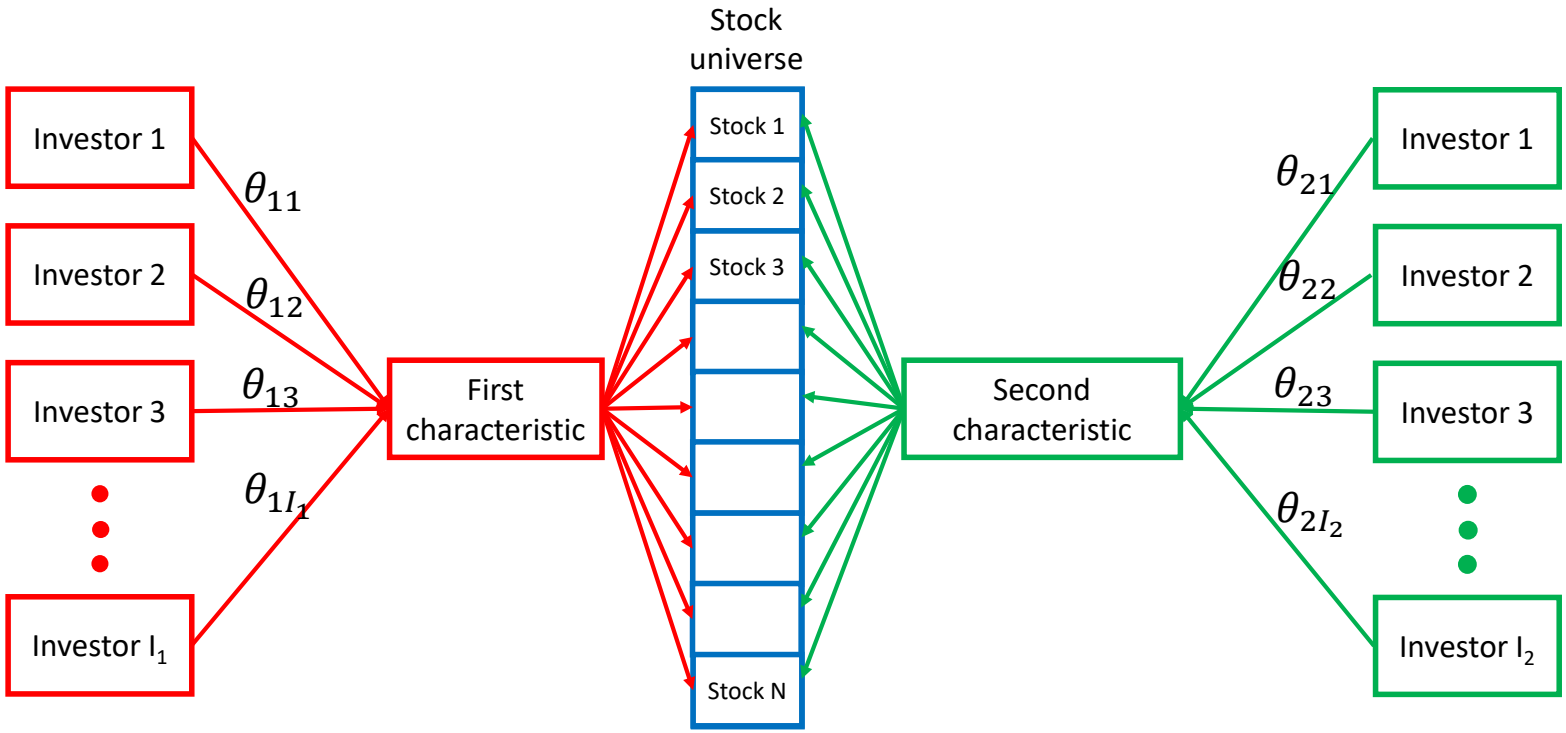
Empirical results: Capacity



Game-theoretic model

Game-theoretic model

- Game-theoretic model of competition between group of I_1 investors exploiting first characteristic and group of I_2 investors exploiting second characteristic.
  - (i) Negative externality (diseconomies) within groups due to price impact.
  - (ii) Positive externality across groups due to trading diversification.



θ_{ki}: investment position of ith investor exploiting kth characteristic.

Game-theoretic model

- **The ith investor exploiting first characteristic** chooses θ_{1i}:

$$\max_{\theta_{1i}} \quad \underbrace{\theta_{1i}\mu_1}_{\text{mean return}} \quad \underbrace{-\overbrace{\theta_{1i}\lambda_1(\theta_{1i}+\theta_{1,-i})}^{\text{negative externality}} - \overbrace{\theta_{1i}\lambda_{12}\textstyle\sum_{j=1}^{I_2}\theta_{2j}}^{\text{positive externality}}}_{\text{price-impact cost}}$$

- **The ith investor exploiting second characteristic** chooses θ_{2i}:

$$\max_{\theta_{2i}} \quad \theta_{2i}\mu_2 - \theta_{2i}\lambda_2(\theta_{2i}+\theta_{2,-i}) - \theta_{2i}\lambda_{12}\sum_{j=1}^{I_1}\theta_{1j}$$

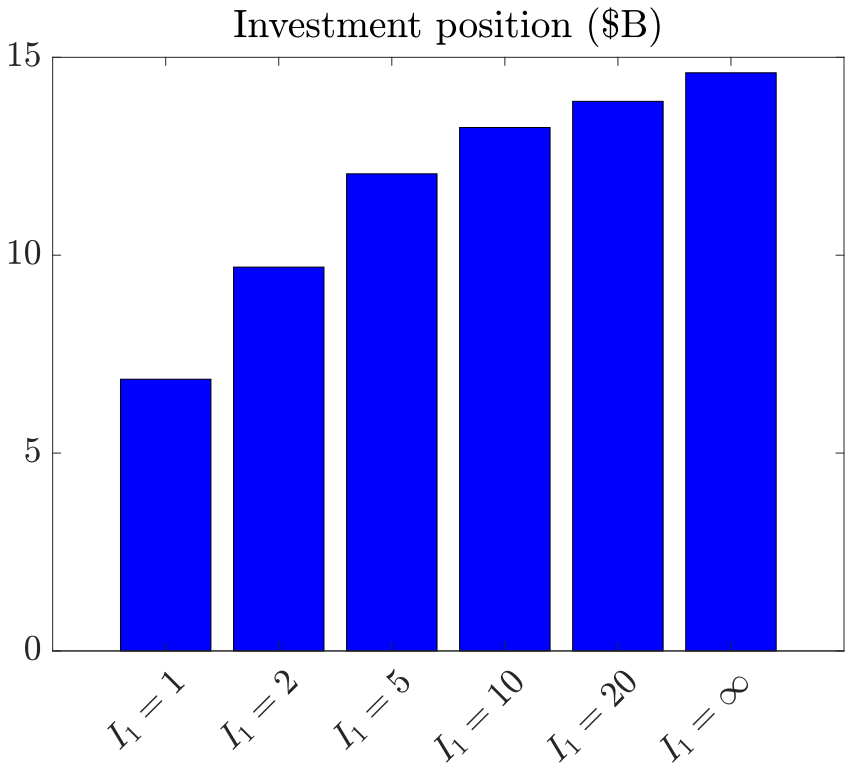
μ_k: mean return of kth characteristic.
λ_k: price-impact parameter for kth characteristic.
λ_{12}: price-impact parameter for interaction between characteristics.
$\theta_{k,-i}$: investment position of rest of investors exploiting kth characteristic.

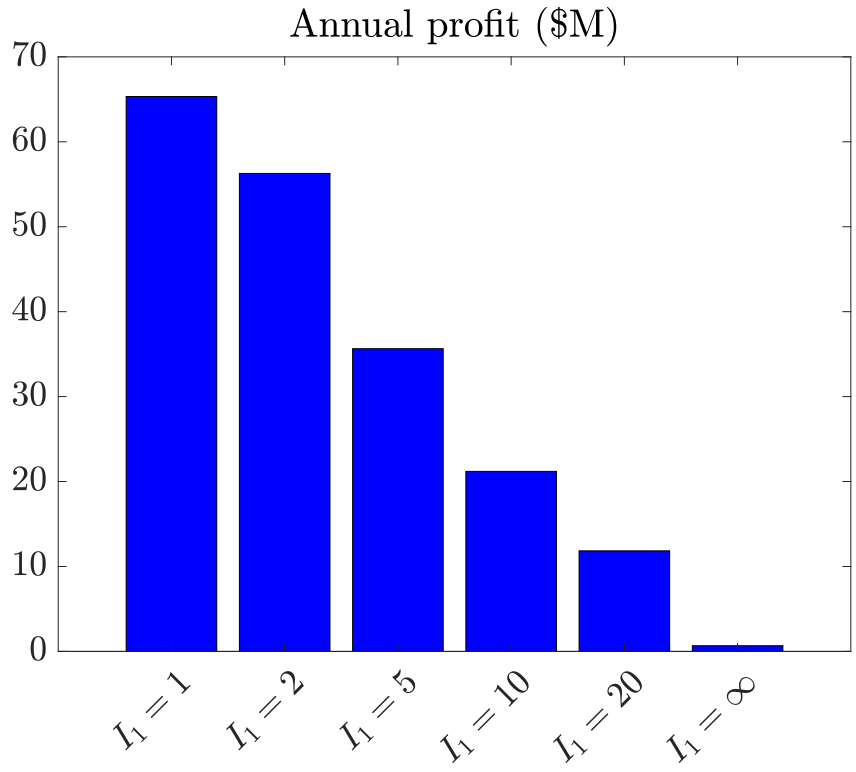
Empirical calibration of game-theoretic model

Data

- We consider asset growth (investment) as first characteristic and gross profitability as second characteristic.
  - Robustness check: book to market and gross profitability.
- We combine data from CRSP and Compustat from January 1980 to December 2017.
- Use price-impact model of Frazzini et al. (2018), which considers linear and square-root terms.
  - Compute the equilibrium numerically.

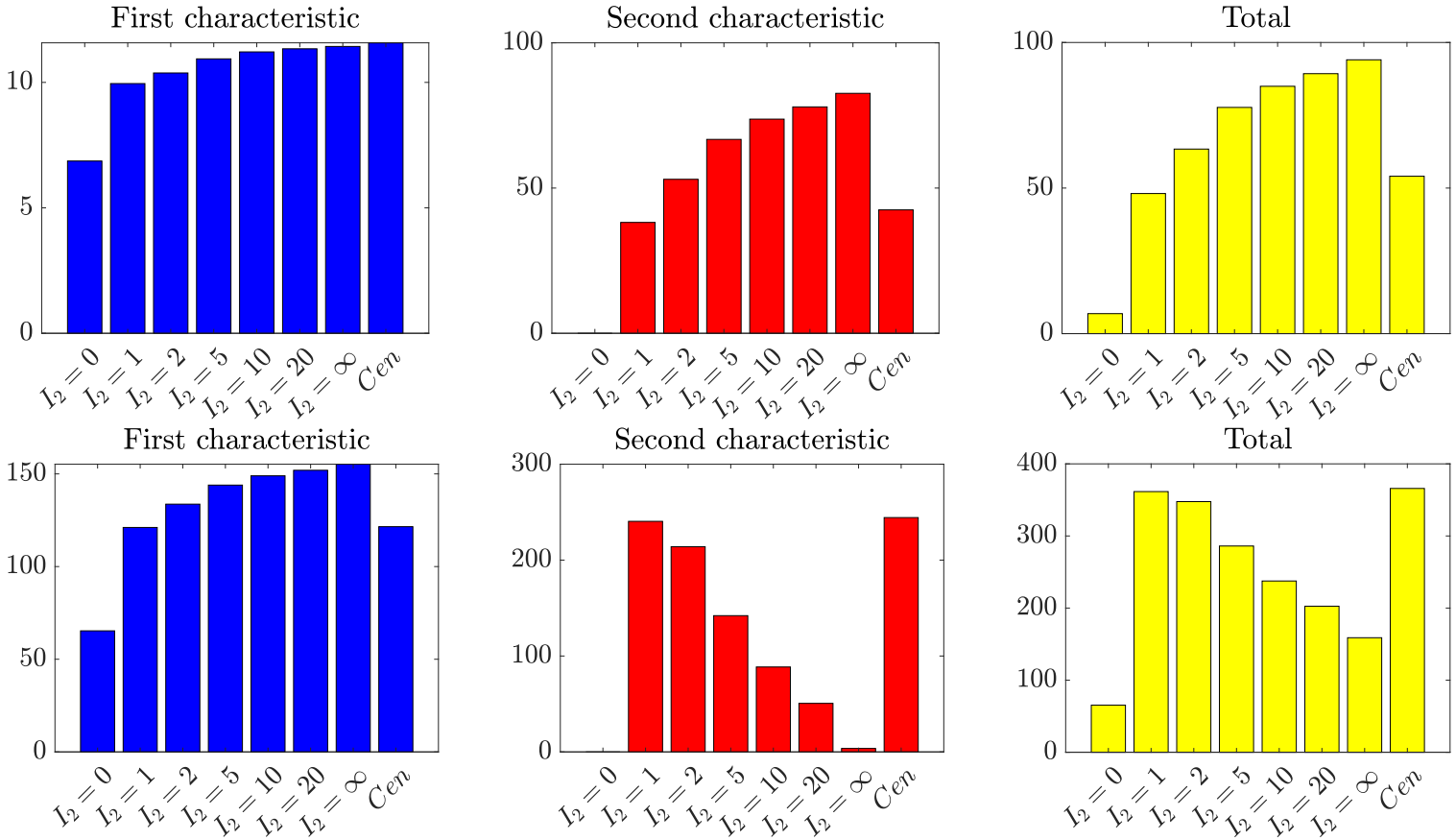
Crowding





- Increasing number of investors in first characteristic (I_1) from one to twenty doubles aggregate investment position and reduces aggregate profits to a fifth because of crowding.
- As investors become perfectly competitive ($I_1 = \infty$), aggregate profits vanish.

Trading diversification



- Single investor in second characteristic leads to an increase in investment in first characteristic by 45% and profits by 85% due to trading diversification.
- Increasing number of investors in second characteristic from one to twenty increases investment in first characteristic by 14% and smart-beta profits by 25%.
- Centralization increases *total* profits by reducing investment in both characteristics.

Conclusion

Main findings

1. What Alleviates Crowding in Factor Investing?
   - Trading diversification: institutions exploiting different characteristics can reduce each other's price-impact costs.
   - Theory: even when their trades are not negatively correlated.
   - Empirics: combining 18 characteristics leads to 50% increase in capacity and investment and 25% increase in profits.
2. Game-theoretic model:
   - Competition among factor investors exploiting same characteristic erodes profits because of crowding,
   - but competition among investors exploiting other characteristics alleviates crowding.
3. Empirical calibration:
   - Trading diversification and competition among investors exploiting the second characteristic increase investment in the first characteristic by 65% and profits by 132%.

Implications for industrial organization and regulation

1. Financial institutions should focus on characteristics that are not only profitable, but also exploited by only a few institutions.
   - BlackRock, Vanguard, State Street hold 79% of ETF assets (Baert, 2018).
   - Incentive to acquire competitors; e.g. Invesco (Carlson, 2019).

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2. Financial institutions should exploit characteristics that allow them to benefit from trading diversification.
   - For instance, institutions exploiting "investment" benefit from other institutions exploiting "gross profitability".

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2. Financial institutions should exploit characteristics that allow them to benefit from trading diversification.
   - For instance, institutions exploiting "investment" benefit from other institutions exploiting "gross profitability".

3. Regulators need to recognize that:
   - Encouraging competition among fund managers to reduce fees may also erode profitability because of crowding, but
   - encouraging the *appropriate* balance of competition between managers exploiting different characteristics can alleviate crowding due to trading diversification.

Thank you!

Empirical results: Characteristics considered

Characteristic	Acronym	Definition
Asset growth	agr	Annual % change in total assets (at).
Beta	beta	Beta from three years of weekly firm and EW market returns.
Book to market	bm	Book value of equity divided by end of fiscal-year market capitalization.
Industry-adjusted book to market	bm_ia	Industry-adjusted book value of equity (ceq) divided by market cap.
Industry-adjusted change in turnover	chatoia	industry adjusted change in sales divided by average total assets.
Change in tax expense	chtx	Percent change in total taxes from quarter $t-4$ to t.
Gross profitability	gma	Revenues minus cost of goods sold divided by lagged total assets.
Industry-sales concentration	herf	Sum of squared % of sales in industry for each company.
12-month momentum	mom12m	11-month cumulative returns ending one month before month-end.
1-month momentum	mom1m	1-month cumulative return.
Market capitalization	mve	Natural log of market capitalization at end of month $t-1$.
Δ% gross margin - Δ% sales	pchgm	Percent change in gross margin minus percent change in sales.
Financial-statements score	ps	Sum of nine indicator variables that form fundamental financial health F-score.
R&D-to-market capitalization	rd_mve	R&D expense (xrd) divided by end of fiscal year market capitalization.
Return volatility	retvol	Standard deviation of daily returns.
Volatility of share turnover	std_turn	Monthly standard deviation of daily share turnover.
Unexpected quarterly earnings	sue	Unexpected quarterly earnings divided by market cap.
Zero trading days	zerotrade	Turnover weighted number of zero trading days.

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