Discussion of "Global housing returns, machine learning, and the emergence of the safe asset, 1465-2024"

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SFS Cavalcade 2025

What is the long-run property of real estate returns?

- Is the growth in house prices a recent phenomenon?
  - Recent papers argue yes, second half of 1900s to now
  - This paper says no

Knoll et al. (2017)

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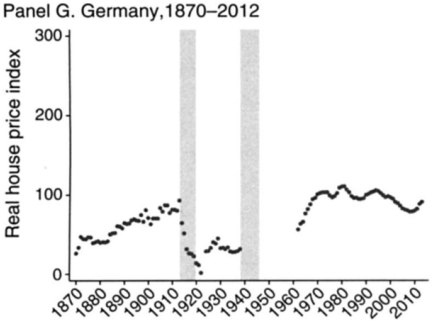

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1870(?)-2012(?)

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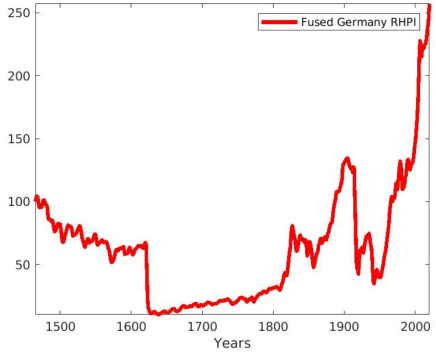
1465-2020



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- What *drives* the changes?
  - Other papers: land scarcity, wealth, supply elasticities
  - This paper: while rental yields have fallen (which should decrease housing value), discount rates and risk have fallen faster – temporary elevation of returns

$$R_{t+1} = \underbrace{\frac{\text{Rent}_t}{P_t}}_{\text{Rental Yield}} + \underbrace{\frac{P_{t+1} - P_t}{P_t}}_{\text{Capital Gains}}$$

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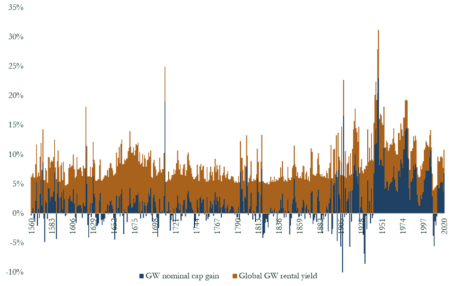
Figure 10: Decomposition of housing total returns, capital gains and rental yields, 1560-2020.



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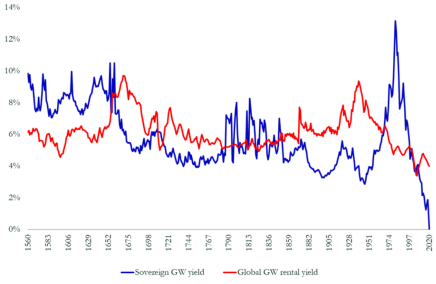
$$P_t = \frac{\text{Rent}_t}{\rho_t + \lambda_t - g}$$



What are key contributions?

- Digitises thousands of pre-modern sales contracts in eleven German cities
  - Repeat-sales price and rental series
- Trains Seq2Seq/TFT models on 1870-2020 data (house-price changes + 13 macro/financial covariates)
  - Back-casts house price growth for the US, UK, NL, FR and DE back to 1500.
- Study statistical properties of these series
  - Runs ADF-GLS, Bai-Perron, half-life calculations and excess-return regressions on the new series.
- Separates total returns into rental yields and capital gains
  - for 1560-2020 and shows rental yields fall while gains dominate.
- Comparing housing yields with sovereign and mortgage yields, fire-sale and crash analysis, Cost, tax, and net-return adjustments

Challenge 1: Turning basic measurement into “econometrics”

- Two ways to debate the long-run property of real estate returns
  1. Ocular regression and yell

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  1. Ocular regression and yell
  2. Time series analysis
- Econometric analysis has many potential pieces, key one I will focus on is Bai-Perron test

Bai and Perron tests

$$r_t = \mu + \epsilon_t \tag{1}$$

vs.

$$r_t = \mu_{k(t)} + \epsilon_t \tag{2}$$

where k denotes a period within $t = 1, \ldots, T$.

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Bai and Perron tests

$$r_t = \mu + \epsilon_t \tag{3}$$

vs.

$$r_t = \mu_{k(t)} + \epsilon_t \tag{4}$$

where k denotes a period within $t = 1, \ldots, T$.

How does Bai-Perron work?

1. Start with no breaks, and assume a mean value. Calculate the SSR.
2. Then, at every time period, try splitting the sample with one break. Calculate the SSR with these two different means. Calculate the F test for that break.
3. Finally, calculate the ”largest” F over all this. This is a supF test. If significant, then this improves over all possible breaks.
4. Algorithm to efficiently try all breaks – minimum break is chosen via trimming (5% here), no more than 5

- Choosing number of breaks is done using information criteria
- Gives you both how mny breaks, and their locations

Challenges with Bai-Perron

1. Key fact highlighted by the paper is longer time series in previous work has lead to different conclusions about trend breaks

> *the primary finding of the paper is that long term real interest rates have been on a persistent downward trend since the 1300's (about seven hundred years) [with no detected breaks from Bai and Perron tests]*

["Long-Run Trends in Long-Maturity Real Rates, 1311-2022", Rogoff et al. (2024)]

Challenges with Bai-Perron

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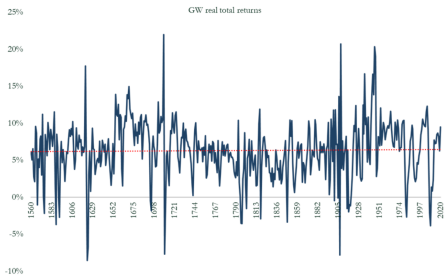
2. Similar results in this setting

Figure 6: Total Gross Returns, real, Global GW housing, 1560-2020.



Challenges with Bai-Perron

1. Key fact highlighted by the paper is longer time series in previous work has lead to different conclusions about trend breaks
2. Similar results in this setting
3. The Bai-Perron test really relies on a correctly specified model for correct coverage. In the given setting, this is an approximation.
    - I particularly worry about how the noise from estimation/imputation with ML will add on to this issue

Given inputs, could we approximate what returns should be as a smooth function?

Challenge 2: Turning a time series into a panel using observables

Year	Germany	UK	US	NL	FR
1490	$\Delta HP_{1490,DE}$	-	-	-	-
⋮	ΔHP_{DE}	-	-	-	-
1870	$\Delta HP_{1870,DE}$	$\Delta HP_{1870,UK}$	$\Delta HP_{1870,US}$	$\Delta HP_{1870,NL}$	$\Delta HP_{1870,FR}$
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2020	$\Delta HP_{2020,DE}$	$\Delta HP_{2020,UK}$	$\Delta HP_{2020,US}$	$\Delta HP_{2020,NL}$	$\Delta HP_{2020,FR}$

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Backfilling the panel

- Paper uses several ML approaches to impute data based on covariates:
  - Building Costs, Government Deficit, Financial Crisis, population growth, lagged growth, nominal interest rates, change in nominal rates, real interest rates, inflation, lagged inflation, change in real p.c. income, FX peg, Geopolitical risk index
- Seq2Seq converts long context into shorter prediction
- My questions:

Table 3: Machine-learning model performance. Target: DM annual house price change

	r-squared	MAE	forecast horizon	context window
Target: nominal y-o-y price change				
Seq2Seq+, 110-36	.544	.032	36	110
Temporal Fusion Transformer (TFT)	.464	.033	36	115
Time Series Dense Encoder (TiDE)	.184	.039	32	110
Target: real y-o-y price change				
Seq2Seq+, RHP, 115-36	.572	.035	36	115
Temporal Fusion Transformer (TFT)	.428	.040	36	115
Time Series Dense Encoder (TiDE)	.169	.040	36	115

Notes: The table reports training results from several machine-learning (ML) approaches, all with annual nominal residential real estate price change as their target variable. The training data set consists of house price changes in addition to ten co-variant variables, annually over 1870-2020, primarily using "JST" (Jorda et al., 2017), except for Germany (excluded up to 1962 to prevent leakage) and the U.S. (where Lyons et al. (2024) is used).

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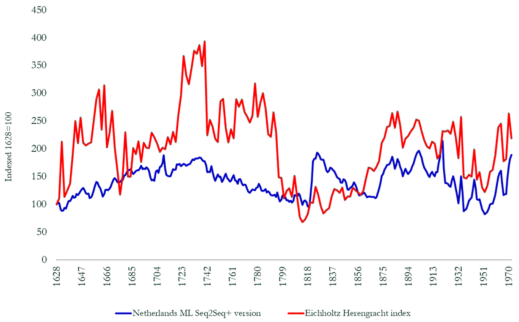
Figure A.12: Machine-learning (ML) Netherlands RHPI index, versus Eichholtz Herengracht index, 1628-1973, with 1628=100.



Notes: The Figure compares the machine learning-generated Netherlands real house price index, compared to the Herengracht Amsterdam real house price index presented by Eichholtz (1997).

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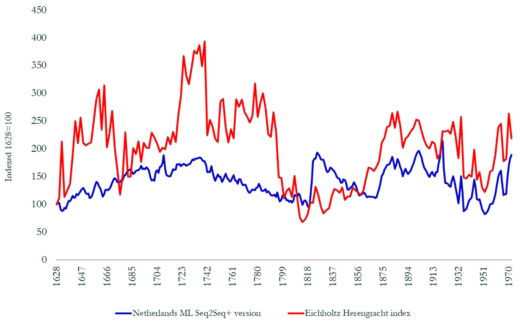

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  - How does it affect statistical tests?

$$\hat{r}_t = r_t + u_t = \mu_k + \epsilon_t + u_t$$

- Bai-Perron in context with generated outcomes
- What does this do?

You can do more serious validation! Or moreover, jointly estimate

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