WORKING PAPER

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Business models of real estate equity companies and capital market volatility

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AGENDA

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- Topic introduction and literature review
- RQ1: Quantifying business models
- RQ2: Business models in the context of the macroeconomy
- Implications, summary and open questions
- Appendix

CAPITAL MARKET VOLATILITY AND BUSINESS MODELS

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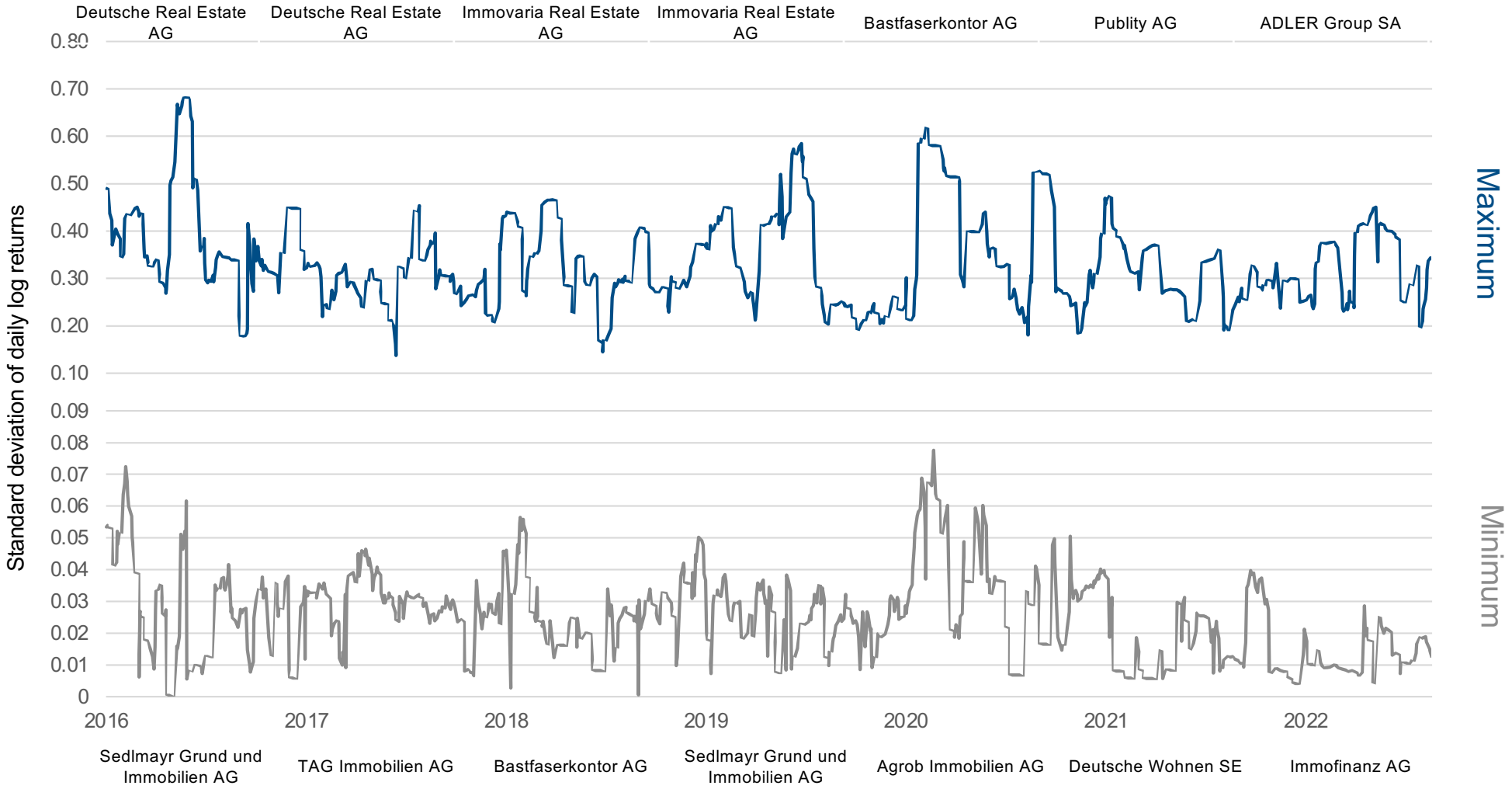

Exhibit 1: Capital market volatiltiy (rolling standard deviation of daily log returns) and business models

ON BUSINESS MODELS AND CAPITAL MARKET VOLATILITY

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- Real estate companies include a wide array of different asset classes and business activities but this complexity has led to oversimplification when describing market participants as business models of real estate equity companies can operate to **generate value along the entire value chain**. There is limited literature regarding this distinction between real estate equity companies.
- For real estate equity companies the question arises to what extent the **characteristics of different business models** are quantifiable and similarities in their pursued long term strategy identifiable according to their turnover structure.
- We define a **business model** of a real estate equity company as the diversification of activities employed as part of the long-term strategy accounting for the dimensions of business and sectors:
  - Sector describes the invested asset classes (e.g. office, residential, etc.)
  - Business segment describes the activities the company is active in along the value chain (e.g. developer, investor)

LITERATURE REVIEW

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Paper	Area of application	Implication
Capozza and Seguin (2003)	REITS	Diversification allows for a greater liquidity of company equity.
Ro and Ziobrowski (2011)	REITS	Analysis of REITs/ REOCs has focused on sectoral, geographical specialization but a co-integrated perspective including the value chain presents a novel approach.
Christensen and Johnson (2009)	Theory	The structuring, quantification and respective analysis of the ramifications of this design is the primary aim of our research.
Osterwalder/ Pigneur (2014)	Theory	
Younas et al. (2021)	Banking sector	The question of effectiveness regarding differentiation of income streams in the business models of REOCs is important both academically but also for market participants.
Elsas (2010)	Banking sector	

RESEARCH QUESTIONS

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Research question 1

Stage 1: Can real estate stock companies in German-speaking countries be **quantified** and assigned to meaningful business models on the basis of turnover focuses.

Stage 2: How do business models vary in their stock index performance and **volatility dynamics**?

Research question 2

Stage 3: How are the findings of RQ1 related to **macroeconomic shocks** and changes macroeconomic environment and are we able to identify lead lag structures due to differences in information efficiency?

Stage 4: How are the findings of stage 3 affected during **phases** of very high uncertainty. We elaborate this with regards to the Covid-19 pandemic and the sharp increase of interest rates thereafter.

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RQ1: METHODOLOGY
BUSINESS MODEL QUANTIFICATION

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Business model	
Business segments	**Sector**
Development	***Residential***
Construction	***Office***
Transactions	***Hotel***
Renting	***Retail***
Service	***Logistics†***
Other	***Special purpose****

Definition: business model (BM)

We define the business model of a real estate equity company as the diversification of activies employed as part of the long term strategy accounted for through the dimensions of business segments and sectors.

The data collection follows a four step process:

- 1. Step: **Categorization** of turnover shares
  1. Business segments: Characterization of the value creation process along the value chain in real estate
  2. Sector: Characterization of the pursued type of real estate that is pursued.
- 2. Step: **Weighting** of turnover shares:
  (1) Main: 75%-100%. (2) Mostly: 50%-75%
  (3) Balanced: 25%-50% (4) Marginal: 0-25%
- 3. Step: **Change of business model**:

Have there been significant changes in business activities in the past 6 years, both on the part of the active business areas and the active sectors?

- 4. Step: Primary **Data** collection:
  1. **Survey** of the German and Austrian Real estate universe via E-Mail and telephone (for more details please refer to the appendix).
  2. **Independent Analysis** of income statements and analyst presentations published during the observation period.

* Special purpose property aggregates parking, plots/land, as well as special uses (e.g. media)
† Logistics aggregates industrial, warehouse and factory uses.

RQ1: METHODOLOGY
CODING AND FRAGMENTATION INDEX

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Research question 1

Stage 1: Can real estate stock companies in German-speaking countries be **quantified** and assigned to meaningful business models on the basis of turnover focuses.

Definition	Variable	Formula	Parameter
Specialisation of a company is measured by the fragmentation of her activities (i.e. the polarization of the activities/turnover structure).	F	$F = 1 - HHI = 1 - \sum_i^k s_i^2$	HHI = Hirschman-Herfindahl index s_i= share of k different turnover categories

- Every feature is assigned a numeric value based on the respective turnover intensity (in %).
- Encoding of categorical values into numeric values under four **assumptions**:
  1. The shares must add up to 100%
  2. Maximization of the fragmentation index (minimal polarization)
  3. Weighting is either retained or categorical averages used
  4. Non-resolvable differences are split equally
- F(min) = 0, where the turnover is fully concentrated in one activity **(fully polarized)**
- F(max) = 0.83 (for k = 6), if the turnover is equally distributed among all activities **(fully diversified)**

THE MAKE UP OF THE UNIVERSE

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	Category	N	Average	Std. deviation	Median	Min	Max
Business segment	Renting	48	69%	37%	75%	0%	100%
	Transaction	48	7%	18%	0%	0%	75%
	Development	48	14%	26%	0%	0%	100%
	Service	48	10%	21%	0%	0%	100%
	Construction	48	0%	1%	0%	0%	8%
	Other	48	1%	3%	0%	0%	12%
Fragmentation index business segment (BS)		48	0,21	0,23	0,19	0,00	0,66
Sector	Residential	48	36%	41%	25%	0%	100%
	Office	48	29%	29%	27%	0%	100%
	Hotel	48	4%	8%	0%	0%	38%
	Logistics/ Factory/ Warehouse	48	5%	12%	0%	0%	62%
	Retail	48	20%	29%	12%	0%	100%
	Special purpose	48	5%	13%	0%	0%	62%
Fragmentation index sector (S)		48	0,37	0,30	0,44	0,00	0,79

* *Special* purpose property aggregates parking, plots/land, as well as special uses (e.g. media)
† *Logistics* aggregates industrial, warehouse and factory uses.

Exhibit 2: Descriptive statistic of the survey and fragmentation

RQ1: METHODOLOGY CLUSTERING PROCESS

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Definition	Variable	Formula	Parameter
Using **Ward's agglomerative** hierarchical clustering process (Bacher 2010, S. 285f) is used to hierarchically construct cluster centers.	$\bar{x}_{gj}$	$\bar{x}_{gj} = x_{gj} \begin{pmatrix} g = 1,2,\dots,n; \\ j = 1,2,\dots,m; x_{gj} \end{pmatrix}$	n = Number of values $\overline{x}$ = Average
Euclidean distance is a distance measure used to determine the dissimilarity $u_{p,i}$ (squared euclidean distance $d^2_{p,q}$) $u_{p.q}$ is that between clusters p and q. Two companies a and b can be differenciated through m different characterstics.	$d_{a,b}$	$d_{a,b} = \lvert\lvert b - a \rvert\rvert_2$ $= \sqrt{(b_1 - a_1)^2 + \dots + (b_m - a_m)^2}$ $= \sqrt{\sum_{i=1}^{n} (b_i - a_i)^2}$	a / b = companies m = characteristics
The **Silhouette** $s(g)$ of object g in cluster p are found through the average distance to the next cluster.	$s(g)$	$s(g) = \begin{Bmatrix} 0 \\ \frac{d(q,g) - d(p,g)}{max\{d(p,g), d(q,g)\}} \end{Bmatrix}$	g = *object* p = cluster $d(q,g)$= avg. Distance to the next cluster
Silhouette index s_C can be derived from the silhouettes $s(g)$ and is used to determine the most compact group in the cluster analsis (Kaufman and Rousseeuw, 1997) through the highest index value.	s_C	$s_C = \frac{1}{n_C} \sum_{o \in C}^{\infty} s(g)$	$s(g)$ = Individual silhouette

RQ1: RESULTS
4 DISTINCT BUSINESS MODELS

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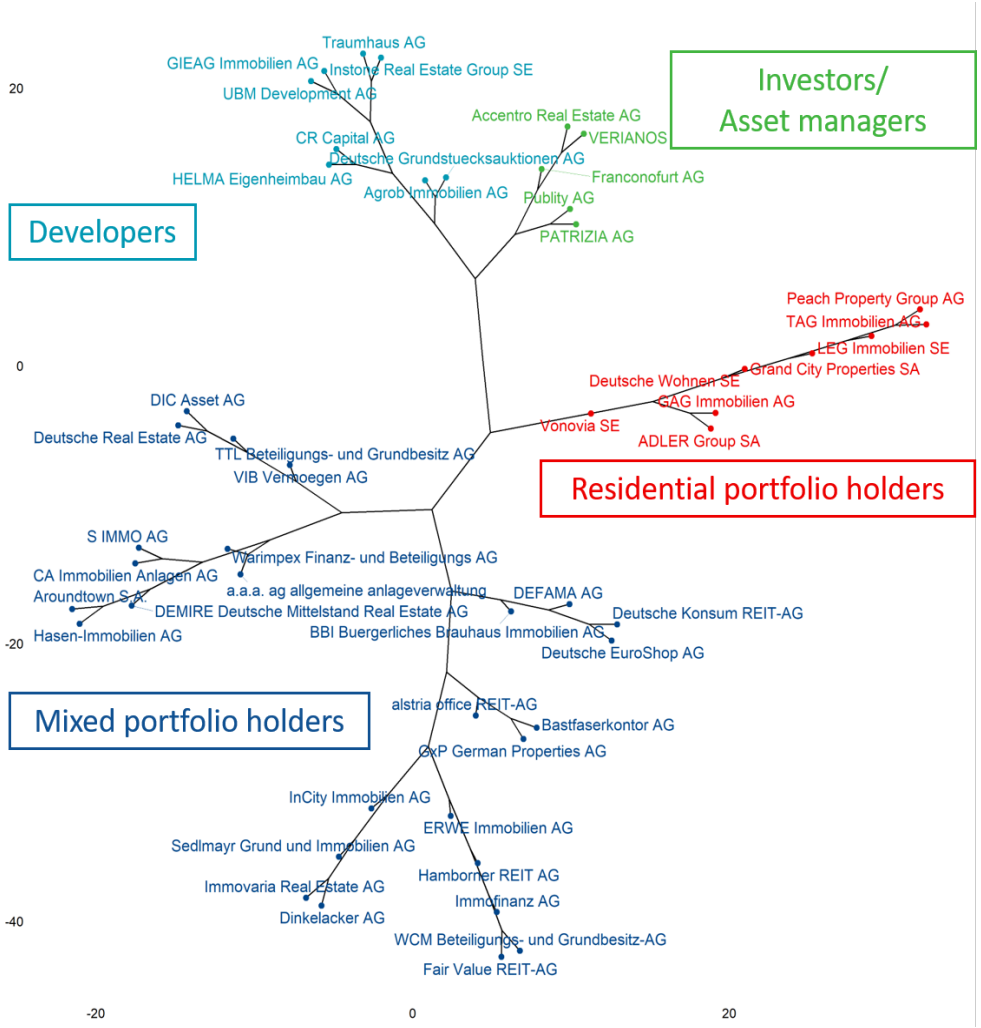

Exhibit 3: Phylogram of the cluster analysis and resulting individual business models (named).

The most compact number of clusters is achieved through four business models:

1. **Developers**
2. **Residential portfolio holders**
3. **Mixed portfolio holders**
4. **Investors/Asset managers**

It follows that…

We are able to achieve meaningful clusters of business models produced on the back of the survey data.

It was not possible to determine these clusters ex ante, yet it is possible to identify and name four distinct business models after conducting the cluster analysis.

RQ1: METHODOLOGY
SELECTED VOLATILTY MEASURES

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Research question 1

Stage 2: How do business models vary in their stock index performance and **volatility dynamics**?

Description	Variable	Formula	Parameter
Standard deviation as a measure of general volatiltiy.	σ	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x-\overline{x})^2}{n}}$	n = Number of values $\overline{x}$ = Average
Maximum drawdown as an asymmetric measure of risk used to compare investment strategies in periods of large series of losses.	$MDD(T)$	$MDD(T) = \max_{\tau\in(0,T)} D(\tau)$ $= \max_{\tau\in(0,T)} D(\tau)\left[\max_{t\in(0,\tau)} X(t) - X(\tau)\right]$	$X(t)$= Stock market price $X(\tau)$ = Highest price
Sharpe ratio (Sharpe, 1966). Used to include the return component.	$Sharpe\ Ratio$	$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p}$	R_p= Return R_f= risk-free interest rate σ_p = Standard deviation

RQ1: DATA: REAL ESTATE INDICES OF THE INDIVIDUAL BUSINESS MODELS

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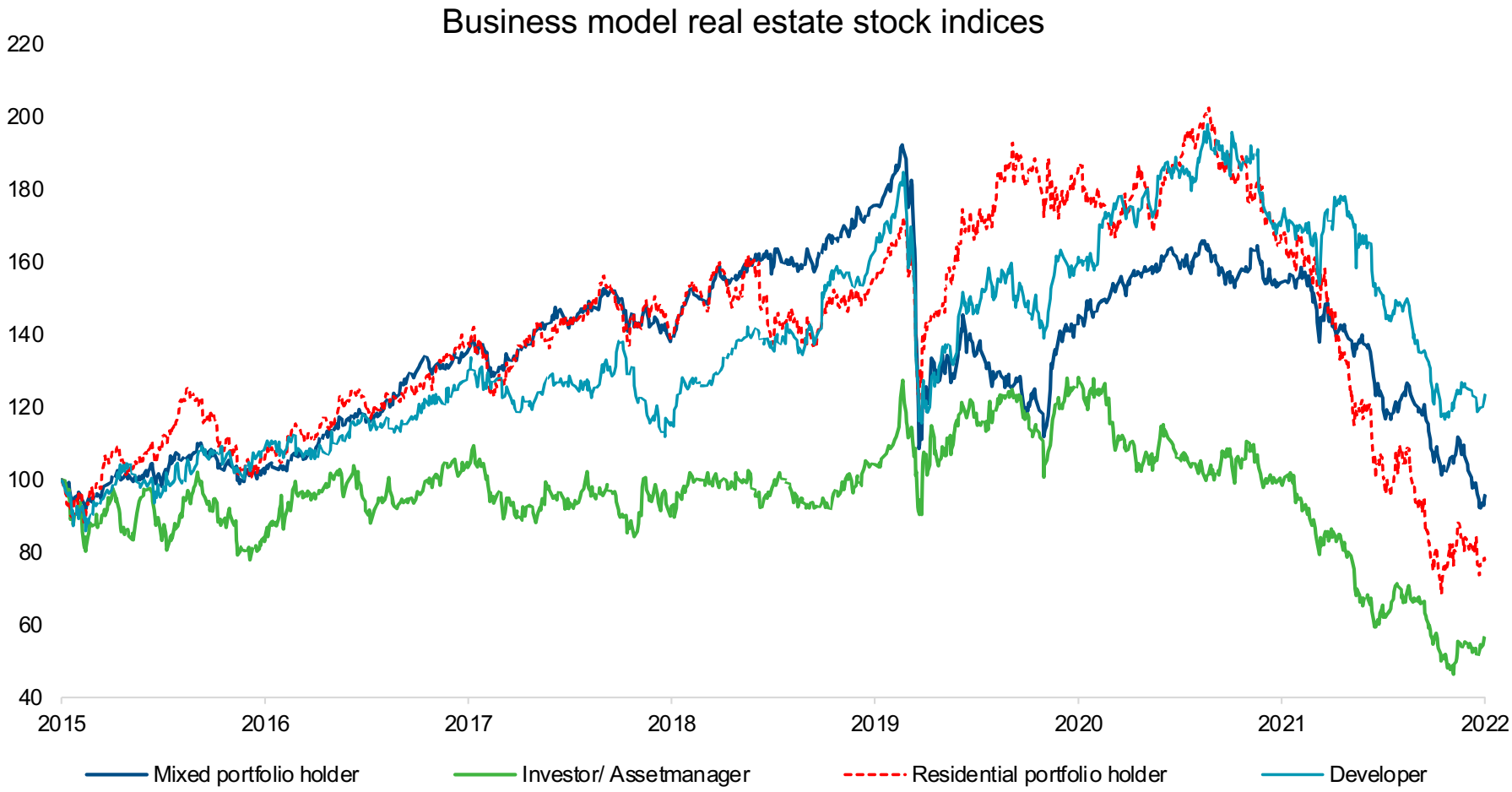

Exhibit 4: Index performance of business models (Base: 12/31/2015 = 100).

RQ1: RESULTS
VOLATILITY OF BUSINESS MODELS

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	Mixed portfolio holders	Residential portfolio holders	Investors/ asset managers	Developers
Std. Dev.	**0.0104**	0.0142	0.0156	**0.0118**
MDD(T)	-0.5206	**-0.6624**	-0.6380	**-0.4107**
Sharpe Ratio	-0.0035	-0.0167	-0.0299	**0.0020**

- *Mixed portfolio holders* display significantly **less** volatility, relative to both *residential portfolio holders* and *investors/asset managers*.
- *Investors and asset managers* and *residential portfolio holders* display relatively **high maximum risk values** (MDD(T)).

It follows that…

The general postulate that residential real estate (in stock companies) is less volatile and more secure than commercial real estate can not be upheld. Specifically the *mixed portfolio holders* perform well in the context of the volatility measures presented. Developers too perform well across the entire sample period for all volatility measures.

Exhibit 5: Performance of business models according to selected volatility measures

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RQ2: RESULTS MACROECONOMIC INDICATORS

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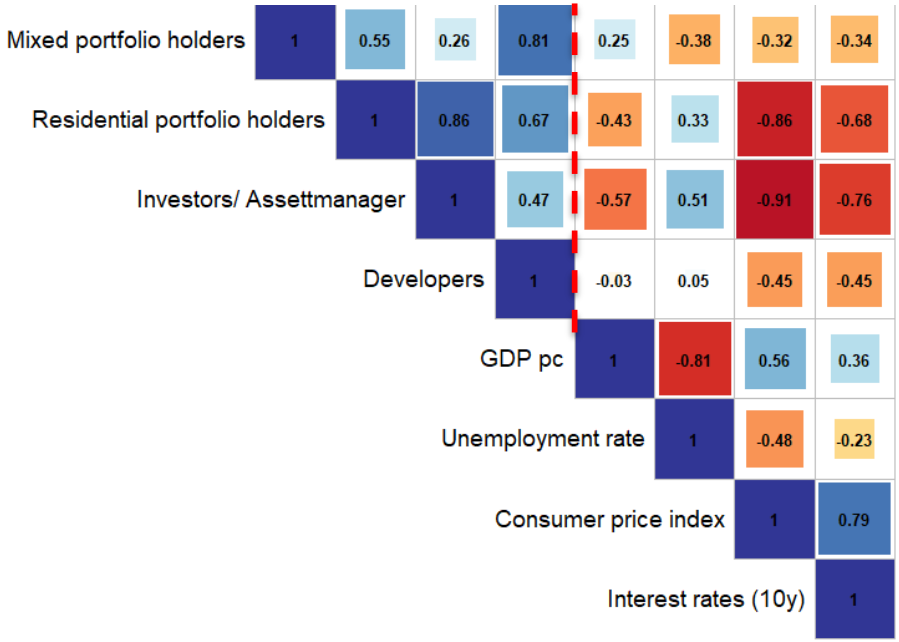
Research question 2

Stage 3: How are the findings of RQ1 related to **macroeconomic shocks** and changes macroeconomic environment and are we able to identify lead lag structures due to differences in information efficiency?



- Mixed *port. holders* and *developers (Group 1)* and *resi. port. holders* and *investors/ asset managers (Group 2)* are strongly correlated, but the correlation in between is weaker.
- Business models react differently to macroeconomic conditions.
  - Inflation & IR(10y): Group 1 is less correlated to both inflation indicators and interest rates than Group 2.
  - Group 2 is negatively correlated to GDP/capita and positively for unemployment.
- This information is relevant to portfolio managers in a risk management context.

Exhibit 6: Correlation matrix

RQ2: RESULTS
GRANGER CAUSALITY

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	F	df_1	df_2	*p*		χ^2	*df*	*p*	
Mixed portfolio holder ← Residential portfolio holder	2.30	4	1767	.057	.	9.18	4	.057	.
Mixed portfolio holder ← Investor/Assetmanager	1.44	4	1767	.219		5.75	4	.218	
Mixed portfolio holder ← Developer	1.80	4	1767	.126		7.20	4	.126	
Mixed portfolio holder ← ALL	1.69	12	1767	.062	.	20.33	12	.061	.
Residential portfolio holder ← Mixed portfolio holder	2.40	4	1767	.048	*	9.61	4	.047	*
Residential portfolio holder ← Investor/Assetmanager	2.44	4	1767	.045	*	9.76	4	.045	*
Residential portfolio holder ← Developer	1.01	4	1767	.400		4.05	4	.400	
Residential portfolio holder ← ALL	1.85	12	1767	.037	*	22.15	12	.036	*
Investor/Assetmanager ←Mixed portfolio holder	3.01	4	1767	.017	*	12.02	4	.017	*
Investor/Assetmanager ← Residential portfolio holder	1.31	4	1767	.265		5.23	4	.264	
Investor/Assetmanager ← Developer	0.90	4	1767	.464		3.60	4	.463	
Investor/Assetmanager ← ALL	2.84	12	1767	<.001	***	34.09	12	<.001	***
Developer ← Mixed portfolio holder	8.76	4	1767	<.001	***	35.03	4	<.001	***
Developer ← Residential portfolio holder	0.50	4	1767	.737		1.99	4	.737	
Developer ← Investor/Assetmanager	1.27	4	1767	.281		5.06	4	.281	
Developer ← ALL	5.74	12	1767	<.001	***	68.94	12	<.001	***

Exhibit 7: Granger causality test results based on a VAR (4) model: * p > 0.05. ** p > 0.01. *** p>.001.

RQ2: METHODOLOGY
CHANGE POINT ANALYSIS

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Research question 2

Stage 4: How are the findings of stage 3 affected during **phases** of very high uncertainty. We elaborate this with regards to the Covid-19 pandemic and the sharp increase of interest rates thereafter.

Definition	Variable	Formula	Parameter
Pruned Exact Linear Time (PELT) method combines the algorithm of optima partitioning of data on an interval (Jackson et al., 2005) with a pruning step. The iterative search minimizes the cost function. The pruning removes values that can not be minima from the minimization at each iteration (Killick, 2012; Wambui, 2015).	$F(n)$	$F(n) = \min_{\tau_m} \{F(\tau_m) + C(y_{\tau_m+1}, \ldots, y_n)\}$	$F(n)$= partitioning τ_m= possible points of change y = value of time series at time m

- Aim is the **identification** of a pre-pandemic reference period for later comparison to later **market phases**, such as the impact of the Covid-19 pandemic and the interest rate reversal.
- PELT is especially useful for high-frequency time series such as daily return series.
- Periods of constant volatility are identified across the entire sample period from 01/01/2016 – 09/31/2022.

RQ2: RESULTS
CHANGE POINT ANALYSIS

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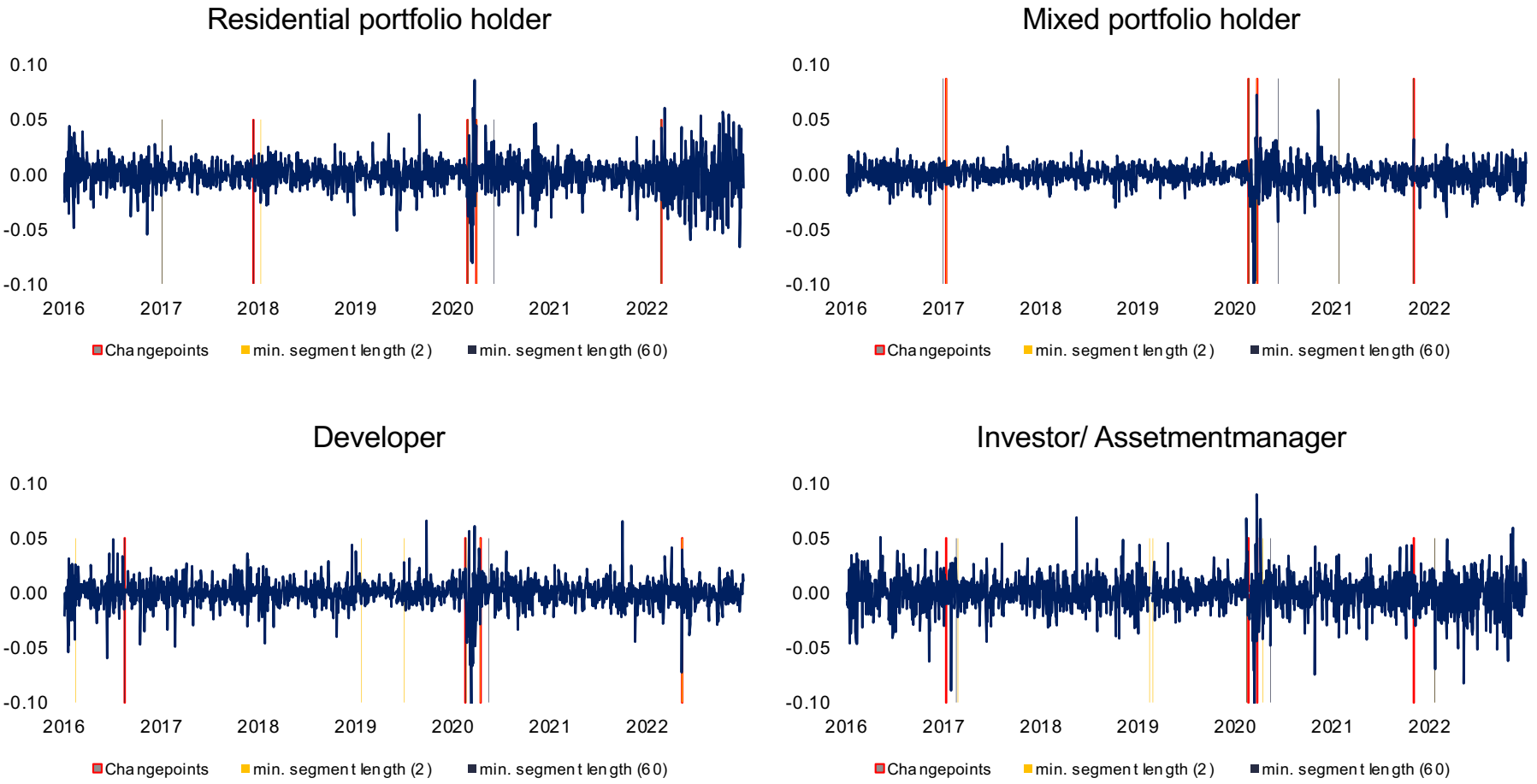

Exhibit 8: Change points of individual market phases (PELT) – return volatility.

RQ2: RESULTS
CHANGE POINT ANALYSIS

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	Reference period	Covid-19 shock	Pandemic phase	Interest rate reversal
Mixed portfolio holders	12.01.2017 (2)	22.02.2020 (3)	25.03.2020 (1)	04.11.2021 (1)
Residential portfolio holders	15.12.2017 (4)	27.02.2020 (4)	31.03.2020 (2)	24.02.2022 (3)
Investors/ Asset managers	18.02.2017 (3)	14.02.2020 (1)	16.04.2020 (3)	22.01.2022 (1)
Developers	17.08.2016 (1)	19.02.2020 (2)	16.04.2020 (3)	14.05.2022 (4)

- Four distinct and mostly homogenous starting points to individual market phases are identifiable via the PELT method for all four business models allowing us to analyse the individual responses to external shocks.
- The different change points give insight into the capital market dependency of the individual business models which could be of further interest if sequential patterns can be identified.
- All Indices show a phase of high volatility until end of March for the portfolio holders and until end of April for the other two business models.
- The interest rate reversal can be observed for mixed portfolio holders in 2021, whilst the rest follow in early 2022 (developers in May of 2022).

Exhibit 9: Change points of individual market phases (PELT). Chronological order of dates presented in brackets (.).

RQ2: RESULTS
VOLATILITY AND MARKET PHASES

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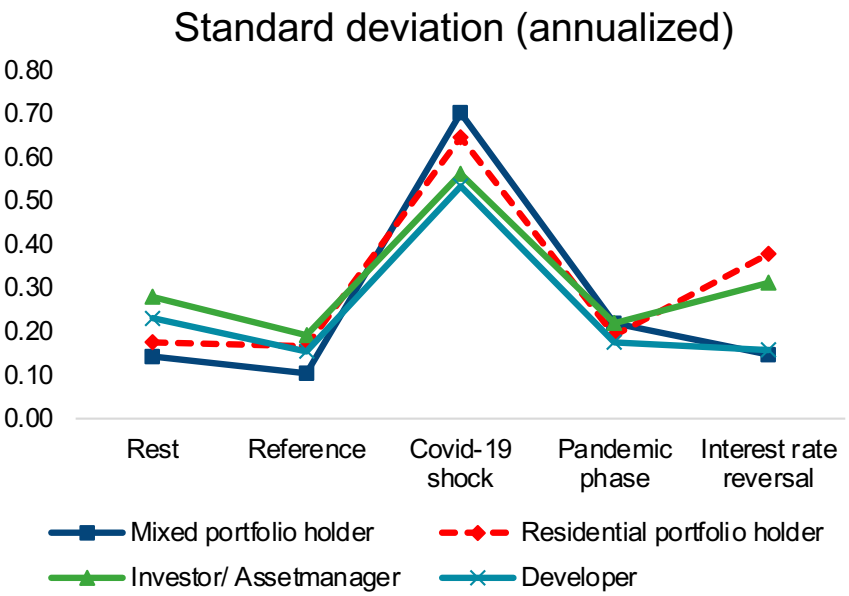

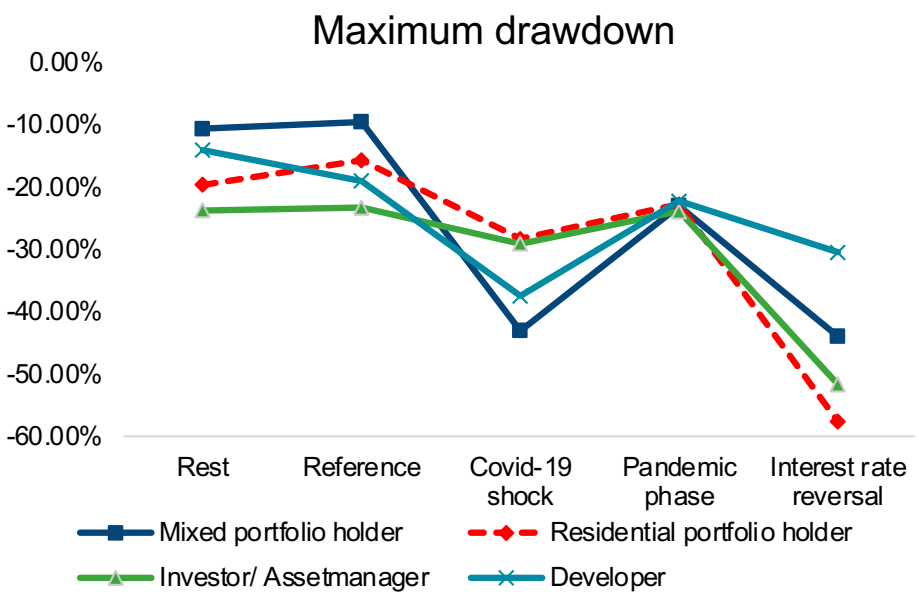

- The Covid-19 shock affects all business models strongly but with different magnitude (resilience).
- During the pandemic phase the market normalised but remained more uncertain than before.
- Business models are relatively synchronous up to the pandemic but have reacted asymmetrically during the interest rate reversal: *Developers* and *mixed portfolio holders* remain at a reasonable level with slightly higher downturns whilst *residential portfolio holders* and *investors/asset managers* display negative development of both volatility measures.

Exhibit 10: Performance of different business models in each market phase identified via PELT method.

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IMPLICATIONS AND SUMMARY

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Research question 1

Stage 1: Can real estate stock companies in German-speaking countries be **quantified** and assigned to meaningful business models on the basis of turnover focuses.

Business models of real estate equity companies can be **quantified** and codified numerically, allowing us to gain a better understanding of how specialised the companies are.

The identified business models are relevant for **benchmarking purposes** in the respective real estate equity universe.

Mixed portfolio holders	Residential portfolio holders	Investors/ Assetmanagers	Developers

Stage 2: How do business models vary in their stock index performance and **volatility dynamics**?

The **general postulate** that *residential* real estate (in stock companies) is less volatile and more secure than commercial real estate can not be upheld. Specifically the ***mixed portfolio holders*** perform well in the context of the volatility measures presented. ***Developers*** too perform well across the entire sample period for all volatility measures.

IMPLICATIONS AND SUMMARY

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Research question 2

Stage 3: How are the findings of RQ1 related to **macroeconomic shocks** and changes macroeconomic environment and are we able to identify lead lag structures due to differences in information efficiency?

The business models show **differentiated correlation to macroeconomic variables**, more specifically between two pairs of clusters which themselves are closely correlated, possibly indicating additional information gains in the context of portfolio management purposes.

The Granger causality tests show the **mixed portfolio holders** to be **ahead** of the other clusters.

Stage 4: How are the findings of stage 3 affected during **phases** of very high uncertainty. We elaborate this with regards to the Covid-19 pandemic and the sharp increase of interest rates thereafter.

Ultimately, the pandemic was primarily a **shock** for real estate companies, but **not a turning point** in terms of market dynamics and volatility. There was not much difference in the reaction to this shock between the business models.

Business models display similar volatility processes whilst reacting with differing magnitude and reaction times to changing market conditions.

LIMITATIONS AND OUTLOOK

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Limitations

- **Data limitations** of collected data on the turnover structure (25% categories).
- Due to the utilized methodology, the **classification** is based on the criteria provided or the cluster analysis. The result can therefore be read as a supplement to other allocations and not as the only correct clustering.
- **Robustness** of fusion algorithm: future research could examine how robust these results are to the choice of other fusion algorithms. We also consider k-means with no meaningful differences.

Outlook

- **Scalability** of the findings on a European or other level utilizing textual analysis (topic modeling algorithms) of annual reports of real estate equity companies (instead of survey-based assessments).
- Other **applications**: The additional information that the identified business models bring could be used to construct a **minimum variance portfolio** over the identified time period and benchmarked against traditional stock allocations.
- Adaption of a **larger time period** requiring more in-depth analysis of possible structural changes within the business models pursued (see Step 2 of RQ1)

OPEN QUESTIONS

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- Are the **volatility metrics** applicable here, are there alternatives? Both regarding volatility (general risk) and resilience (event risk).
- Is the **regional component** a defining part in the business model distinction?
- **Literature** on diversification of income streams in banking is prevalent, is there literature regarding other financial assets?
- Do the clusters provide an accurate representation of the current landscape of real estate equity companies? Is there a difference to **international**/ US markets? Are there other **data sources** / **structures** that should be considered?
- Is there further **practical value** to investors the analysis should consider within the presented scope?

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DATA COLLECTION ON TURNOVER SHARES

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Timeline and individual steps

Contact

- Investor Relations
- Management-Level
- Public Relations
- Contact details were obtained via the company website,-/Contact forms Financial statements and team pages.
- Former managers of the companies were interviewed as experts.

Survey

- Contacting companies by email (August 26, 2022)
- Reminder mail (5 September)
- Telephone contact(s) (8th to 20th of September)
- End: September 20th, 2022

Data Cleansing

- Companies with changes in business activities are analysed individually. A clearly identifiable conversion of one or more segments or business areas is assigned to a category with a view to the point in time.
- Due to several conversions, one company was excluded from consideration.
- Companies that no longer actively operate at the market or have filed for insolvency are be removed from the data set.
- One of the construction companies replied by e-mail. A classification of the other companies has emerged as too different in the context of the set sectors. As a result, the construction companies were excluded from consideration.

SURVEY RESULTS

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Market capitalization	Number	Share	Description	Included
50.081.495.316€	23	35,94%	Company	✓
12.188.398.894€	5	7,81%	Expert	✓
18.509.126.747€	12	18,75%	Clear weighting possible	✓
6.086.582.718€	8	12,50%	Weight based off market assumptions	✓
915.491.642€	13	20,31%	No classification / insolvency	✗
11.635.250.859€	3	4,69%	Construction	✗

- The response rate of the written and telephone survey amounted to 39% of the companies which together represent a market capitalization of € 52 billion.
- A total of 10 companies did not want to give an answer.
- By cleaning up the universe from construction companies, bankruptcies, a delisting, as well as companies with too little or granular reporting, which did not allow classification, there was a reduction of 16 companies and 12 billion € market capitalization (construction companies).
- Survey of experts and own analysis of financial reports was able to clearly identify 17 business models and 8 more via meaningful market assumptions.
- The resulting data basis includes a total of 49 companies with a market capitalization of just under €87 billion, 87,48% of the complete and 98,60% of the cleaned data set.

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	Average	Std. Dev.	Median	Min	Max
Portfolio holders mixed	136,0	21,5	138,5	93,6	189,5
Portfolio holders residential	144,3	27,0	144,7	88,2	202,3
Investors/ Asset Managers	99,4	12,0	98,3	58,5	129,4
Developers	135,1	26,0	129,3	85,7	193,4

- There are significant differences between the indices observable.
- Three of the four indices are nominally positive (above the base value of 100 = 12/31/2015) over the observed period.
- Investors/ Asset managers are dragged down significantly due to an overweight title having developed negatively.
- The standard deviations of the business model of investors and assetmanagers was the smallest. The other three all were higher.
- The indices of portfolio holders residential and developers show a similar degree of variance.
- The indices are weighted according to average market capitalization of the included companies over the full sample period from 01/01/2016 – 09/31/2022.
- New companies are included by reweighing at entry.

RQ1: CLUSTER ANALYSIS THE SILHOUETTE INDEX

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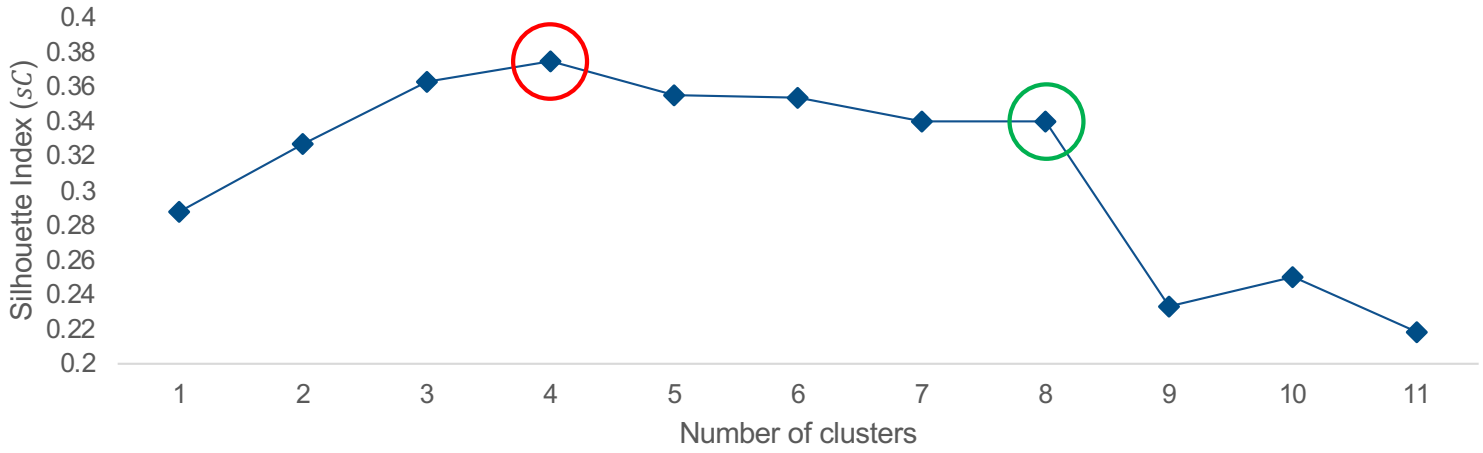

- The cluster analysis identifies **four clusters** as the most compact group.
- Significant drop of Silhouette Index is observable from the 8th cluster onwards. We will discuss choice of analysed clusters in the concluding remarks.

<u>It follows that…</u>

The cluster analysis is able to provide insight based on the numerical transformation of the categorical values obtained through the survey.

The finding is intuitive from the perspective that there is a limit to which differentiation of business models provide more insight rather than information.

Exhibit 10: Silhouette-index of the Cluster Analysis