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Cointegration of matched home purchases and rental price indexes — Evidence from Singapore

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ABSTRACT

This paper exploits the homogeneity feature of the Singapore private residential condominium market and constructs matched home purchase price and rental price series using the repeated sales method. These matched series allow us to conduct time series analysis to examine the long-term present value relationship in the housing market. Three key findings are obtained. First, we fail to establish a cointegrating relationship between the home purchase price and rental price based on nationally estimated indexes. Second, area-specific indexes demonstrate strong cross-correlations, invalidating the use of first generation panel unit root tests that ignore these cross-correlations. Third, Pesaran's CIPS test indicates that the unit root hypothesis is rejected for the first difference of both indexes. We also do not reject the hypothesis that area-specific home purchases and rental price indexes are cointegrated with a cointegrating vector $(1, -1)$.

1. Introduction

It is well established that housing markets exhibited exaggerated cyclical patterns, which is especially highlighted by the 2007 U.S. financial and housing crisis. As a first step in understanding housing price dynamics, several measures of fundamentals have been proposed with which to compare house prices. One of the most widely adopted measures is the present value of rents.[2] However, a long-standing issue with using the deviation of price to rent as a proxy for mispricing resides in the appreciable difference in the *quality* of units that are transacted on the housing sales market and the housing rental market respectively. This paper exploits the homogeneity feature of the Singapore private residential condominium market to match the quality of housing. We construct home purchase price and rental price series for nearly identical units on this market based on the repeated sales method. This approach provides an opportunity to explore and better understand various implications of the housing price present value relationship both in the short run and in the long run.

There has been an extensive literature examining the cost of owning a home relative to renting using the present value model. This model is also referred to as the user cost model, which defines the equilibrium relationship between housing rents and prices, after taking into account favorable tax treatments given to owner occupied properties and mortgage interest payments. Beginning with Poterba (1984), many authors have compared the user cost of owner-occupying with the cost of renting to assess potential mispricing and generate implications on the efficiency of the housing market (Meese and Wallace, 1994; Clark, 1995; Chen, 1996; Leamer, 2002; Crone et al., 2004; Krainer and Wei, 2004; Cutts et al., 2005; Himmelberg et al., 2005; Ayuso and Restoy, 2006; Davis et al., 2008; Gallin, 2008; Campbell et al., 2009; Mayer and Sinai, 2009; Ambrose, Eichholtz, and Lindenthal, 2013; Feng and Wu, 2015, etc.). This pricing strategy is similar to the dividend discount model for the stock market, except that the yield to housing is the rent–price ratio. Campbell et al. (2009), in particular, apply the dynamic Gordon growth model which decomposes the rent–price ratio into the expected present discounted values of rent growth, real interest rates, and a housing premium and find similar housing dynamics to those found for stocks and bonds.

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[2] Other measures used to gauge housing prices include comparing house prices to the underlying construction cost or corresponding economic fundamentals, such as income and population (see Poterba, 1991; Rosenthal, 1999; Case and Shiller, 2003; McCarthy and Peach, 2004; Gallin, 2006; Holly et al., 2010, to mention a few).

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The present value model has its strength in providing a convenient framework to consider the impact of the user cost on house prices as well as to explore potential mispricing in the housing market. However, researchers often use different price and rent indexes under the assumption that the rent index is a good proxy for the rent that might be paid for an equivalent owner-occupied property. For example, in the Meese and Wallace (1994) study, the characteristics of the rental sample do not exactly match that of the owner-occupied sample. Gallin (2008), as another example, uses the housing price index published by the Federal Housing Finance Agency, which is based on a sample of housing units unmatched to those included in the rental shelter index from the Consumer Price Index. As Glaeser and Gyourko (2007) point out, such comparison is inaccurate given that dwellings included in the price indexes do not match the dwellings in the rental indexes. In fact, the owner-occupied houses are often better maintained than rental houses (Shiling, Sirmans, and Dombrow, 1991). With comparatively poorly maintained rental units, the time series path of the rental price indexes may vary significantly from the implicit rents of the owner-occupied units.

The lack of homogeneous units transacted on both the property sales market and the rental market has been recognized and addressed in the literature in various ways. For instance, Smith and Smith (2006) and Hill and Syed (2012) make use of owner-occupied houses that have comparable characteristics to those that are also available for rent. Garner and Verbrugge (2009) rely on the U.S. Consumer Expenditure Survey to compare self-reported rents and house values of the same house. A more recent study is Bracke (2015) which isolates properties that were both sold and rented out within six months and measure their rent–price ratios. However, due to data availability, these studies often focus on exploring matched data at the micro-level to shed light on cross-sectional variation in rent–price ratios.[3] They lack the data capacity to construct both rental and price series for an extended and continuous period of time. The ability to construct time series data using matched rental and owner-occupied units is, however, important for a better understanding of the long-term cointegrating relationship between prices and rents and their short-term price dynamics.

This paper extends the literature by constructing matched home purchases and rental price quarterly index series (from 2000Q1 to 2014Q4) using transaction-level data from the Singapore private condominium market. All units within each residential condominium project are homogeneous given that they are all fully furnished units with the same interior design, the same type of furnishing, the same major electrics, and the same outdoor facilities. This means that, after adjusting for observed characteristics, we have essentially identical units that are transacted on both the property sales market and the corresponding rental market at the same time. This feature enables us to construct both the purchase price index sequence and the rental price index sequence for a sample of residential housing projects that have their units both purchased by a homebuyer and rented out to a tenant at a certain point in time. More importantly, the richness of the data allows us to construct both quarterly purchase price and rental time series indexes based on matched units for twelve years of time span and for separate geographic areas. This provides valuable opportunities for rigorous time series analysis, taking into consideration potential cross-sectional heterogeneity and spatial correlations.

The construction of the time series indexes makes use of the repeated sales method as proposed in Bailey, Muth, and Nourse (1963) and later generalized and popularized by Case and Shiller (1989). The idea is to rely on a set of units (or residential projects in this case) that have been transacted (or rented out) more than once during the sample period. The percentage change in house prices (or rental prices) between two sale dates is regressed on a set of dummies associated with the quarter of the turnover. Attributes of the home and their shadow prices are assumed to be unchanged between turnover dates and, therefore, drop out of the model. This method allows us to construct time series variables not only for *national* home purchase–rental price indexes (based on the national sample), but also for *area-specific* home purchase–rental price indexes (based on the area-specific sample). The latter will be particularly useful in addressing cross-section heterogeneity and spatial dependence in the housing market, as will become apparent later.

We first use the constructed home purchase and rental price indexes at the national level to test for the long-term cointegrating relationship of the log real home purchase and rental prices, as suggested by the theory. Unit root tests have been employed to test the stationarity of both series. We find that at the national level, both indexes generally follow the I(1) process. However, the cointegration test fails to reject the null of a unit root in the residuals of the regression of real house purchase prices on real rental prices. This is likely caused by the short time span of the data that we consider in this paper or potential cross-sectional heterogeneity that may bias the results. It might also be caused by the possibility that the weighted national average of purchase and rental price series disguises the underlying cointegrating relationship that might be otherwise present at a more refined geographic level.

To cope with the above-mentioned problem, we construct separate home purchase and rental price index pairs for ten heterogeneous areas in Singapore based on a sample of repeatedly transacted residential projects in each of these areas. This allows us to utilize the panel structure of the data and to take into consideration possible cross-sectional dependence of the time series across these heterogeneous areas. To elaborate on the latter, for example, a set of common shocks to the embedded user cost of owner-occupying may affect each area simultaneously and contribute to cross-sectional correlation of both the purchase and the rental price indexes across these areas. We apply the common correlated effects (CCE) estimator of Pesaran (2006) which allows for unobserved common factors to be possibly correlated with area-specific regressors. This estimator is consistent under heterogeneity and cross-sectional dependence.[4]

Three key findings are obtained for area-specific home purchase and rental prices. First, the cross-sectional dependence (CD) test statistics of (Pesaran, 2004) show that the cross-correlations are statistically significant, and thus invalidate the use of first generation panel unit root tests, such as the Im, Pesaran and Shin (2003) IPS test, which does not allow for cross-sectional dependence (see Breitung and Pesaran, 2008). Second, allowing for second-generation panel unit root tests that take into consideration cross-section dependence, like the Pesaran's CIPS test, we find that the unit root hypothesis is rejected for the first difference of the log real house purchase and rental price indexes, respectively (Pesaran, 2007). This result is robust to the choice of the lag order underlying the cross-sectionally dependent augmented Dickey–Fuller (CADF) regressions. This result is also invariant to whether trends are taken into account. Third, our panel cointegration test suggests that, when a time trend is included, area-specific home purchases and rental prices are cointegrated with a cointegrating vector of $(1, -1)$. This suggests that in the long run, home purchase prices do not significantly deviate from the corresponding rentals and any persistence in present value errors is transitory. This is consistent with the long-run implications of housing market efficiency.

The reminder of the paper is organized as follows: Section 2 introduces the institutional background of the Singapore private condominium market. Section 3 provides a theoretical review of the present value model. Section 4 discusses the data and the construction of home purchases and rental price indexes. Section 5 presents the empirical findings. Section 6 concludes.

[3] Although Hill and Syed (2012) managed to construct 9 years of quality-adjusted price–rent ratios, they are of relatively low frequency, which is not sufficient for rigorous time series analysis for long-run relationships.

[4] The CCE procedure also copes with the presence of spatial effects (Pesaran and Tosetti, 2011). This is because spatial dependence is dominated by the common factor error structure that underlies the CCE estimator.