International
Conference on
Real
Estate
Statistics

Tokyo
2026

Constructing Limited-Revisable and Stable CPPIs for Small Domains

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19-02-2026

Stability

Limited revisions

Turning points

Identity

Time reversal

Circularity

TUDelft

What makes a CPPI publishable?

Practical

- Stable index
- No continuous revisions
- Early detection of turning points

Methodological

- Identity
- Time reversal
- Circularity

Stability

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What do we want?

Identity

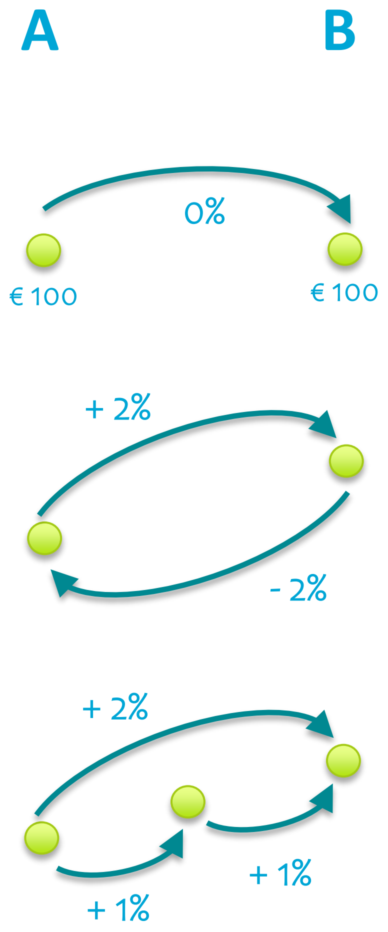
If the prices in period A and B are equal, then the price estimations of period A and B should be equal too.

Time reversal

The development between A and B is the opposite of the development between B and A.

Circularity

An accumulation of the developments between periods A and B and periods B and C is equal to the direct development between A and C.



Method: 4 steps

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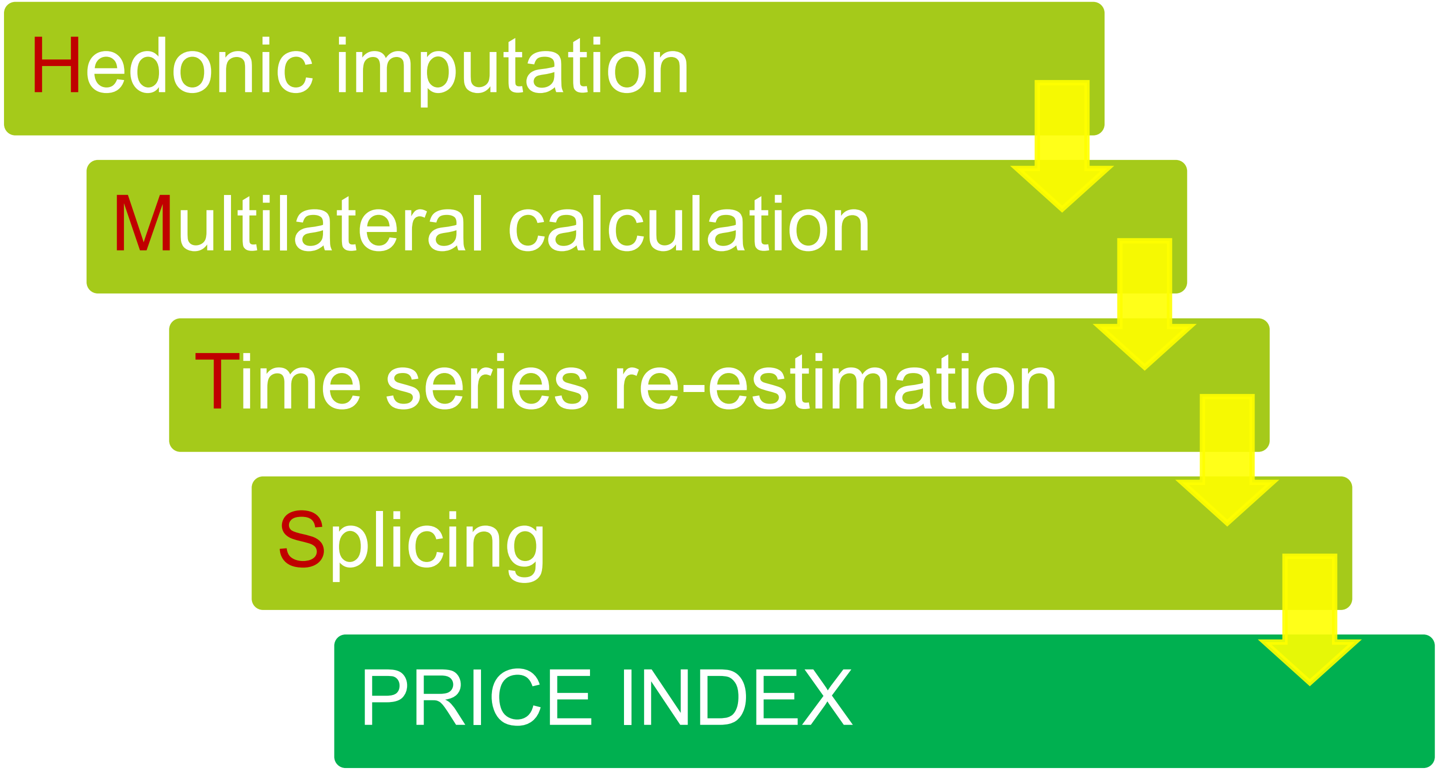

Hedonic imputation

Multilateral calculation

Time series re-estimation

Splicing

PRICE INDEX

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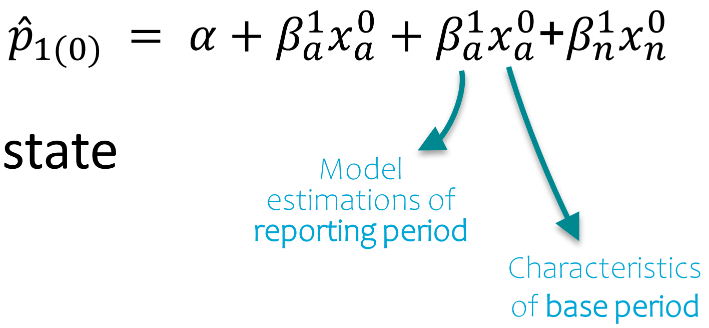
Step 1: Hedonic imputation

What?

Estimate prices with one base period

		Reporting period			
		0	1	2	3
Base period	0	$\overline{\hat{p}_{0(0)}}$	$\overline{\hat{p}_{1(0)}}$	$\overline{\hat{p}_{2(0)}}$	$\overline{\hat{p}_{3(0)}}$



$$\hat{p}_{1(0)} = \alpha + \beta_a^1 x_a^0 + \beta_a^1 x_a^0 + \beta_n^1 x_n^0$$

Model estimations of reporting period

Characteristics of base period

Why?

Correct for quality of sold real estate

Side effect:

If observations are few and heterogeneous: inaccurate estimations

Stability

Limited revisions

Turning points

Identity

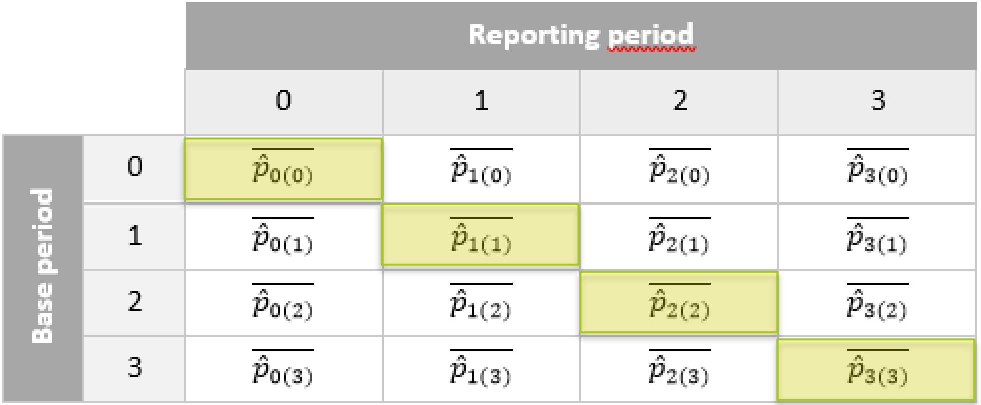
Time reversal

Circularity

Step 2: Multilateral calculations

What?

Estimate prices with all possible base periods



		Reporting period			
		0	1	2	3
Base period	0	$\overline{\hat{p}_{0(0)}}$	$\overline{\hat{p}_{1(0)}}$	$\overline{\hat{p}_{2(0)}}$	$\overline{\hat{p}_{3(0)}}$
	1	$\overline{\hat{p}_{0(1)}}$	$\overline{\hat{p}_{1(1)}}$	$\overline{\hat{p}_{2(1)}}$	$\overline{\hat{p}_{3(1)}}$
	2	$\overline{\hat{p}_{0(2)}}$	$\overline{\hat{p}_{1(2)}}$	$\overline{\hat{p}_{2(2)}}$	$\overline{\hat{p}_{3(2)}}$
	3	$\overline{\hat{p}_{0(3)}}$	$\overline{\hat{p}_{1(3)}}$	$\overline{\hat{p}_{2(3)}}$	$\overline{\hat{p}_{3(3)}}$

Why?

Limit the importance of the first period

Side effect:

Revision after adding one period

Stability

Limited revisions

Turning points

Identity

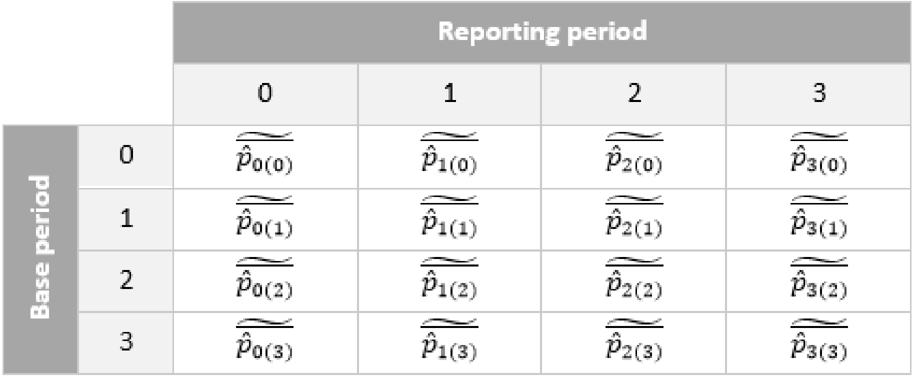
Time reversal

Circularity

Step 3: Time series re-estimation

What?

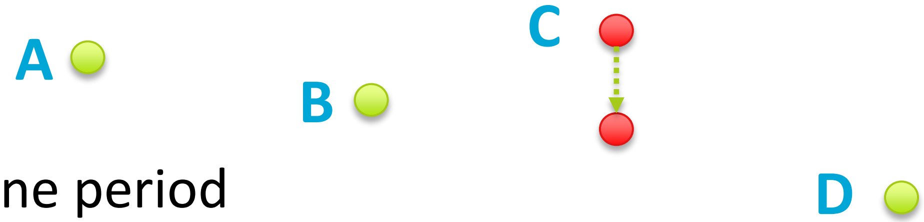
Improve estimations with Kalman filter (smoothen)



		Reporting period			
		0	1	2	3
Base period	0	$\widetilde{\hat{p}_{0(0)}}$	$\widetilde{\hat{p}_{1(0)}}$	$\widetilde{\hat{p}_{2(0)}}$	$\widetilde{\hat{p}_{3(0)}}$
	1	$\widetilde{\hat{p}_{0(1)}}$	$\widetilde{\hat{p}_{1(1)}}$	$\widetilde{\hat{p}_{2(1)}}$	$\widetilde{\hat{p}_{3(1)}}$
	2	$\widetilde{\hat{p}_{0(2)}}$	$\widetilde{\hat{p}_{1(2)}}$	$\widetilde{\hat{p}_{2(2)}}$	$\widetilde{\hat{p}_{3(2)}}$
	3	$\widetilde{\hat{p}_{0(3)}}$	$\widetilde{\hat{p}_{1(3)}}$	$\widetilde{\hat{p}_{2(3)}}$	$\widetilde{\hat{p}_{3(3)}}$

Why?

Previous estimations contain transaction noise



Side effect:

Revision after adding one period

Stability

Limited revisions

Turning points

Identity

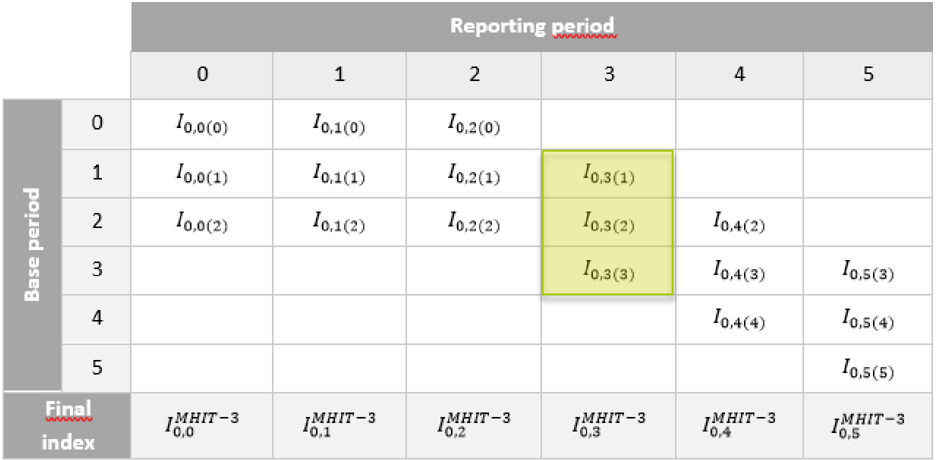
Time reversal

Circularity

Stap 4: Splice

What?

Use estimations within a window



		Reporting period					
		0	1	2	3	4	5
Base period	0	$I_{0,0(0)}$	$I_{0,1(0)}$	$I_{0,2(0)}$			
	1	$I_{0,0(1)}$	$I_{0,1(1)}$	$I_{0,2(1)}$	$I_{0,3(1)}$		
	2	$I_{0,0(2)}$	$I_{0,1(2)}$	$I_{0,2(2)}$	$I_{0,3(2)}$	$I_{0,4(2)}$	
	3				$I_{0,3(3)}$	$I_{0,4(3)}$	$I_{0,5(3)}$
	4					$I_{0,4(4)}$	$I_{0,5(4)}$
	5						$I_{0,5(5)}$
Final index		$I_{0,0}^{MHIT-3}$	$I_{0,1}^{MHIT-3}$	$I_{0,2}^{MHIT-3}$	$I_{0,3}^{MHIT-3}$	$I_{0,4}^{MHIT-3}$	$I_{0,5}^{MHIT-3}$

Why?

Limit revisions of all periods to just a few periods

Side effect:

Index does not formally pass all methodological tests

Stability
Limited revisions
Turning points

Identity
Time reversal
Circularity

Data

- Offices
- 2008 - 2022
- 150 – 1.100 transactions per quarter
- Hedonic model:

Ln(price) = ln(floor area) +
neighbourhood segment +
large city dummy +
building age +
distance to train station

Stability

Limited revisions

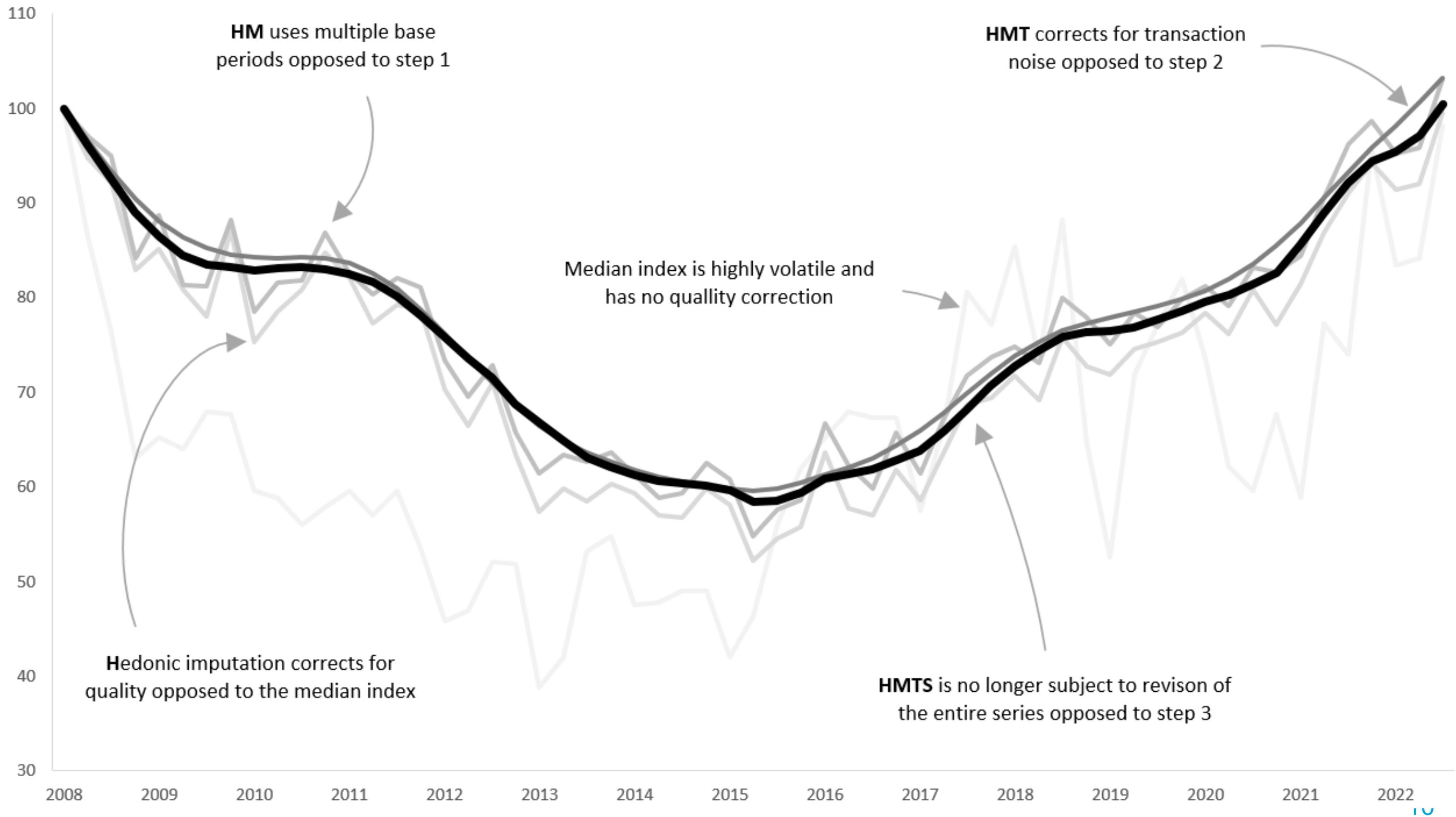
Turning points

Identity

Time reversal

Circularity

HMTS introduces stability



HM uses multiple base periods opposed to step 1

HMT corrects for transaction noise opposed to step 2

Median index is highly volatile and has no quallity correction

Hedonic imputation corrects for quality opposed to the median index

HMTS is no longer subject to revison of the entire series opposed to step 3

Stability

Limited revisions

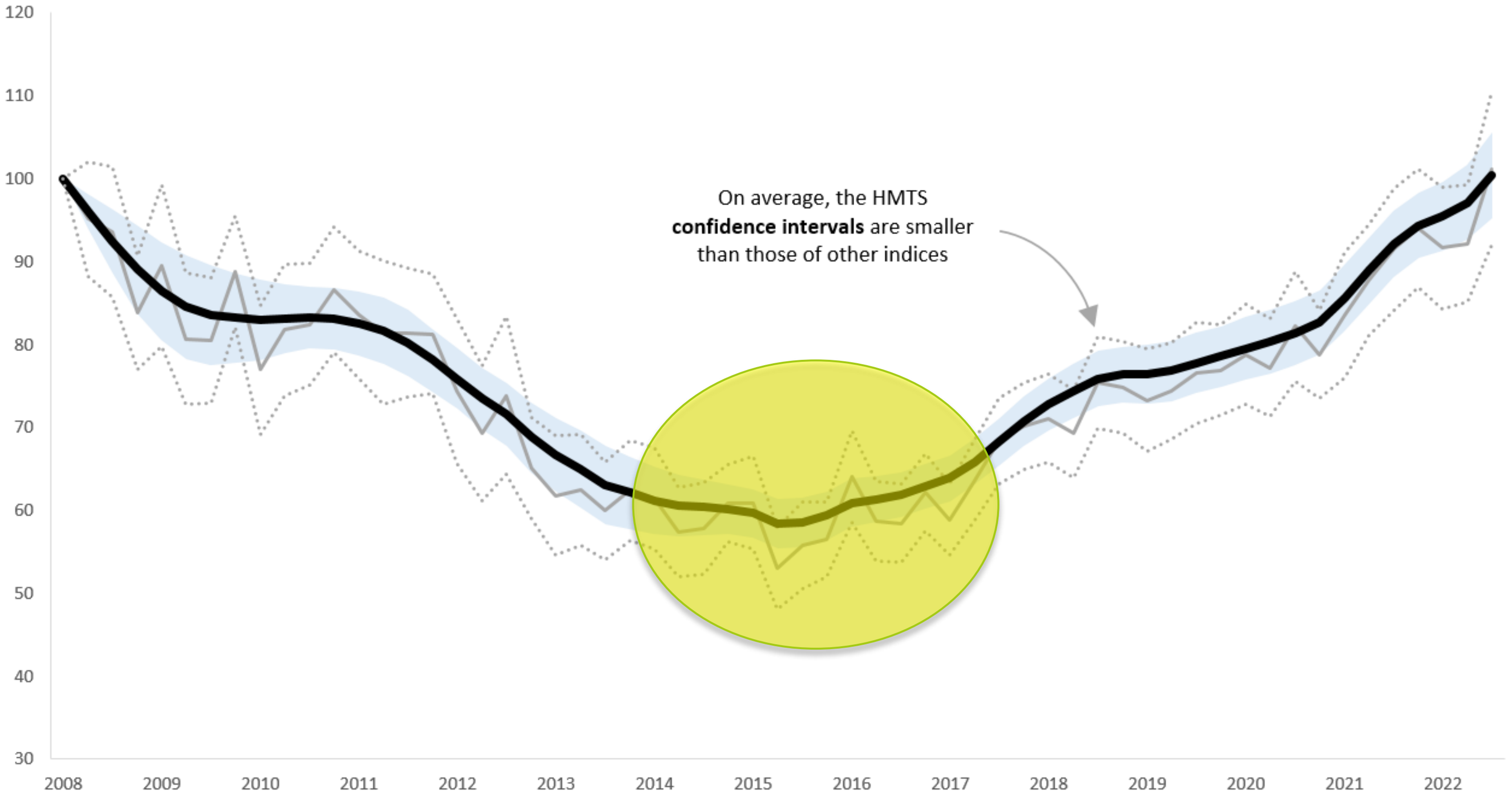
Turning points

Identity

Time reversal

Circularity

Smaller error margins



On average, the HMTS **confidence intervals** are smaller than those of other indices

Stability

Limited revisions

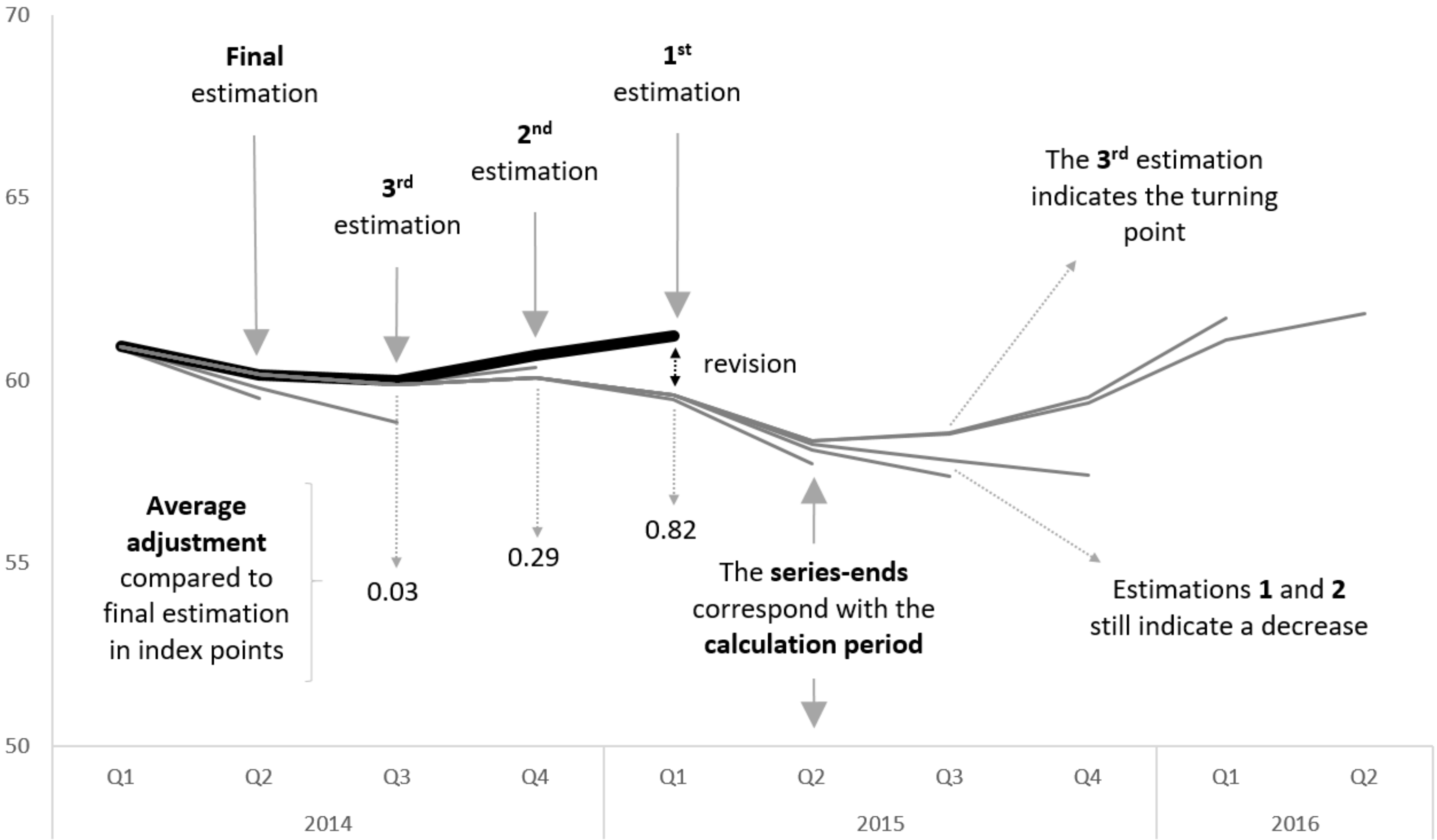
Turning points

Identity

Time reversal

Circularity

Few revisions are required



Earlier detection of turning points

Stability

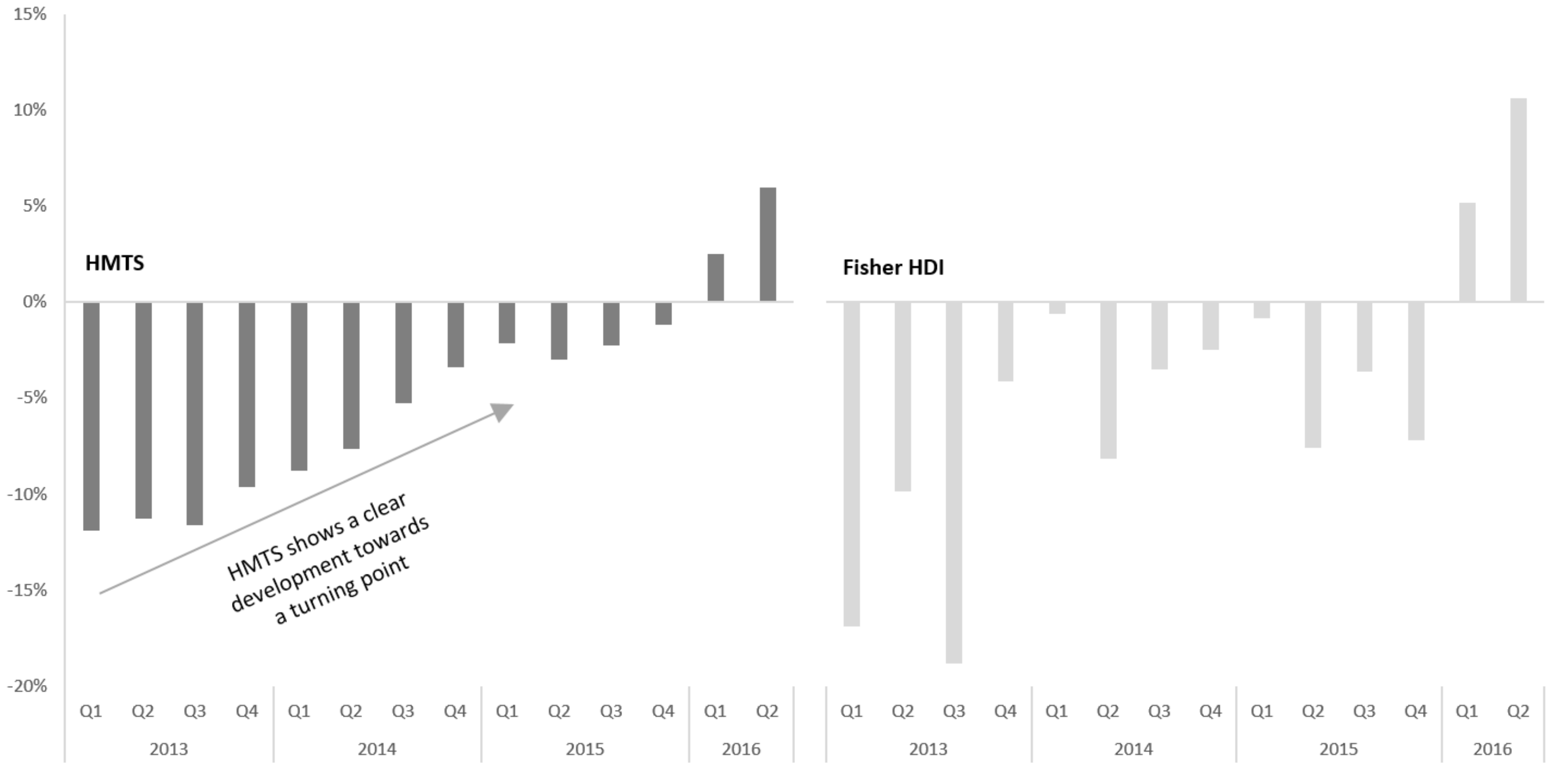
Limited revisions

Turning points

Identity

Time reversal

Circularity



HMTS shows a clear development towards a turning point

Stability

Limited revisions

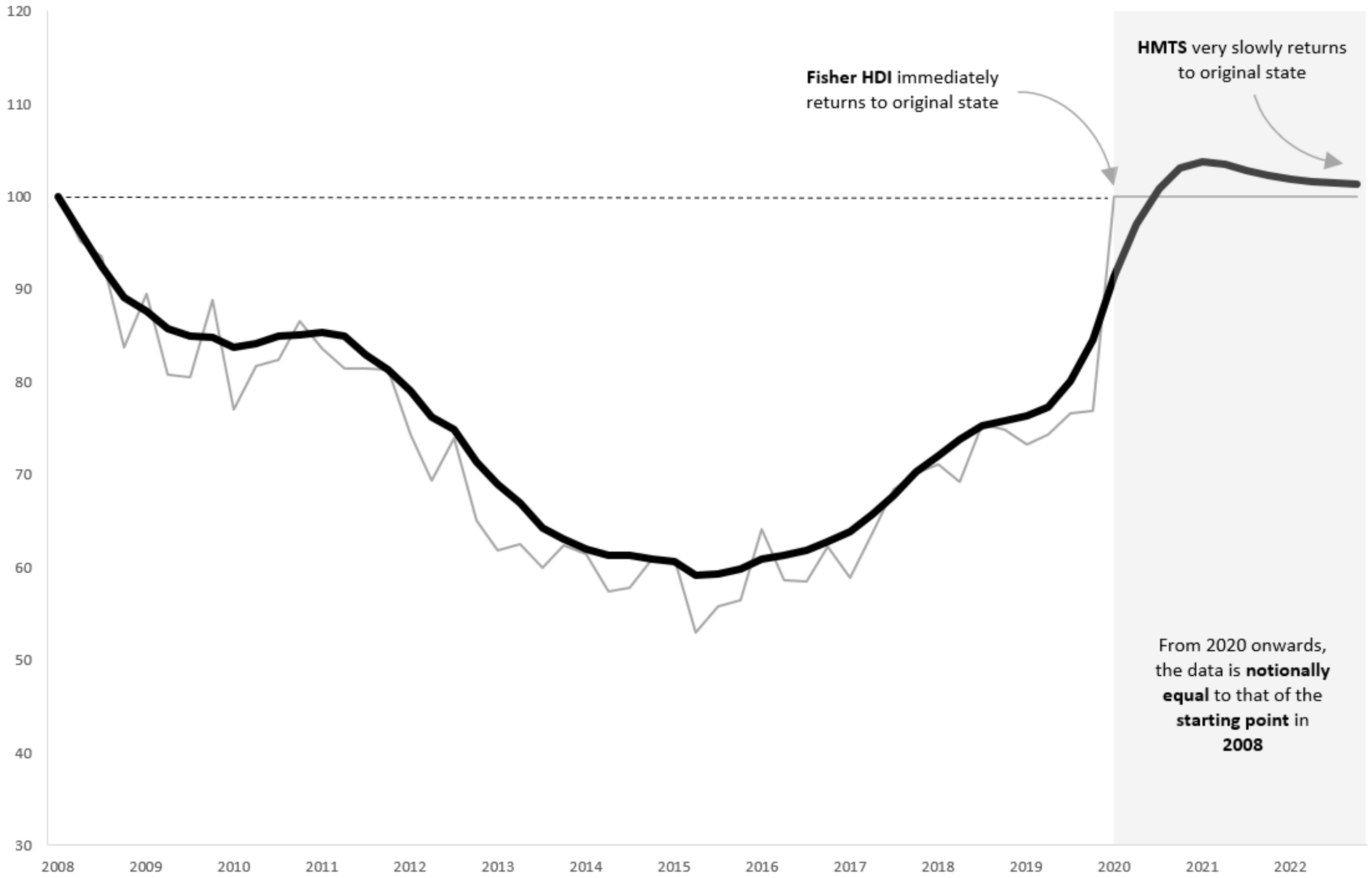
Turning points

Identity

Time reversal

Circularity

Slower response to data



Fisher HDI immediately returns to original state

HMTS very slowly returns to original state

From 2020 onwards, the data is **notionally equal** to that of the **starting point** in **2008**

Price trend seems time reversible

Stability

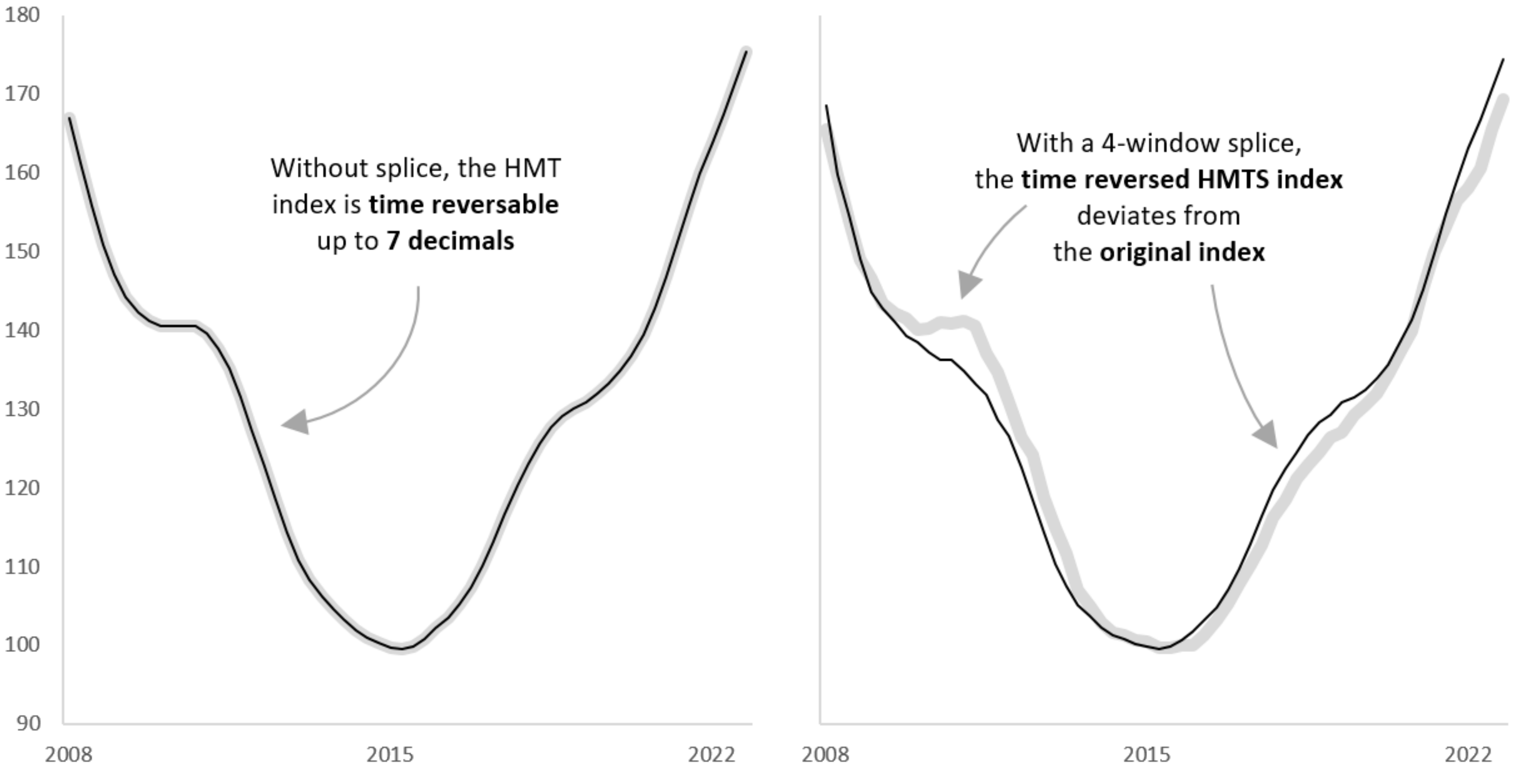
Limited revisions

Turning points

Identity

Time reversal

Circularity



Without splice, the HMT index is **time reversable** up to **7 decimals**

With a 4-window splice, the **time reversed HMTS index** deviates from the **original index**

Price trend seems circular

Stability

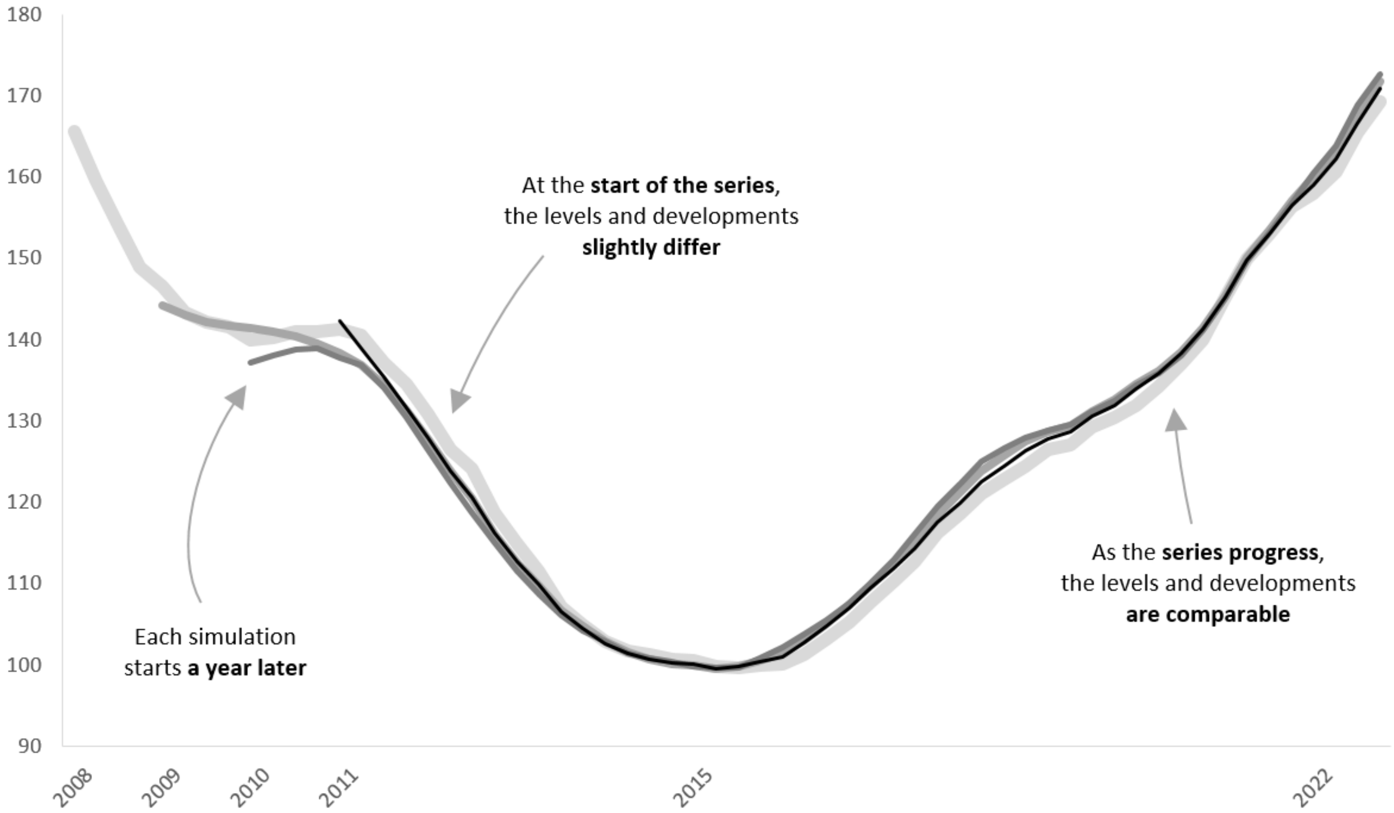
Limited revisions

Turning points

Identity

Time reversal

Circularity

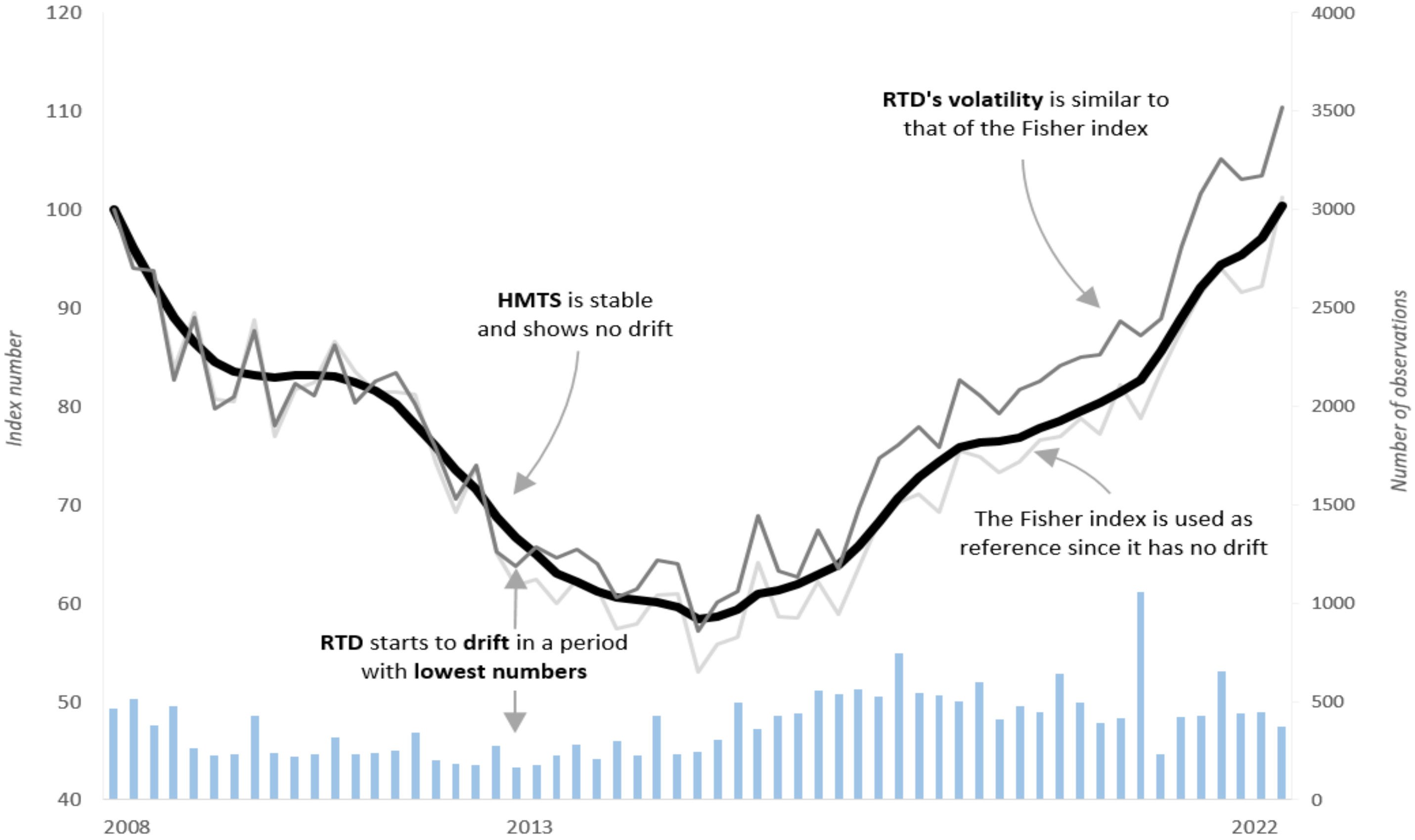


At the **start of the series**, the levels and developments **slightly differ**

Each simulation starts **a year later**

As the **series progress**, the levels and developments **are comparable**

HMTS not subject to drift



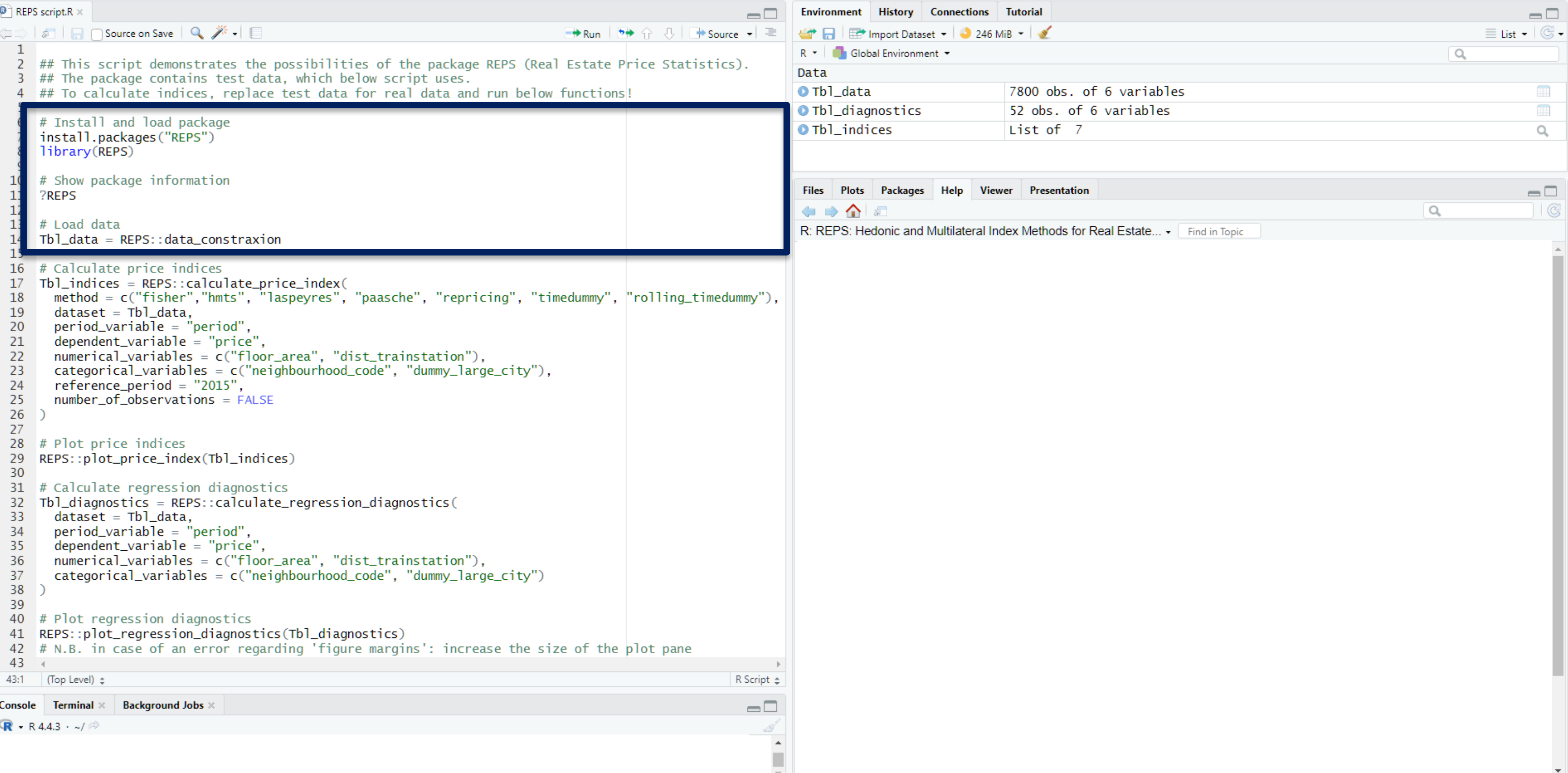
RTD's volatility is similar to that of the Fisher index

HMTS is stable and shows no drift

The Fisher index is used as reference since it has no drift

RTD starts to **drift** in a period with **lowest numbers**

R-package REPS



```r

## This script demonstrates the possibilities of the package REPS (Real Estate Price Statistics).
## The package contains test data, which below script uses.
## To calculate indices, replace test data for real data and run below functions!

# Install and load package
install.packages("REPS")
library(REPS)

# Show package information
?REPS

# Load data
Tbl_data = REPS::data_constraxion

# Calculate price indices
Tbl_indices = REPS::calculate_price_index(
  method = c("fisher","hmts", "laspeyres", "paasche", "repricing", "timedummy", "rolling_timedummy"),
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  dependent_variable = "price",
  numerical_variables = c("floor_area", "dist_trainstation"),
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```
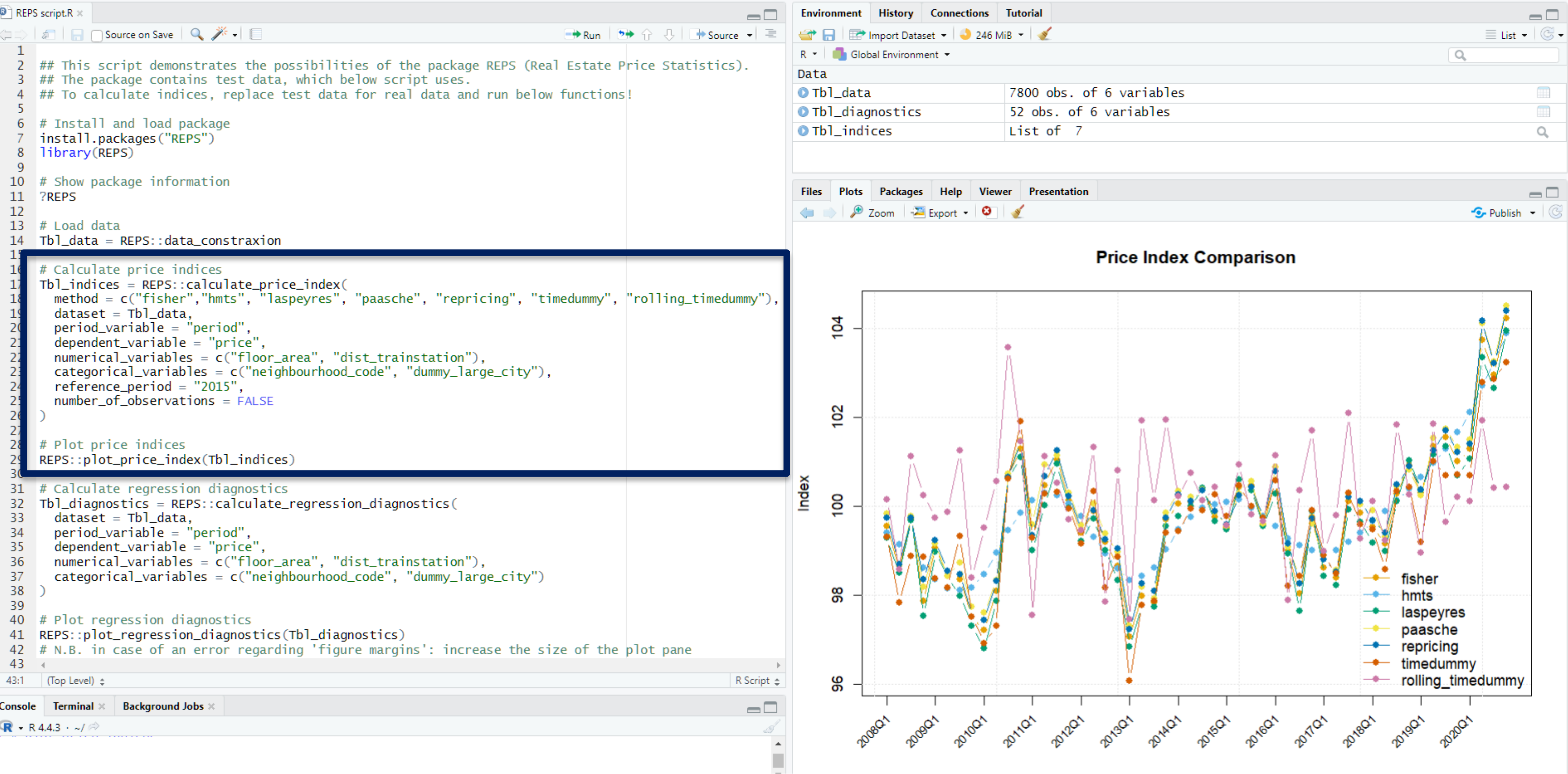

Data

Tbl_data	7800 obs. of 6 variables
Tbl_diagnostics	52 obs. of 6 variables
Tbl_indices	List of 7

R: REPS: Hedonic and Multilateral Index Methods for Real Estate...

R-package REPS



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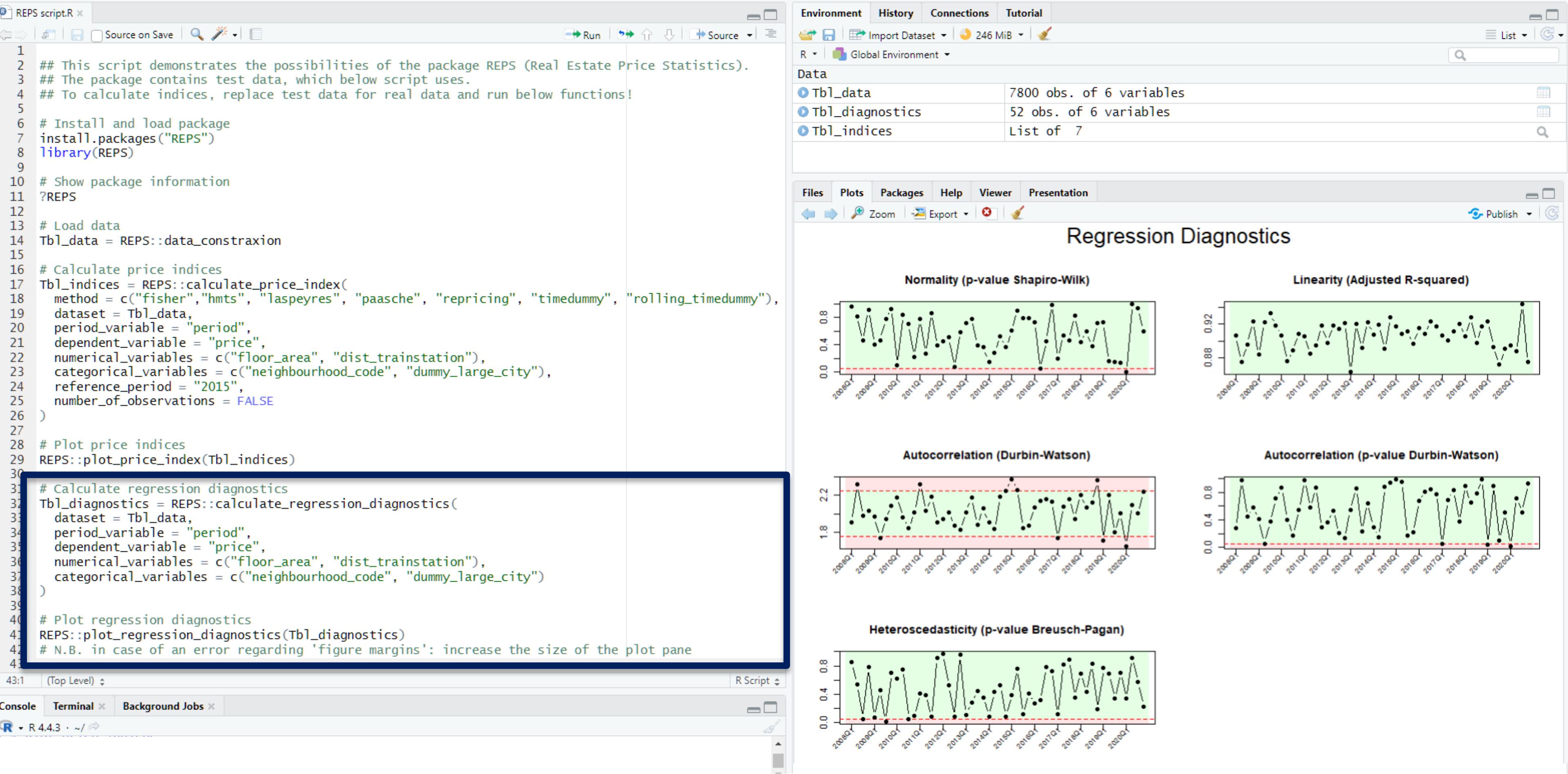

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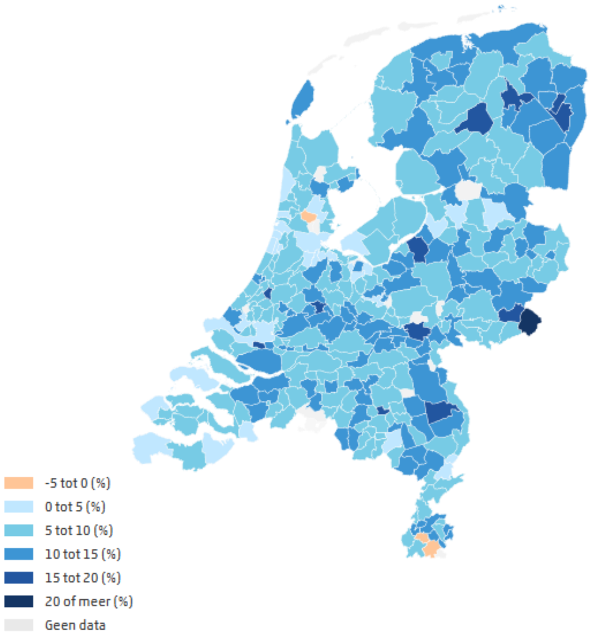
Use of HMTS in official statistics

House prices are rising the most in Winterswijk

February 11, 2026, 6:30 AM

Price development of existing owner-occupied homes, 4th quarter 2025 1)



Bron: CBS, Kadaster

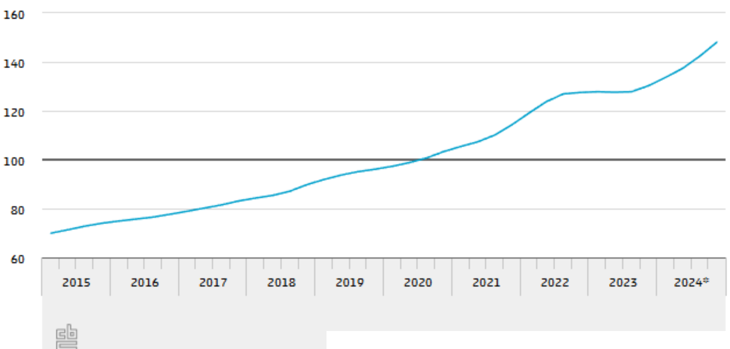
CBS HPI news article

Prices of new-build plots continued to rise in 2024

March 31, 2025, 6:30 AM

Price index for new building plots

2020 = 100

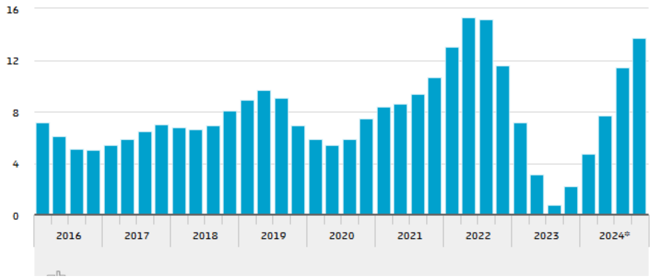


Bron: CBS, Kadaster

*provisional figures

Price development of new construction plots

% change compared to a year earlier



CBS building plot news article

Conclusions

- HTMS balances all needs for official statistics
- HMTS is already used for official municipal HPIs and will soon be used for official CPPIs
- However, method could be difficult to implement
- Therefore, our REPS package is published on CRAN

Arigatō

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REPS example code

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