Housing prices and transaction volume

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Abstract

We use annual, quarterly and monthly data from the US to show that the correlation between housing prices and transaction volume (number of existing houses sold) differs across different frequencies. While the correlation is high at the low frequencies it declines to the levels close to zero at high frequencies. Granger causality tests for different frequencies show the way of causality in housing market goes from transactions to housing prices. Our findings provide a litmus test for the existing theories that are proposed to explain the positive correlation between transaction volume and housing prices.

1 Introduction

In this paper, we use US data to analyze the relationship between housing prices and transaction volume at different frequencies. Our analyses provides several tests to evaluate the theories offered to explain the comovement of housing prices and transaction volume documented in the literature.

The first test in our analysis utilizes the different correlations observed at different frequencies. The theories proposed in the literature generate positive comovement at higher frequencies (in the short run) but do generate negative comovement or non at lower frequencies (in the long run). In this respect, we investigate the relationship between housing prices and transactions by using spectral analysis to reveal how much different frequencies contribute to the correlation. Since both theories and data have implications about the correlation at different frequencies our paper proposes a new

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way of testing the existing theories in the literature which generate the comovement of housing prices and transaction volume.

In addition to the correlation analysis we also explore the direction of the causality between the two series by using Granger causality test at different frequencies. This is important to evaluate the theories because the direction of causality between housing prices and transactions differs depending on the model..

For our analysis we use yearly, quarterly and monthly housing prices and transaction volume data from the US. We use HP and band-pass filters and dynamic correlations to obtain the correlations of the two series at different frequencies. In our analysis we show that the largest part of the positive correlation between housing prices and transaction volume comes from the low frequency components. However, at higher frequencies the correlation becomes smaller and sometimes negative. We, also, find that the way of causality between the two series is from transactions to housing prices. While Granger causality tests partially support the search models, non of the theoretical models proposed passes the dynamic correlation test. Hence, our analysis poses a challenge for the existing theories.

The paper is organized as follows. In Section2 we provide a brief summary of the literature about housing prices and transaction volume and discuss what those theoretical models imply about the correlation of the two variables at different frequencies. In Section 3 we give a brief description of the spectral method. We describe our data set in Section 4. We provide the results and explain our findings in Section 5. Section 6 concludes.

2 Housing Prices and Transaction Volume: Theory and Evidence

There are numerous influential articles in the literature that document and analyze the relationship between housing prices and transaction volume in the housing market. On the empirical front, Stein(1995) finds a positive relation between the percentage change in real sales prices for existing single family homes and transaction volume for the period 1968-1992 in the US. Andrew and Meen (2003) report positive correlation for the same two variables for the UK data. On the other hand, Follain and Velz (1995) finds a negative relationship between the level of house prices and the transaction volume. Hort (2000), however, does not find a robust pattern of these variables using simple regressions of housing prices on the level of transactions volume for Swedish housing market but finds a robust negative results after introducing regional and time dummies.

The empirical findings we mentioned above (either positive or negative correlation) contradicts with the Lucas' (1978) result that there will be no correlation between prices and transactions in an environment with rational agents and perfect capital markets. The theoretical models that are developed to explain this puzzling feature of the data can be classified into three main groups. [1]The first group is pioneered by Stein (1995) and advanced by Ortalo-Magne and Rady (2006) and uses the down-payment requirement in the housing market as an explanation of the positive correlation between the two series. Main driving force of this theory is that for repeat buyers, a big portion of their down-payment is coming from the proceeds of the sale of their existing homes. The theory suggests that as housing prices increase it becomes easier to finance the down-payment requirement with an increase in the liquidity of current homeowners. Hence, transaction volume increases. The second group uses search and matching frictions to model the housing market. Berkovec and Goodman (1996) and Wheaton (1990) show that with search and matching frictions their model can generate a positive comovement in housing prices and transaction volume. Recently, Ngai and Tenreyro (2010) use a similar model to explain the seasonality in housing prices and transaction volume that they document in the US and the UK data. The third group uses behavioral approach to explain the comovement. Genesove and Mayer (2001) argue that in the data, households who experience housing price losses tend to ask higher prices compared to the others. This behavior, which is consistent with loss averse preferences, causes prices to sluggishly adjust to the equilibrium price. It is this sluggishness in the housing prices that causes the decline in transaction volume in this theory.

The theories proposed in the literature generate positive comovement at the higher frequencies but does not generate positive comovement at lower frequencies. To illustrate our point, suppose that housing prices fall permanently in all the models discussed above. A permanent fall in housing prices corresponds to a low frequency movement in housing prices. The mechanism in Stein (1995) and Ortalo-Magne and Rady (2006) generates positive correlation in the short run but no correlation in the long run since after the initial decline in housing prices consumers will accumulate enough wealth for the down-payment and then they will be able to move later. In the long run, transaction volume will return to the initial value while housing prices stay low. Consequently, housing prices and transaction volume will have zero correlation at low frequencies since there will be a symmetric effect when housing prices increase. In case of the mechanism in Genesove and Mayer (2001), over time as sellers with higher prices (remember that loss averse agents post higher prices then the market prices) sell their houses their negative effect on transactions will disappear. As a result,

[1]Although the empirical evindence is mixed, the theoretical models developed so far are developed to explain the positive correlation.

transaction volume will decrease in the short run but then will increase back to its earlier value implying zero correlation in the long run. For the search models proposed, a decline in the housing prices at lower frequencies will result in a smaller number of houses built which decreases the vacancy rate (1 minus number of households divided by number of housing units). As vacancy rate decreases sales time will decrease hence transaction volume will increase (see for example Figures 1 and 2 in Wheaton (1990)). Hence, for the search models, there is a negative correlation between housing prices and transaction volume at lower frequencies. Given the high and low frequency predictions of the models we explore whether these predictions are consistent with the data.

3 Spectral Analysis

In this section we provide a brief description of the spectral methods that we use in our analysis. Most of the time series have complex structures and can be decomposed into many frequency components by using filtering techniques. This decomposition enables us to explore the relation between two series at different frequencies. In the economics literature, for example, King and Watson (1994) show that the negative correlation between unemployment and inflation appears to be strong in business-cycle frequencies even though it is hard to see the same pattern in the original inflation and unemployment time series. Ramsey and Lampart (1998) explain the anomalies in the permanent income hypothesis by decomposing a series into a number of frequency levels.

To analyze the relationship between housing prices and transactions at different frequencies we use the concept of dynamic correlation which is proposed by Croux et al.(2001) and band-pass filter introduced by Christiano and Fitzgerald (2003). The necessary measure to obtain dynamic correlation is the cross spectrum. Basically, cross spectrum is defined as the frequency domain representation of the covariance of two series. One necessary condition is that the series should be stationary. To stationarize our data we use HP filter. We can denote cross spectrum of price (p) and transaction (tr) as

$$\Gamma_{p,tr}(\omega) = \sum_{t=-\infty}^{\infty} \gamma_{p,tr}(t) e^{-i\omega t}$$

where $\gamma_{p,tr}$ is the cross covariance function and ω is the angular frequency. The dynamic correlation for price and transaction at frequency ω defined as:

$$\rho_{p,tr}(\omega) = \frac{C_{p,tr}(\omega)}{\sqrt{S_p(\omega) S_{tr}(\omega)}}$$

where $S_p(\omega)$ and $S_{tr}(\omega)$ are the spectra of prices and transactions at frequency ω, respectively, and $C_{p,tr}(\omega)$ is the cospectrum. $C_{p,tr}(\omega)$ is the real part of cross spectrum i.e. $C_{p,tr}(\omega) = \mathrm{Re}\{\Gamma_{p,tr}(\omega)\}$. Specifically, as Corsetti et al. (2011) point it out, the cospectrum measures the portion of the covariance between two series that is attributable to cycles of a given frequency ω.

In addition to the dynamic correlation we use another spectral method to highlight the relationship between housing prices and transactions for robustness. We use the band-pass filter developed by Chiristiano and Fitzgerald (2003) to decompose the series into low, business cycle and high frequency components and measure the correlations for each component between housing prices and transactions.

4 Data

The annual data that we use consists of existing single-family home sales, transactions, and prices for the US and four regions: Northeast, Midwest, South, and West. Data covers the period between 1968-2009 except for 1989. The annual prices are deflated for the US and each region by non-seasonally adjusted CPI. (Source: NATIONAL ASSOCIATION OF REALTORS).[2]

Quarterly transaction data includes sales of single-family homes, town homes, condominiums, and co-ops for the US and four main regions. Nominal price data is median price index between 1999Q1 to 2011Q1. We deflate the nominal prices by using 3-month average non-seasonally adjusted CPI for the US and four regions. (Source: Bloomberg: ETSLTOTL Index and METRUS index).

We obtain our monthly data from the website of Real Estate Center at Texas A&M University. We use total number of home sales and average prices for Texas and its four cities: Dallas, Houston, Austin and San Antonio. Data covers the period between January 1990 and May 2011. Average nominal prices are deflated by using monthly CPI of South Urban region. (Source: Real Estate Center at Texas A&M University). We seasonally adjust the monthly and quarterly data.

5 Correlations

Annual data

[2] For robustness, we also performed our analysis with transactions divided by the population. Since the results are very similar we provide the one that uses transactions only.

Table 1: Band-pass filtered yearly data , correlations

Region	Business Cycle	Low Frequency
U.S.	0.40	0.95
Northeast	0.18	0.87
Midwest	0.58	0.91
South	0.53	0.94
West	−0.12	0.90

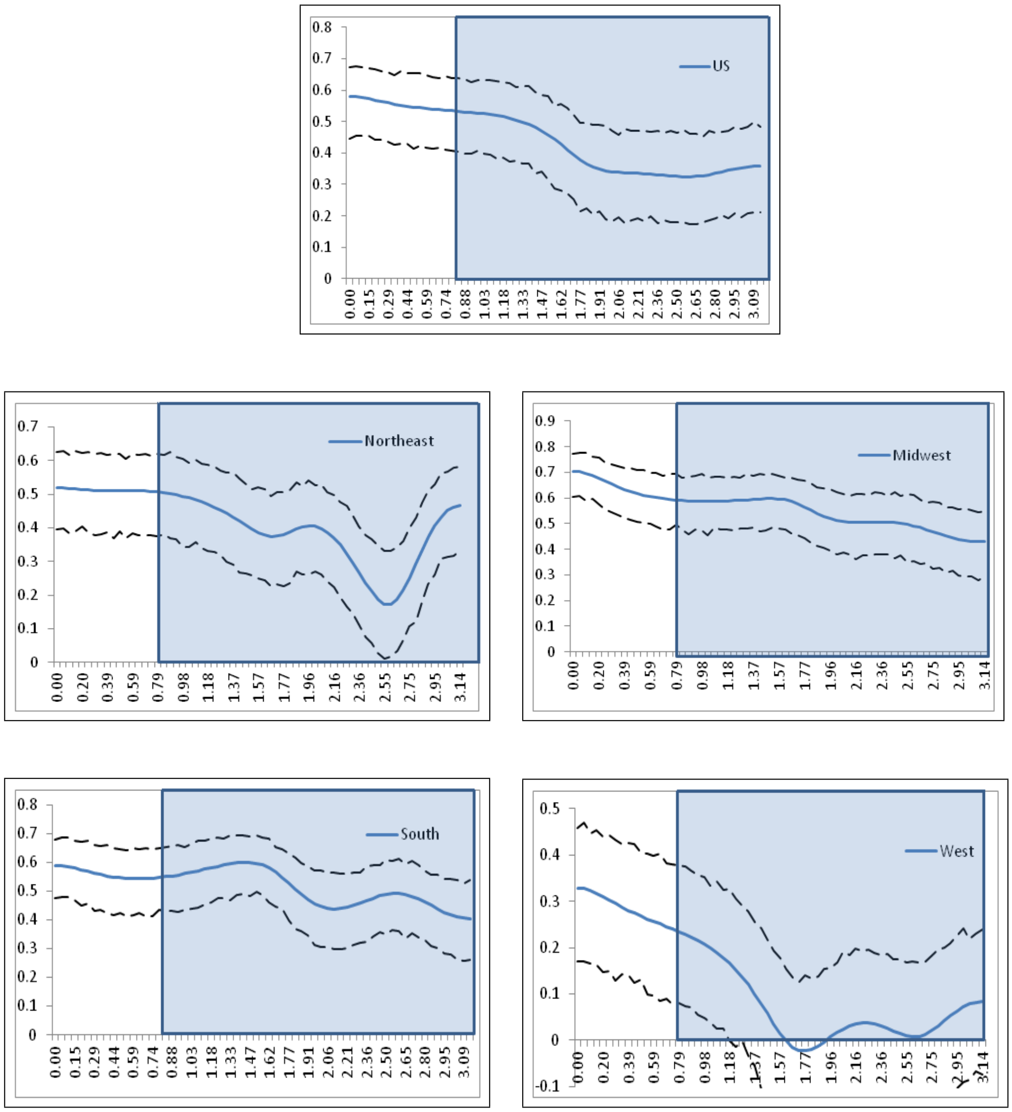
Note: Business cycle frequency corresponds to 2-7 years. Low frequency corresponds to 8 or more years

We start our analysis with annual data. We measure the dynamic correlations of the HP-filtered series for the US and four regions.[3] Panel A shows our results. It shows that there are high correlations of transaction volume and housing prices for every region at the lower frequencies (unshaded areas). However, it declines significantly as frequency increases and even goes to zero for the West. The declining correlations between housing prices and transaction volume as frequencies increase, cast doubt on the theories which try to explain the positive correlation between the two series.

For robustness, we use the band-pass filter to decompose the two series into low and high frequency components and calculate the correlations between housing prices and transactions for each components. With yearly data, the high frequency component corresponds to the business cycle frequency (which is 2-7 years) and the low frequency component corresponds to the cycles of 8 or more years. We find that correlations at the low frequency is much higher than the business cycle frequency which is consistent with the results of the dynamic correlation analysis (see Table 1).

[3] We, also, provide the dynamic correlations of first-differenced data in the appendix which shows similar pattern, however, all correlations are more volatile.

Panel A: HP-filtered annual data, dynamic correlations



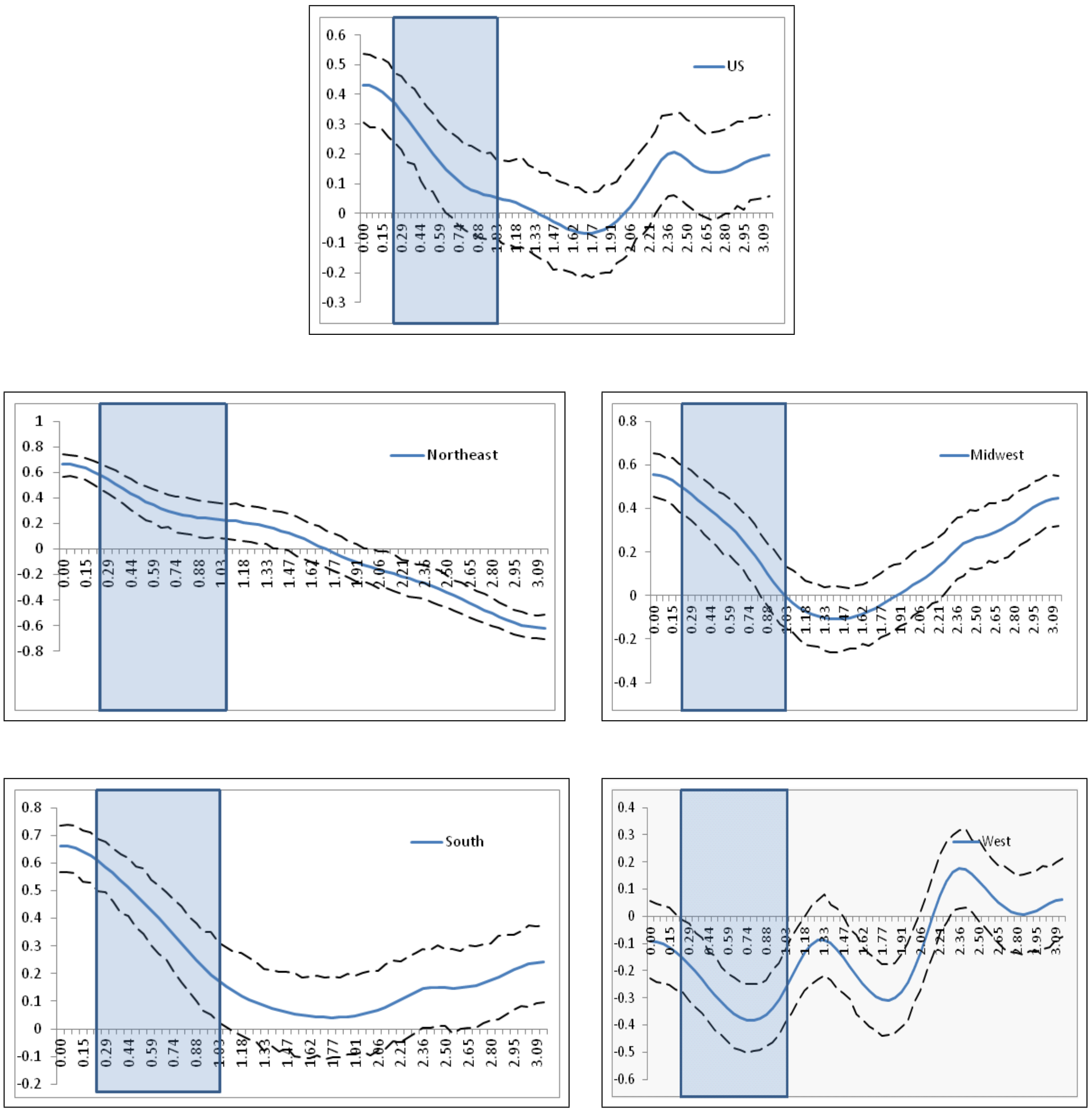
Notes: Correlations are at the y and frequencies are at the x axis. Dashed lines correspond to one standard deviation by Fisher transformation. Frequency between 0.79-3.14 (highlighted) captures business cycles.

Quarterly Data

With quarterly data, we do the same exercises that we did with the yearly data. Similar to the yearly data, the correlations are significantly positive and reach to highest levels at low frequencies, except for the West. Correlations are close to zero, are even negative for some regions, for the frequencies that correspond to cycles less than 32 quarters. Correlations turn to be positive at very high frequencies except for the Northeast but still lower than the low frequency levels.

When we decompose the series by the band-pass filter, correlations are the smallest at the highest frequency except for the West and the highest at the lowest frequency except for the Northeast (See Table 2). Without decomposition, the correlation between two series is on average 0.5 for the quarterly data.

Panel B: HP-filtered quarterly data, dynamic correlations



Notes: Correlations are at the y and frequencies are at the x axis. Dashed lines correspond to one standard deviation by Fisher transformation. Frequency between 0.20 and 1.03 (highlighted) captures the business cycle

Monthly Data

The monthly data that we have is from Real Estate Center at Texas A&M University. The correlation between transaction volume and housing prices is around 0.4 at the lowest frequency.

Table 2: Band-pass filtered quarterly data, correlations

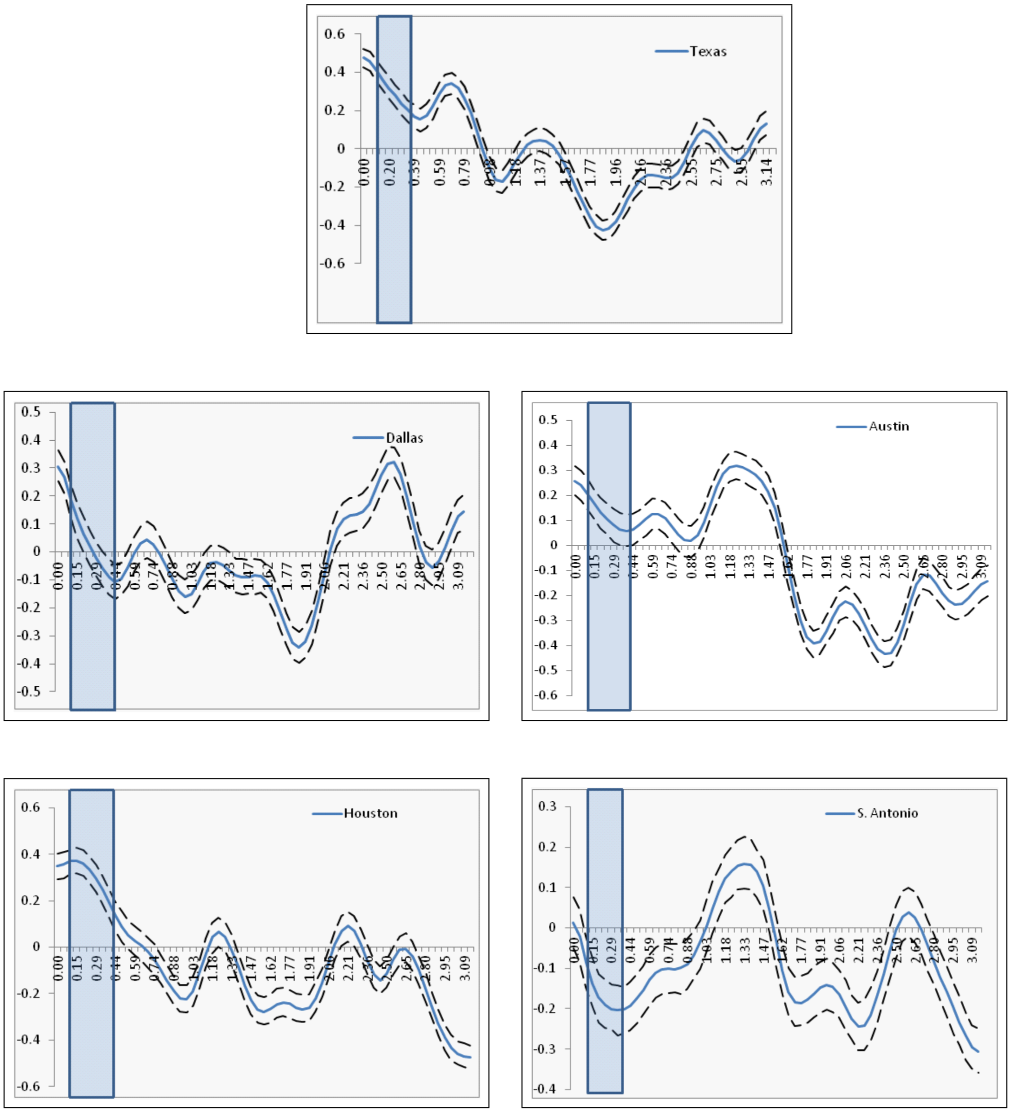
Region	High Frequency	Business Cycle	Low Frequency
U.S.	0.05	0.20	0.66
Northeast	−0.18	0.45	0.30
Midwest	0.08	0.33	0.54
South	0.14	0.37	0.82
West	−0.12	−0.28	0.57

High frequency corresponds to 2-5 quarters. Business cycle frequency corresponds to 6-32 quarters. Low frequency corresponds to more than 32 quarters.

It declines to lower levels (but still positive except Saint Antonio) at the business cycle frequency, 18 to 96 months. At higher frequencies we do not find any systematic correlation between housing prices and transaction volume.

As we did for quarterly and yearly data, we use the band-pass filter to decompose the series into different frequency components. With monthly data we are able to decompose the series into three frequencies; high frequency (2-17 months), business cycle frequency (18-96 months) and low frequency (96 months and more). In Table 3 we report our results. Our result confirm our findings with the quarterly and yearly data. The correlations are higher at the lower frequencies and lower at the higher frequencies.

Panel C: HP-filtered monthly data, dynamic correlations



Notes: Correlations are at the y and frequencies are at the x axis. Dashed lines correspond to one standard deviation by Fisher transformation. Frequency between 0.1 and 0.35 (highlighted) captures the business cycle.

6 Causality

In the previous section, the relationship between housing prices and transactions is analyzed by using dynamic correlations. However, this analysis does not imply any causality between the two variables. The developed theories that try to explain the relationship between the two variables also generate a direction of causality between two variables. For instance, Stein's (1995) down-payment

Table 3: Band-pass filtered monthly data, correlations

Region	High Frequency	Business Cycle	Low Frequency
Texas	0.50	0.72	0.82
Dallas	0.56	0.59	0.70
Austin	0.39	0.69	0.47
Houston	0.33	0.59	0.84
S. Antonio	0.12	0.19	0.82

High frequency corresponds to 2-17 months. Business cycle frequency corresponds to 18-96 months. Low frequency corresponds to more than 96 months.

theory explains the decline in transaction with a decline in housing prices. The decrease in housing prices causes a fraction of sellers not to move due to their reduced capability of paying the down-payment of new homes. Genesove and Mayer (2001) use loss aversion behavior that homeowners are less willing to sell their homes in falling market to avoid losses. The direction of causality is again, from prices to transactions. On the other hand, Berkovec and Goodman (1996) and Wheaton (1990) have search and matching models in which transactions cause the housing prices.

In this section, we investigate relationship between housing prices and transactions by using the Granger causality test. First, we decompose the series into high, business cycle and low frequencies and then apply the Granger causality test to investigate the relationship between two variables at different frequencies. Table 4 and Table 5 show the Granger causality test results for the quarterly and monthly data, respectively. For all frequencies, transactions Granger cause housing prices. On the other hand, housing prices also Granger cause transactions at the business cycle frequency. For this reason we conclude that transactions Granger causes housing prices only for high and low frequencies not for the business cycle frequency.

7 Conclusion

In this paper, we use HP and band-pass filters, dynamic correlation to study the relationship between the housing prices and transaction volume in at different frequencies in the US data. We show that low frequency component is the major driver of the positive correlation. We also find that the way of causality between the two series is from transactions to housing prices. These findings pose a challenge for the current theories which explain the positive correlation between two series.

Table 4: Quarterly Data Granger Causality Test Results

Region	The Way of Causality	High Frequency	Business Cycle	Low Frequency
US	*transactions* $\Rightarrow$ *prices*	17.95* (0.000)	1.70 (0.171)	8.43* (0.000)
	prices $\Rightarrow$ *transactions*	0.42 (0.792)	2.67* (0.048)	0.70 (0.596)
Northeast	*transaction* $\Rightarrow$ *prices*	8.27* (0.000)	4.31* (0.006)	3.21* (0.024)
	prices $\Rightarrow$ *transactions*	1.80 (0.151)	29.85* (0.000)	1.76 (0.158)
Midwest	*transaction* $\Rightarrow$ *prices*	5.68* (0.001)	30.18* (0.000)	1.95 (0.123)
	prices $\Rightarrow$ *transactions*	0.14 (0.967)	57.63* (0.000)	1.26 (0.305)
South	*transaction* $\Rightarrow$ *prices*	11.46* (0.000)	1.26 (0.000)	6.39* (0.000)
	prices $\Rightarrow$ *transactions*	0.14 (0.967)	28.40* (0.000)	1.81 (0.097)
West	*transaction* $\Rightarrow$ *prices*	11.93* (0.000)	46.03* (0.000)	6.15* (0.001)
	prices $\Rightarrow$ *transactions*	0.74 (0.574)	10.52* (0.000)	1.58 (0.200)

F statistics are listed. The significance levels are in parentheses. * indicates significance at 5% level. High frequency captures 2-5 quarters, business cycle frequency captures 6-32 quarters and low frequency captures more than 32 quarters.

Table 5: Monthly Data Granger Causality Test Results

Region	The Way of Causality	High Frequency	Business Cycle	Low Frequency
Texas	*transactions* $\Rightarrow$ *prices*	2.17* (0.047)	28.22* (0.000)	3.07* (0.007)
	prices $\Rightarrow$ *transactions*	3.21* (0.005)	37.05* (0.000)	3.59* (0.002)
Dallas	*transaction* $\Rightarrow$ *prices*	2.90* (0.009)	36.41* (0.000)	3.71* (0.002)
	prices $\Rightarrow$ *transactions*	1.94 (0.075)	25.54* (0.000)	1.61 (0.146)
Houston	*transaction* $\Rightarrow$ *prices*	2.60* (0.019)	15.12* (0.000)	1.11 (0.355)
	prices $\Rightarrow$ *transactions*	1.88 (0.085)	12.87* (0.000)	2.25* (0.040)
Austin	*transaction* $\Rightarrow$ *prices*	1.83 (0.093)	11.47* (0.000)	4.30* (0.000)
	prices $\Rightarrow$ *transactions*	1.34 (0.240)	14.82* (0.000)	1.81 (0.097)
San Antonio	*transaction* $\Rightarrow$ *prices*	3.12* (0.006)	18.06* (0.000)	3.96* (0.001)
	prices $\Rightarrow$ *transactions*	0.19 (0.979)	17.53* (0.000)	0.50 (0.806)

F statistics are listed. The significance levels are in parentheses. * indicates significance at 5% level. High frequency captures 2-17 months, business cycle frequency captures 18-96 month and low frequency captures more than 96 months.

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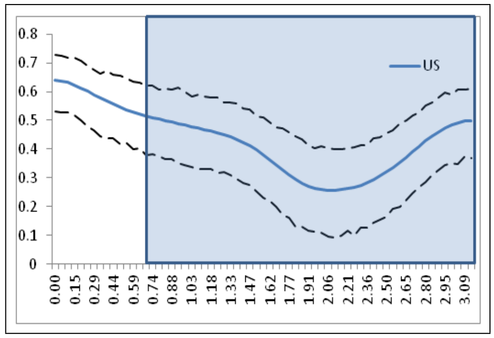
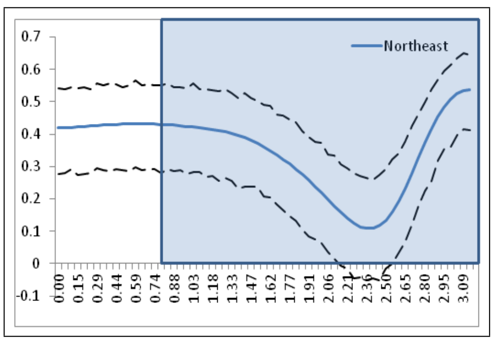
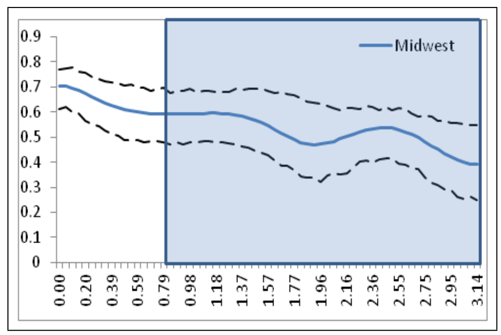
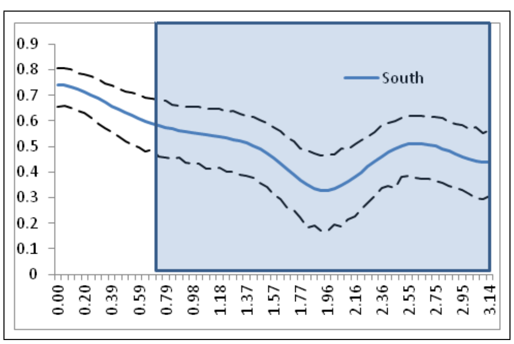
A Appendix

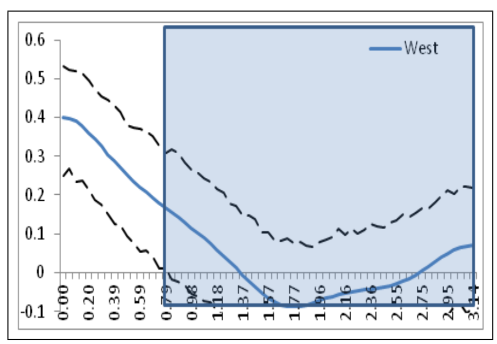
Panel D: First-differenced annual data, dynamic correlations





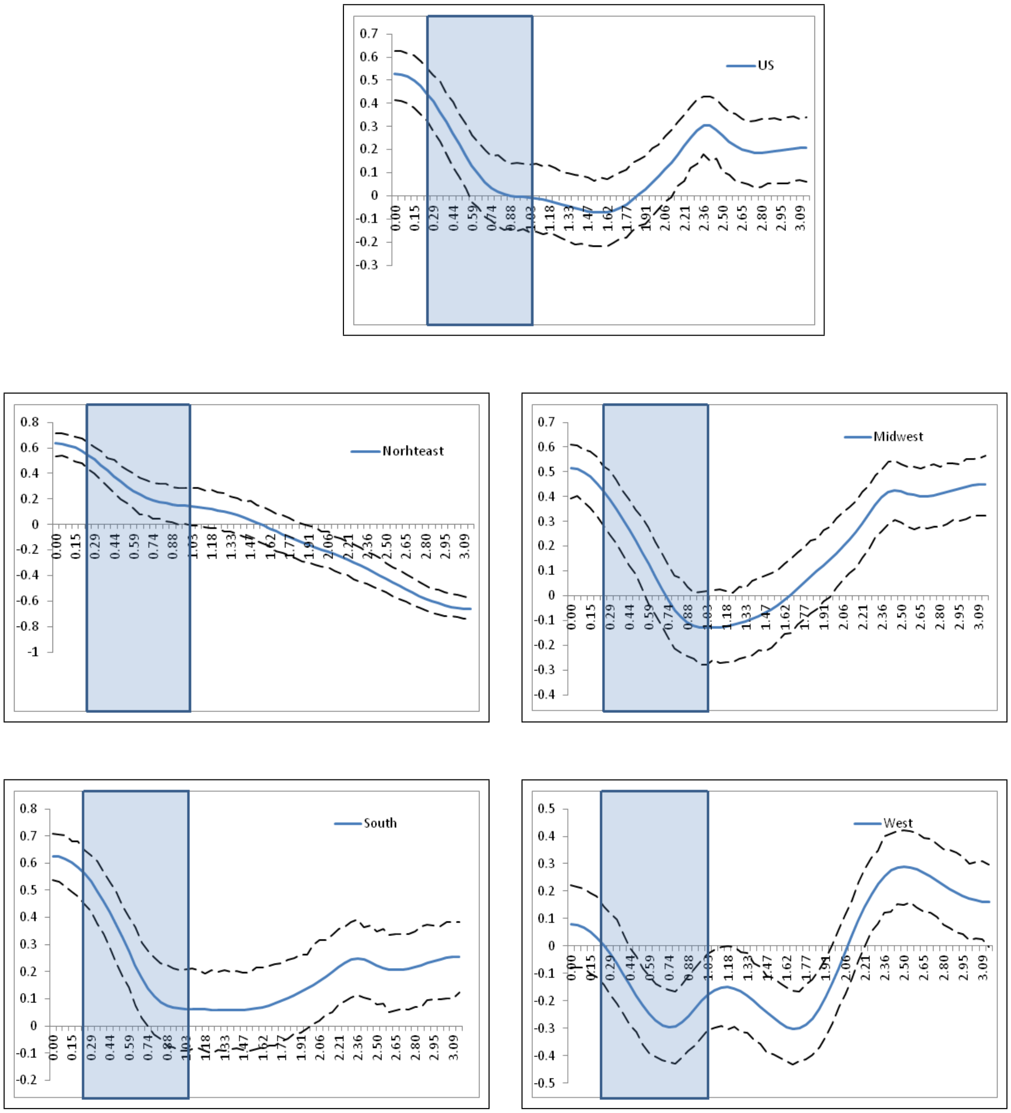






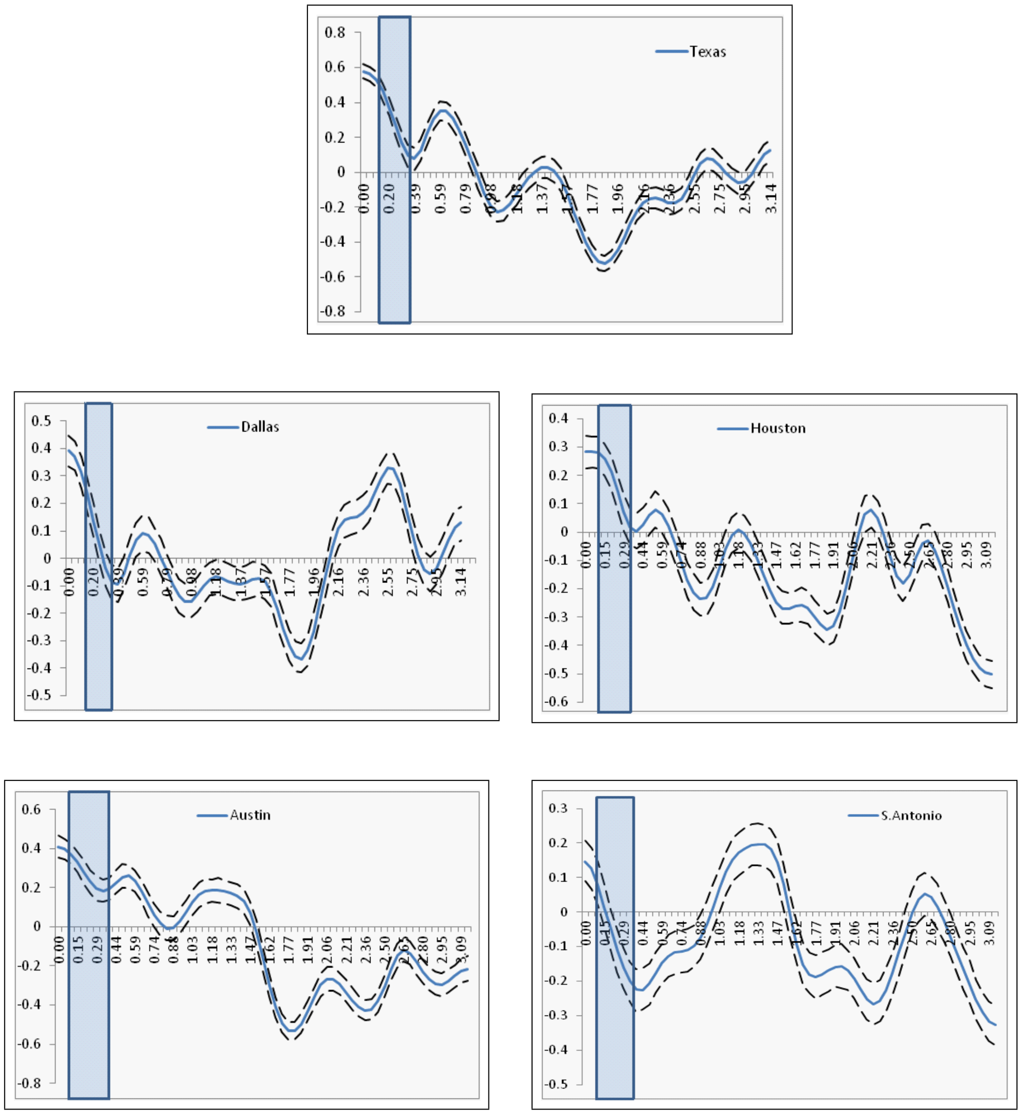
Notes: Correlations are at the y and frequencies are at the x axis. Dashed lines correspond to one standard deviation by Fisher transformation. Frequency between 0.79-3.14 (highlighted) captures business cycles

Panel E: First-differenced quarterly data, dynamic correlations



Notes: Correlations are at the y and frequencies are at the x axis. Dashed lines correspond to one standard deviation by Fisher transformation. Frequency between 0.20 and 1.03 (highlighted) captures the business cycle.

Panel F: First-differenced monthly data, dynamic correlations



Notes: Correlations are at the y and frequencies are at the x axis. Dashed lines correspond to one standard deviation by Fisher transformation. Frequency between 0.1 and 0.35 (highlighted) captures the business cycle.