Regional interdependence of the Japan REIT market: A heteroscedasticity-robust time series approach

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For many investors, a common way to invest in real estate is purchasing a share of a real estate investment trust (REIT).

REITs are companies that manage portfolios of real estate properties, and many of them are traded on stock exchanges.

Different REITs take different diversification strategies in terms of the types and locations of individual properties.

Some Japanese REITs (J-REITs) are specializing in mutually disjoint regions but in the same property type.

By pairing regionally disjoint J-REITs with the property type and a market return being controlled, we can evaluate the effects of regional diversification strategies within J-REIT securities.
Based on this insight, we fit a trivariate vector error correction model (VECM) to the daily stock returns of a “central” REIT, a “local” REIT, and a market portfolio.

The “central” and “local” areas should be defined carefully.

The J-REIT market is an ideal environment in this regard, since it is one of the most transparent REIT markets of the world.

Contribution #1: The proposed approach of pairing two regionally disjoint REITs conditional on the property type and the market return has never been taken before for any countries.

Contribution #2: We are not aware of any previous work that studied individual J-REIT shares from a time series perspective.
In our analysis, the error term is allowed to have **conditional heteroscedasticity of unknown form**, a realistic framework for daily asset returns.

To ensure asymptotically valid inference, we adopt some state-of-the-art heteroscedasticity-robust methods.

1. We jointly select the cointegrating rank and lag length of VECM based on the BIC-based algorithm of Cavaliere, De Angelis, Rahbek & Taylor (2018; CDRT2018).

2. We compute the confidence interval of impulse response functions using the residual-based moving block bootstrap of Brüggemann, Jentsch & Trenkler (2016; BJT2016).

**Contribution #3**: Our work is one of the earliest applications of these advanced methods (Jentsch and Lunsford, 2019).
According to the BIC-based selection algorithm of CDRT2018, we find **no cointegration** (i.e., the absence of long-run relationship among the central REIT, local REIT, and the market portfolio).

A practical interpretation of no cointegration is that investing in the central and local REITs, even within the single property type, could deliver portfolio diversification effects in the long run.

Based on the bootstrapped confidence interval of BJT2016, we find **significant** impulse responses of the local REIT to the central REIT, a potential signal of arbitrage opportunities.

The central-to-local impacts have become **stronger** after the COVID-19 crisis period (March–April 2020).
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Methodology: Set-up

- Let $P_{1t}$ be the stock price of a “central” J-REIT on day $t$.
- Let $P_{2t}$ be the stock price of a “local” J-REIT on day $t$.
- The central (local) REIT is defined as a REIT whose individual properties concentrate on a certain central (local) area.
- Let $P_{m}^t$ be the level of the TSE REIT Index on day $t$.
- Define the log-price series as:

$$ Y_t = (Y_{1t}, Y_{2t}, Z_t)^	op = (\ln P_{1t}, \ln P_{2t}, \ln P_{m}^t)^	op. $$

- Define the log-return series as:

$$ y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \\ z_t \end{bmatrix} = \begin{bmatrix} \Delta Y_{1t} \\ \Delta Y_{2t} \\ \Delta Z_t \end{bmatrix} = \begin{bmatrix} \Delta \ln P_{1t} \\ \Delta \ln P_{2t} \\ \Delta \ln P_{m}^t \end{bmatrix} = \Delta Y_t. $$
Methodology: VECM

- Formulate trivariate VECM with unknown cointegrating rank $r$ and unknown lag length $p$:

$$\Delta Y_t = \alpha \beta^\top Y_{t-1} + \sum_{k=1}^{p} A_k \Delta Y_{t-k} + \alpha \rho^\top t + A_0 + u_t.$$ 

- To capture volatility clustering, the error term $u_t$ is allowed to have **conditional heteroscedasticity of unknown form**.

- We adopt the data-driven joint determination of $(r, p)$ proposed by CDRT2018.

- CDRT2018 showed that the BIC-based joint determination approach satisfies the **asymptotic validity** and sharp finite sample performance under a general class of weakly dependent series, including GARCH and stochastic volatility processes.
In our analysis, the optimal pair is \((\hat{r}^*, \hat{p}^*) = (0, 1)\). In this case, \(Y_t\) is not cointegrated and VECM\((r, p)\) reduces to VAR\((1)\):

\[
y_t = A_0 + A_1 y_{t-1} + u_t.
\]

We perform the impulse response analysis with an explicit care of the conditionally heteroscedastic error of unknown form.

We compute the 90% confidence interval for the impulse responses based on the residual-based moving block bootstrap (MBB) of BJT2016.

See the full paper for the detailed procedure of MBB.

BJT2016 proved that MBB is asymptotically valid under various forms of conditional heteroscedasticity including GARCH.
Data: Selecting central and local J-REITs

- As of February 2021, 62 REITs are listed on the TSE. Some of them specialize in a certain property type, region, or both.
- A REIT is called a **hotel REIT** if 80% or more of its portfolio consist of hotel properties in terms of the appraisal value.
- Based on the first financial statement of 2020, there are six hotel REITs, and two of them are regionally disjoint:
  1. **Central**: MORI TRUST Hotel Reit, Inc. (MTH) is a unique hotel REIT that invests 79.7% in Tokyo.
  2. **Local**: Ooedo Onsen Reit Investment Corporation (OOR) is the only hotel REIT that invests 0% in Tokyo.
- In the full paper, the same approach is taken for office and residential REITs.
Data: Time series plots of log-prices

- The shaded area depicts the COVID-19 crisis period: Feb. 27 – May 1, 2020 (45 days). The pandemic had an enormous impact on the entire J-REIT market.


- Post-crisis period: May 7, 2020 – March 11, 2022 (454 days).
We clearly observe conditional heteroscedasticity in the log-return series, a common phenomenon in asset returns.

We analyze the pre-crisis and post-crisis periods separately.

We do not analyze the crisis period due to the extreme volatility.
Empirical results: BIC-based selection of \((r, p)\)

- For both pre-crisis and post-crisis periods, the BIC-based selection algorithm of CDRT2018 points to \((\hat{r}^*, \hat{p}^*) = (0, 1)\).

- Having \(\hat{r}^* = 0\) implies that MTH, OOR, and TSE are not cointegrated.

- A practical interpretation of no cointegration is that investing in the central and local REITs, even within the single property type, could deliver portfolio diversification effects in the long run.

- Having \(\hat{p}^* = 1\) implies that the interdependence between the central and local REITs is short-lived.
Empirical results: Pre-crisis IRFs

- The impulse response functions and the MBB-based 90% confidence intervals are plotted.
- We find **significantly positive** IRFs in mutual directions at the 1-day horizon, a potential signal of arbitrage opportunities.
Empirical results: Post-crisis IRFs

Post-crisis IRF of $y_1$ to $y_2$

- We find significantly positive IRFs in mutual directions again.
- The IRFs of $y_2$ to $y_1$ have become larger after the crisis.
- The stronger central-to-local impacts are not surprising, as it is well known that the comovement of asset returns tends to be stronger in a period of turmoil (e.g., Page and Panariello, 2018).
Empirical results: Variance decomposition

<table>
<thead>
<tr>
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<th>Pre-crisis period</th>
<th>Post-crisis period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MTH (y₁)</td>
<td>OOR (y₂)</td>
</tr>
<tr>
<td>FEVD of y₁</td>
<td>0.996</td>
<td>0.003</td>
</tr>
<tr>
<td>FEVD of y₂</td>
<td>0.108</td>
<td>0.892</td>
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- In the pre-crisis period, the FEV of $y_2$ is explained 10.8% by $y_1$.
- In the post-crisis period, the share has risen to 32.7%.
- We have confirmed the larger impacts from the central to local REITs after the crisis.
- This result suggests that the portfolio diversification effects have become smaller in the post-crisis period.
Conclusion

- We have investigated the dynamic interaction of the regionally disjoint J-REIT securities, where the property types and the market return are controlled.

- We fit VECM and VAR to the daily stock returns of the central and local REITs, where the error term is allowed to have conditional heteroscedasticity of unknown form.

- The heteroscedasticity-robust methods of CDRT2018 and BJT2016 are adopted to ensure asymptotically valid inference.

- We have found significant impacts of the central REIT on the local REIT, a potential signal of arbitrage opportunities.

- The central-to-local impacts have become stronger after the COVID-19 crisis period (March–April 2020).

