REVISITING THE HOUSE PRICE-INCOME RELATIONSHIP

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Background

- The relationship between house prices and income has been used in various ways to examine house price misalignments.
- However, the actual nature of the relationship between house prices and income remains unclear.
  - For instance, The house price-income ratio is often used as an indicator for house price misalignments, but the evidence is still lacking on whether the ratio is stable in the long run.
- Why is this important?
  - Reliable assessments of whether prices are under or over their long-term equilibrium levels are desirable.
  - Regional differences in the dynamics have significant policy and predictability implications.
  - The house price-income relationship affects trends in the wealth-income relationship.
- We aim to provide new insights into the nature of the relationship.
Summary of Empirical Literature

- Investigations of house prices and income generally entail restrictive assumptions regarding the nature of the relationship, including:
  1) A one-to-one long-term relationship between house price and income growth assumed by the use of price-income ratios
  2) A linear stationary relationship between prices and per capita personal income
  3) Homogeneity across locations assumed by pooled estimations
  4) No or insignificant spatial dependence assumed (which is implied by not considering it)

- Empirical findings regarding the relationship between prices and income vary (perhaps as a result of these methodological issues)

- The price-income ratio is often used “uncritically” as an indicator of bubbles and as a basis for the long-term equilibrium relation for house prices
What Do We Do (Better)?

- We derive a spatial general equilibrium model to consider theoretically the stability of the house price-income ratio over time.

- In empirical analysis, we relax the restrictive assumptions of earlier studies:
  
a) We specify the price-income relationship in various ways and compare the results.

b) We allow for regional heterogeneity in the relationships.

c) We control for spatial dependence in the unit root / cointegration tests.

d) We consider complications with panel unit root / cointegration tests.
Implications of Theoretical Model

1) House prices, wages, and population are jointly determined

2) They also are cross-sectionally dependent

3) Long-term stability of house price-income ratio is expected to be a “special case” rather than a rule

4) The equilibrium price-income ratio can be altered by various shocks in the city itself or in other cities

5) The elasticities of housing supply and demand are key determinants for the influence of various shocks on the house price-income ratio (also the elasticities in other cities affect the outcomes in a given city)

6) The income elasticity of house prices is expected to vary considerably across cities.
Hypotheses

1) The house price-income ratio is generally not stationary → not a good indicator for house price misalignments

2) Aggregate income is a better variable capturing the long-term (fundamental) equilibrium house price level than income per capita

3) A regression model that includes population and income per capita separately – thus relaxing the assumption of similar coefficients on income per capita and population – works even better than aggregate income

4) The slope coefficients on income and population vary significantly across cities
Empirical Data and Methodology

- 50 largest U.S. MSAs
- Quarterly data for the period 1980-2014 on house prices, income per capita, population, and aggregate income
- All in natural logs and prices and income in real terms
- Baseline models estimated with Fully Modified OLS mean-group (FMOLS-MG) estimator (Pedroni, 2000, 2001)
  - Consistent in the presence of endogenous regressors
  - Suitable for non-stationary variables in the presence of cointegration
  - Allows for heterogeneous slope coefficients across MSAs
- Results are compared with some other estimators: Pooled OLS and FMOLS, CCE (Pesaran, 2006), and DCCE (Chudik and Pesaran, 2015)
- Panel cointegration and unit root test: CIPS test by Pesaran (2007)
  - Allows for heterogeneity (lags, coefficients) across MSAs
  - Caters for cross-sectional dependence
  - Based on city-specific CADF equations
Analyzed Relationships

• Price-income ratio: $p_{i,t} - y_{i,t}$

• Three regression specifications:
  
  Model 1: $p_{i,t} = \beta_{0i} + \beta_{y,i} y_{i,t} + \epsilon_{i,t}$
  
  Model 2: $p_{i,t} = \beta_{0i} + \beta_{ya,i} y_{a,i,t} + \epsilon_{i,t}$
  
  Model 3: $p_{i,t} = \beta_{0i} + \beta_{y,i} y_{i,t} + \beta_{pop,i} pop_{i,t} + \epsilon_{i,t}$
Summary of Findings

• Non-stationary data

• CIPS test rejects the hypothesis of non-stationarity / no-cointegration in each studied relation (except for the model estimated with CCE estimators)

• Homogeneity of slope coefficient(s) is clearly rejected in each regression specification

• Hypothesis $\beta_y = 1$ is clearly rejected

• $\beta_y = \beta_{pop}$ is accepted for the mean-group estimates, but great variations between the two point estimates in individual MSAs

• FMOLS-MG point estimates:
  • $\beta_y = 0.846$
  • $\beta_{ya} = 0.478$
  • $\beta_y = 1.529; \beta_{pop} = -0.661$ (multicollinearity complications)
Summary of Findings Cont’d

• The conventionally used panel unit root test is complicated:
  • $H_0$: each of the residual series is non-stationary (i.e. none of the MSA-specific equations is cointegrated)
  • $H_1$: **one or more** residual series are stationary (i.e. one or more MSA-specific equations are cointegrated)

→ Rejection of the null hypothesis can be interpreted to provide evidence of stationarity of a non-zero fraction of the series (Pesaran, 2012)

• Thus, a typical interpretation of the CIPS test results may well be (and is!) misleading

• Based on individual MSA-specific CADF tests:
  • Price-income ratio is non-stationary in most cities (*)
  • As the restrictions are relaxed, the relationship is cointegrated in more and more MSAs (**)  

* Unit root is rejected only for 11 MSAs at the 10% level
** Unit root rejected for 27 (Model 1), 31 (Model 2) and 34 (Model 3) MSAs at the 10% level
Price-Income Ratios

Stationary: 11
Non-stationary: 39
Sig. positive slope: 8
Sig. negative slope: 23
Trends in House Price-Income Ratio and the Supply Elasticity of Housing

\[ y = -0.003 \ln(x) + 6E-05 \]

\[ R^2 = 0.4998 \]
Price-Income Ratios
(dashed curves)
vs.
Model 2
(deviations from “equilibrium”)

- .0
- .2
- .4
Concluding Remarks

• The house price-income ratio is generally not a reliable indicator of housing price misalignments

• Model 3, which includes income per capita and population is problematic due to multicollinearity issues

• Hence Model 2, which includes aggregate income, is preferred

• Heterogeneity across cities is substantial; hence, it is important to allow for such heterogeneity when analyzing the relationship between house prices and income

• Price-income trends and estimated income elasticities are closely associated with the supply elasticity

• Downward trending price-income ratios suggest that increases in the wealth-income ratios have not taken place due to house price trends since 1980 and are not inevitable in the future, at least within the U.S