Hedonic price estimates for new vehicles: When do rotations lead to drift?

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Summary

- New vehicles and other items subject to product cycle effects

- Multilateral methods alone do not address product cycle
  - ▶ Price change must be measured across versions
  - ▶ Hedonic methods allow price measurement across product cycles

- Hedonic imputation can be used with similarity linking
  - ▶ New link method based on the similarity of regression estimates based on a Chow test
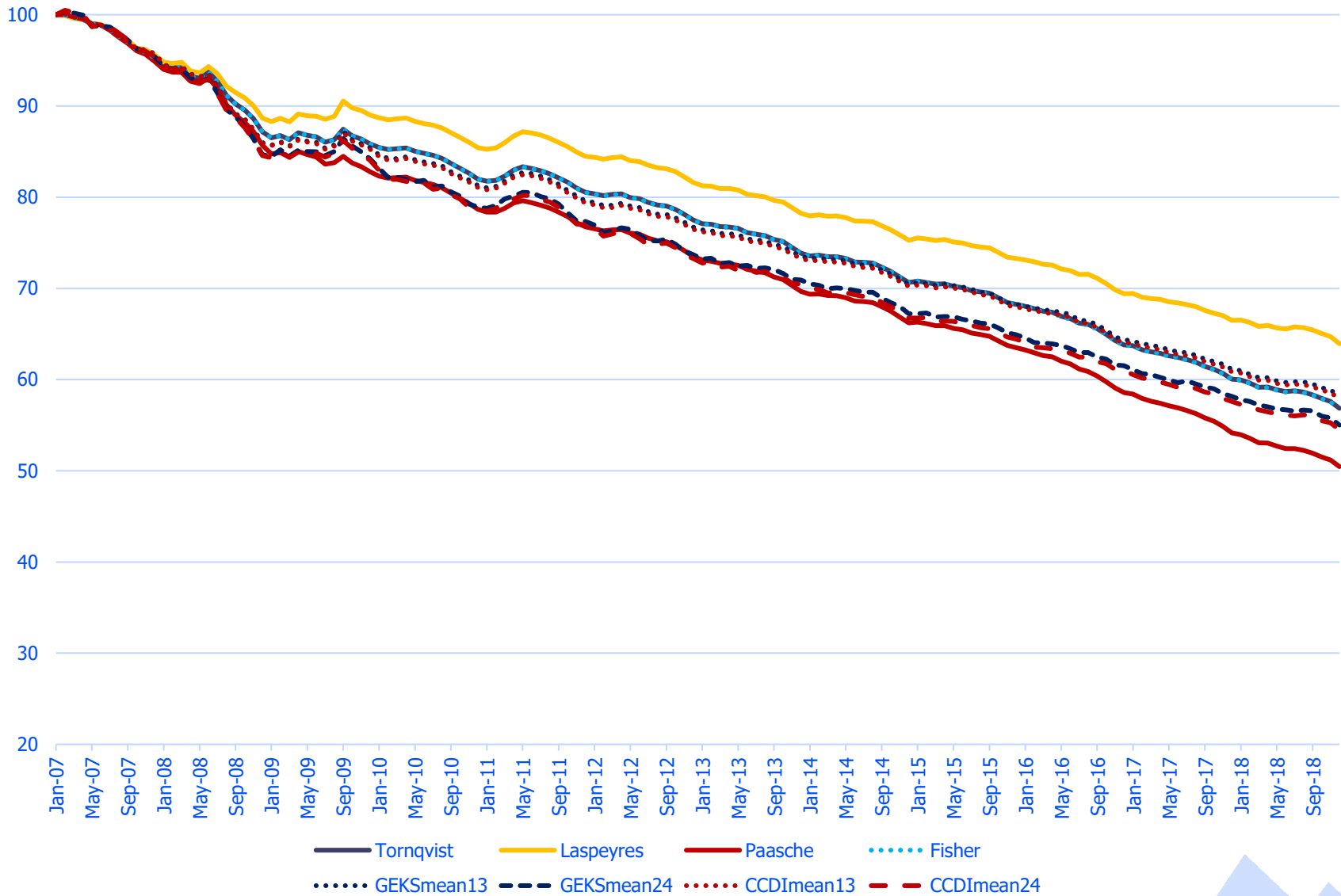
Data

- J.D. Power: Transaction records of car sales
  - ▶ SquishVIN as product ID
  - ▶ Some information on features
- Wards: Specification information
  - ▶ Data on vehicle performance and other features
    - – Horsepower, torque, fuel efficiency, vehicle size…
- Combine based on manufacturer, engine type, and string matching for model and trim
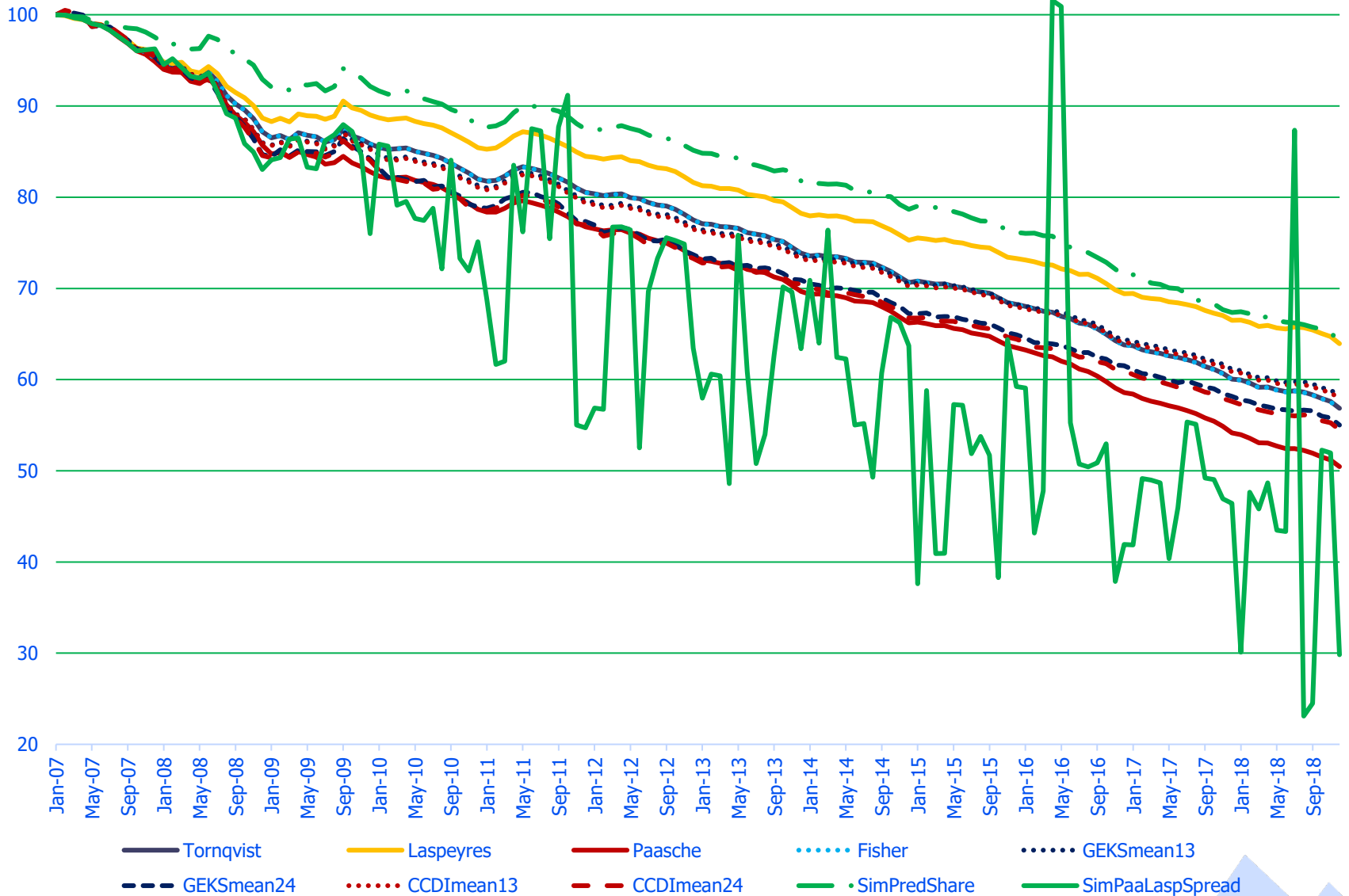
Product Cycle

- Intertemporal price discrimination
  - ▶ Evidence documented in Aizcorbe, et al. (2010) and Williams and Sager (2019)
  - ▶ Price decreases consistently for a product over a given model year
- Price updates with model updates
  - ▶ Sellers introduce new pricing regimes with product updates
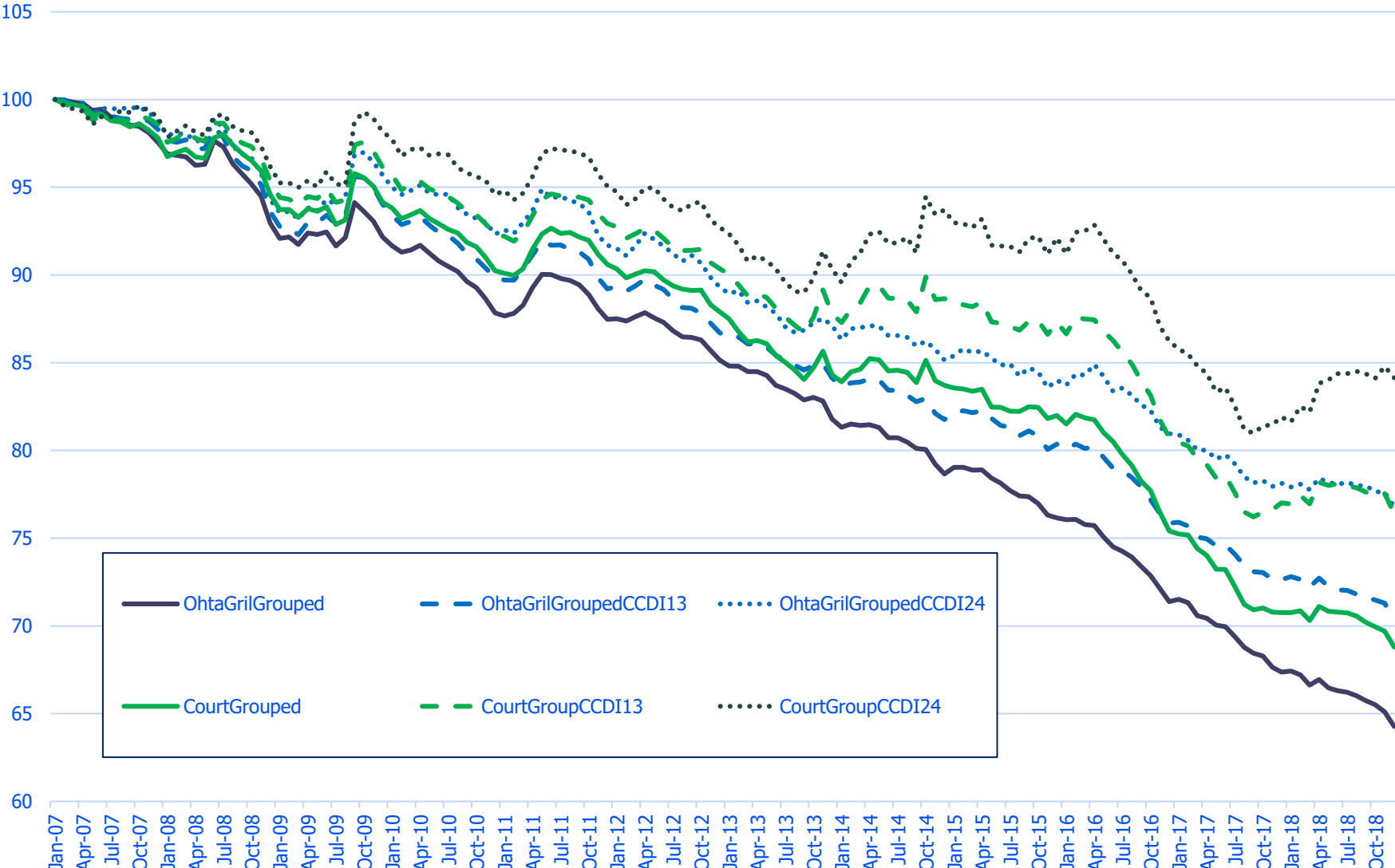 - ▶ Related to theory of price rigidity

Matched Model (SquishVIN) Price Indices

Legend: Tornqvist, Laspeyres, Paasche, Fisher, GEKSmean13, GEKSmean24, CCDImean13, CCDImean24

Matched Model (SquishVIN) Price Indices

Legend: Tornqvist, Laspeyres, Paasche, Fisher, GEKSmean13, GEKSmean24, CCDImean13, CCDImean24, SimPredShare, SimPaaLaspSpread

Product Grouping with CCDI

Legend:
- OhtaGrilGrouped
- OhtaGrilGroupedCCDI13
- OhtaGrilGroupedCCDI24
- CourtGrouped
- CourtGroupCCDI13
- CourtGroupCCDI24

Historical Models

|	Court (1939)	Griliches (1961)	Triplett (1969)	Triplett Truncated (1969)	Cowling & Cubbin (1972)	Ohta & Griliches (1976)
Weight	x	x	x	x		x
Wheelbase	x	Length/wheelbase				
Horsepower	x	X	x		x	x
Length		Length/wheelbase	x		x	x
V8		X	x			x
Hardtop		x	x			x
Transmission		x	X	Comb.		
Power brakes		x	Comb.	Comb.	x	
Power steering		x	Comb.	Comb.		
Compact		x	x	x		
Over4Gears					x	
Luxury					x	
PassengerArea					x	
Efficiency					x	
Make						Indicator variables

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Interacted Model

- Wheelbase, length, weight, horsepower, displacement, height, MPGCity, MPGHwy, torque

- Indicators: # of Cylinders, Make, Bodystyle, Hybrid, AWD

- Interactions:
  - ▶ Hybrid (MPGCity, MPGHwy, torque)
  - ▶ MPGCity/MPGHwy (weight, horsepower, displacement)
  - ▶ horsepower/weight

Basic Hedonic Methods

- A bilateral Time-Product Dummy, WLS regression

  ▶ Nearly identical to matched model

- TPD is a "fully interacted" time-dummy hedonic, Krsinich (2016)

- Pooled TDH constrains feature values to a constant over pooled time period

- Hedonic imputation: Hedonic predicted price for each specification weighted with observed quantities
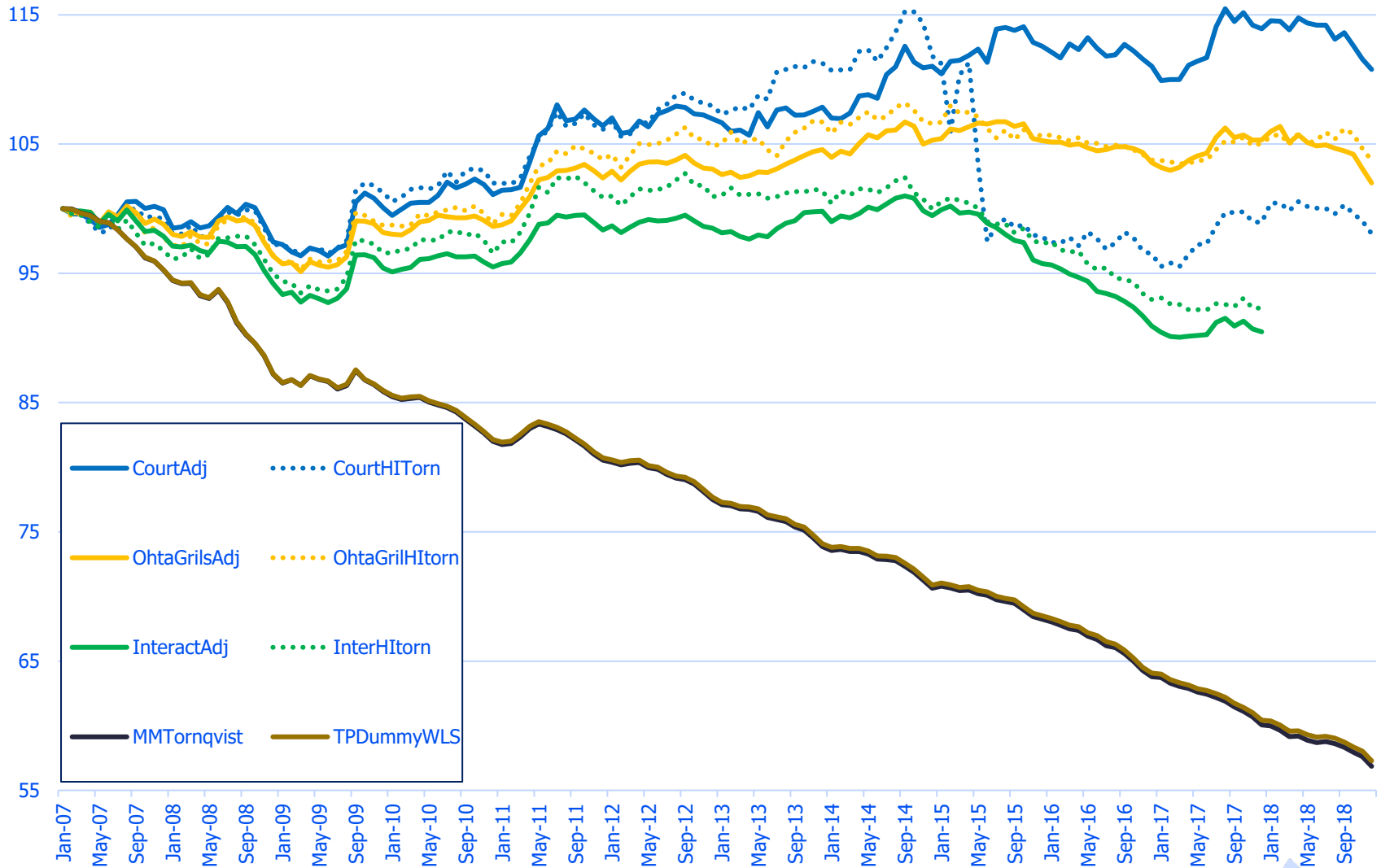
Pooled vs Adjacent Period Hedonic Indexes

Legend:
- CourtPooled
- CourtAdj
- OhtaGrilPooled
- OhtaGrilsAdj
- InteractPool
- InteractAdj
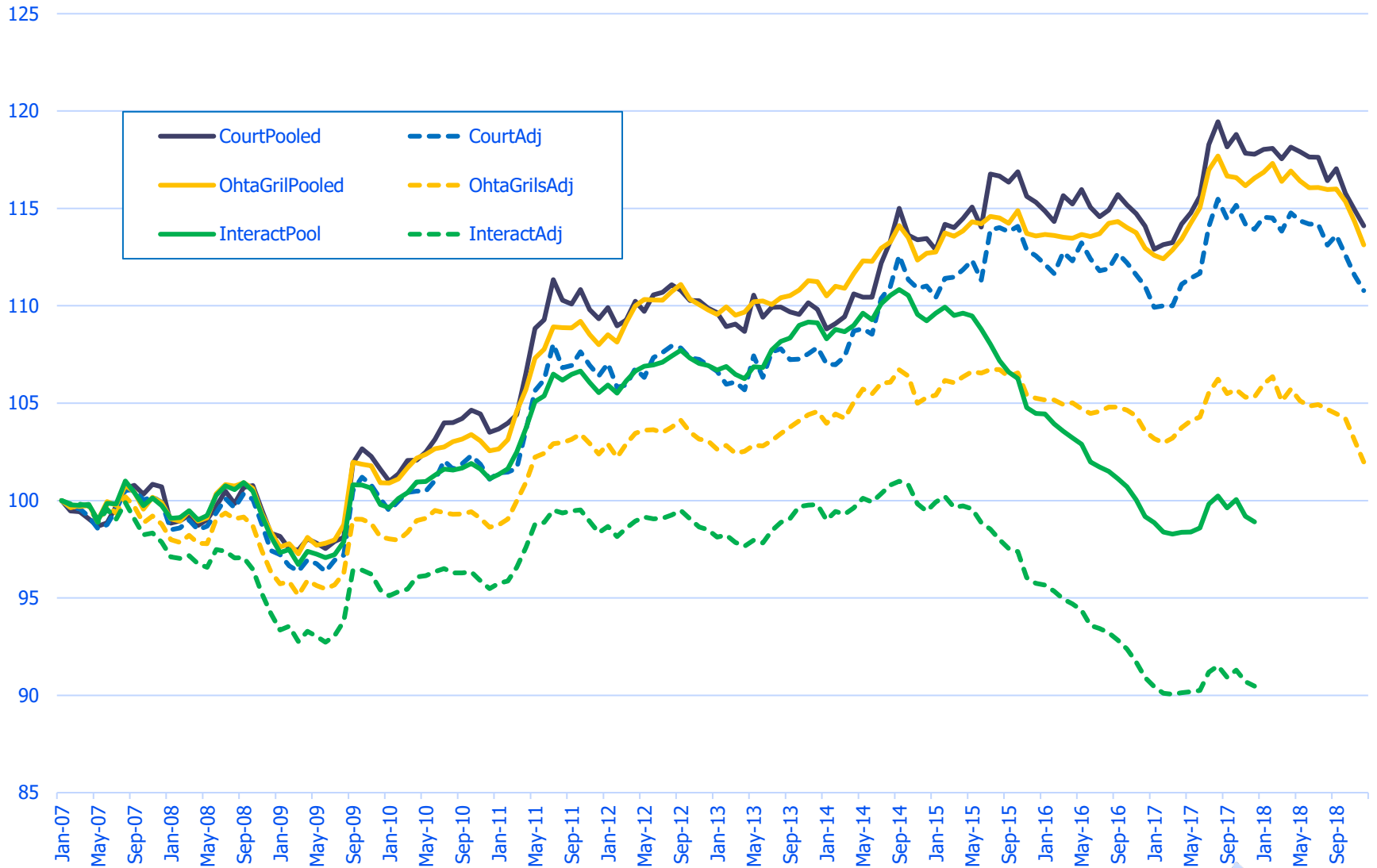
Pooled Regression Fits

Model Specification	R-Squared	Adjusted R-Squared
Court	0.6887	0.6884
Ohta & Griliches	0.8717	0.8715
Interacted	0.9253	0.9252

Adjacent TDH vs Hedonic Imputation

Product Cycle and Measurement

- Long-term objective price change should fully reflect the difference between completely different regimes

- In the case of IPD, long-run relative may still be biased, but will not compound and cycle patterns may disperse over a longer time horizon

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Index Methods and Product Cycle: Accuracy Issues

■ Matched model, TPD

▶ Inaccurate: Price change omitted between regimes

■ Product grouping or product matching

▶ Partially accurate: Dependent on matching method and weighting

■ Short-term hedonic imputation and adjacent period TDH

▶ Partially accurate: Dependent on weighting of transition

Index Methods and Product Cycle: Most Accurate Measures

- Long-term relatives

- Intermediate price changes are transitive or not included

- Methods:

  ▶ Hedonic imputation with fixed base
    – No chain drift, but dependent on base period and losses representivity

  ▶ Hedonic imputation multilaterals

  ▶ Similarity linking

Ohta and Griliches Model Imputes with Multilaterals

Legend: Adj TDH — Hed Impute — HI CCDI Mean13 — HI CCDI Mean 24 — HI CCDI Mean 36 — HI Fixed Base
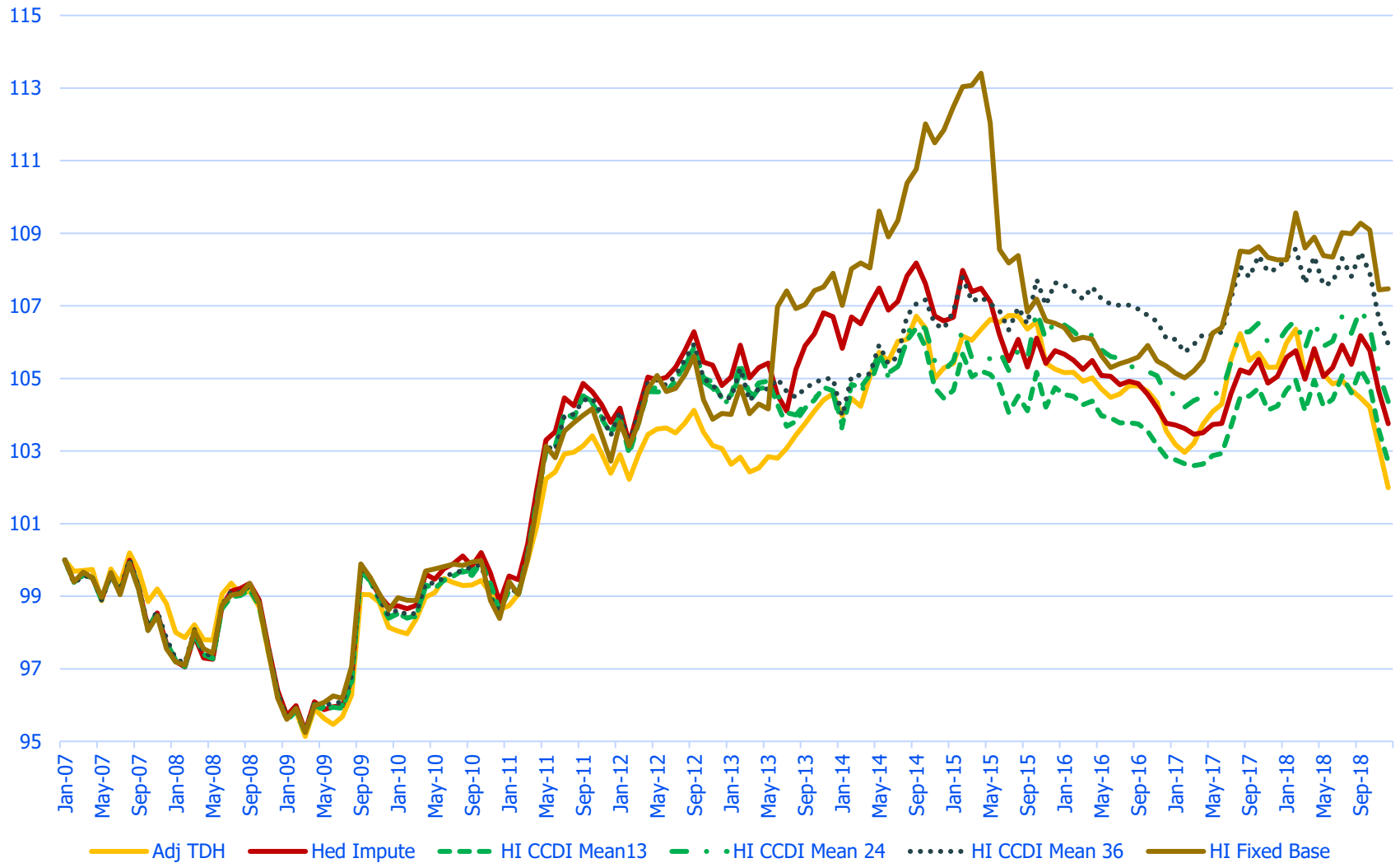
Similarity Linking Indexes

- Pass multiperiod identity test and are fully transitive

- A new period index, I^t, is found by creating a bilateral index of the most similar previous period
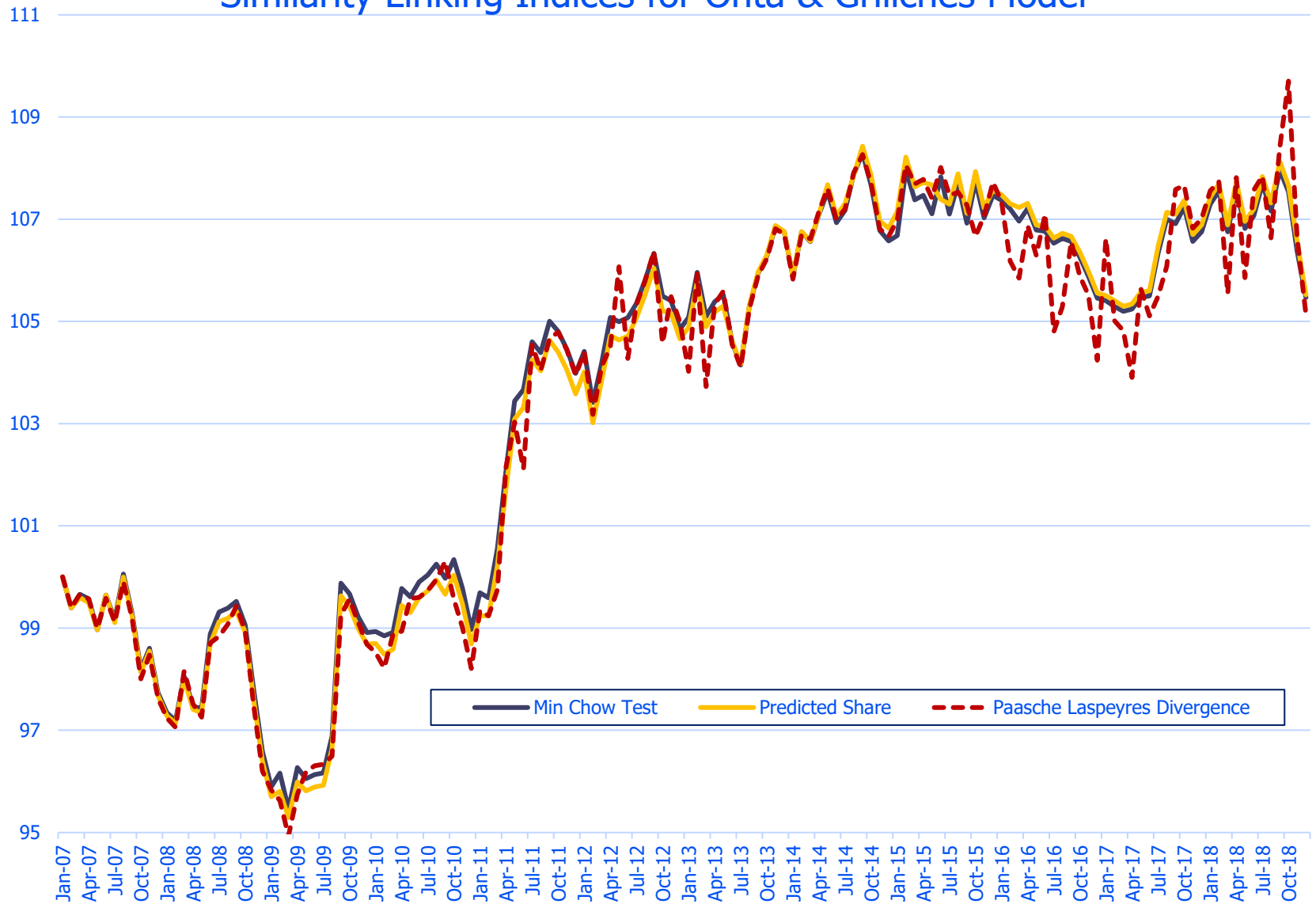
$$I^t = I^{t^{Sim}} \times P(p^t, q^t, p^{t^{Sim}}, q^{t^{Sim}})$$

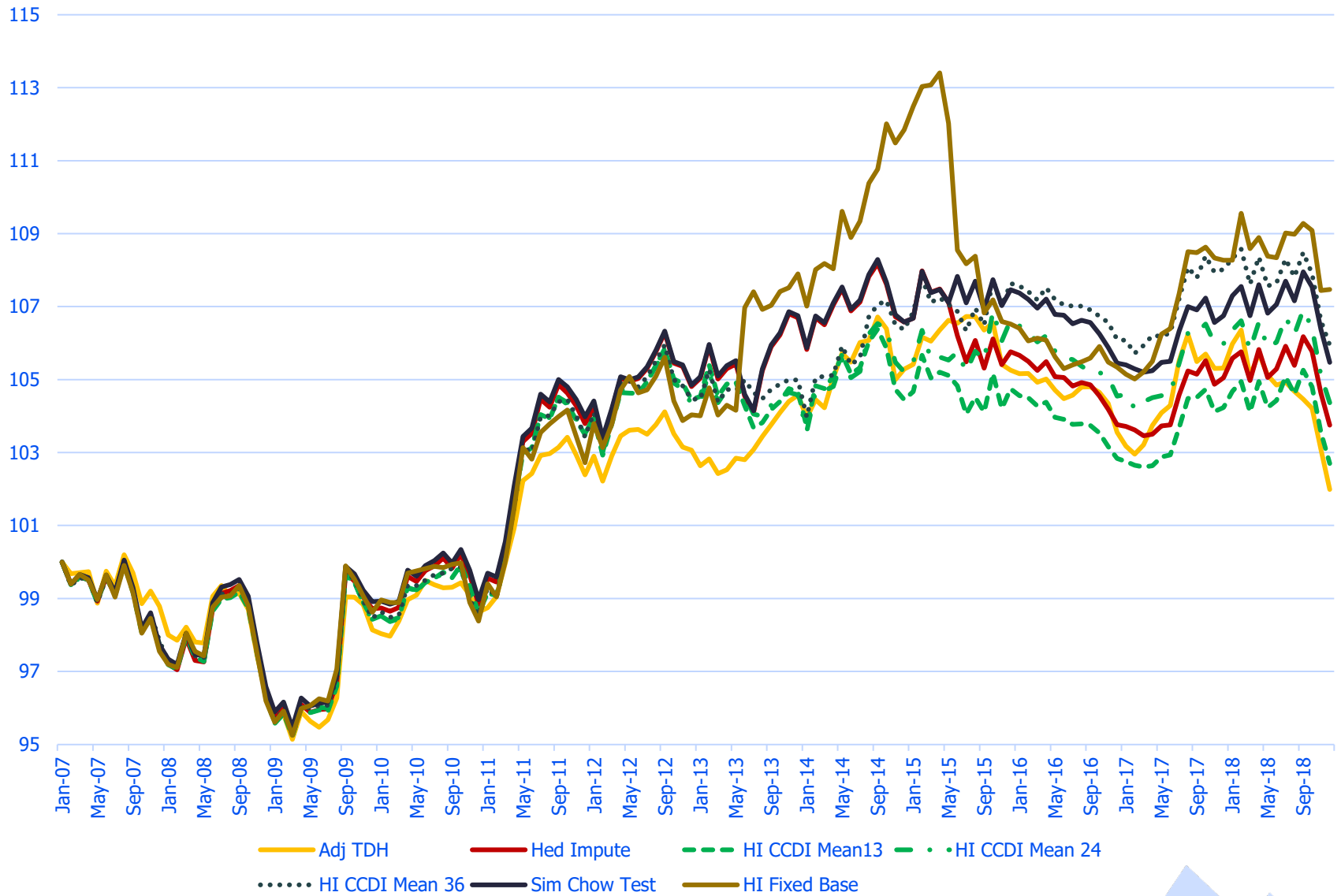- Different methods exist for quantifying similarity or dissimilarity

Similarity Linking and Hedonics

- ■ Use hedonic imputed price with a similarity linking method

- ■ New similarity linking method
  - ▶ Estimate a single period hedonic regression and find the previous period with the closest fit

- ■ For all prior periods to *t, t-a,* find
  - ▶ $F = \dfrac{(SSE_{Combo} - (SSE_t - SSE_{t-a}))/k}{(SSE_t - SSE_{t-a})/(N_t + N_{t-a} - 2k)}$
  - ▶ The prior period with the lowest Chow test statistic is used as a link

Similarity Linking Indices for Ohta & Griliches Model

Legend: Min Chow Test — Predicted Share — Paasche Laspeyres Divergence

Ohta and Griliches Model Imputes with Multilaterals

Legend:
- Adj TDH
- Hed Impute
- HI CCDI Mean13
- HI CCDI Mean 24
- HI CCDI Mean 36
- Sim Chow Test
- HI Fixed Base

Conclusions

- Product cycle effects dominate quality change in certain markets.

- Product cycle can drive drift and chain drift/multilateral may be a secondary effect.

- Hedonic imputation should be preferred over product matching when possible.

- Similarity linking with hedonic imputation appears promising.

Contact Information

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