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Analysis Of Housing Price Fluctuations Across The Five Regions Of US

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ANALYSIS OF HOUSING PRICE FLUCTUATIONS ACROSS THE FIVE REGIONS OF US

By

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Bachelor of Business Administration, University of Dhaka, 2012

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This thesis submitted by Sukanta Sarbabidya in partial fulfillment of the requirements for the Degree of Master of Business Administration from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

Prodosh Simlai, PhD (Chairperson)

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

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May 1, 2018
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Sukanta Sarbabidya
May 1, 2018

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ABSTRACT

This paper studies the factors that cause difference in fluctuations of home price indices across the five regions of U.S. The factors that affect the home price index are not the same for all the five regions of the U.S.A. - West, Southwest, Midwest, Northeast, and Southeast. Additionally, not all the factors contributing to the home price index in a particular region remain significant contributors always. Finally, the extent of impact the contributing factors cast on the home price index fluctuations also change overtime. So, in this paper, I have determined which factors play role in determining the home price index fluctuations in each state. Then I have developed a comparative analysis on which factors play more significant role in determining the home price index fluctuations in each state. Finally, I forecasted the home price index fluctuations in each state for four quarters. After I finished all the analyses and made all the relevant forecasts, I came up with the conclusion that among all the independent variables, percentage change in income is the most important factor in determining the home price index fluctuations. GDP Growth Rate and Inflation play role too, but in a limited manner. However, interest rate and unemployment rate are the least influential factors in determining the home price index fluctuations.

CHAPTER I

INTRODUCTION

Real estate plays a key role in most of the economies, and is considered as one of the major contributors to the GDP of any country. A recent study says that real estate construction contributed $1.07 trillion to the US economic output, which was 6% of the US GDP in 2017 (AMADEO, 2018). However, construction is only one part of the real estate, and there are many other areas of the economy which are influenced by the housing prices. For example, a research suggests that there exists linear relationship between the US real estate and S&P 500 stock performance (Okunev, Wilson, & Zurbruegg, 2000).

Housing prices in the USA vary drastically over time. However, this variation doesn't follow the same trend across different regions of the USA. Additionally, factors contributing to the fluctuations are not the same for all the regions either. Moreover, the extent of influence of the contributing factors tend to change over time. So, considering the importance of housing markets in the US economy, it is truly important to figure out what factors contribute to the housing price variability in the USA in general and in different regions of the USA in particular. Though a number of studies have been conducted to identify the determinants of the housing prices in the USA, the number of studies trying to identify the housing price determinants of the individual regions in the USA is very limited. That's why I chose to do my research on identifying the housing price determinants of the five regions in the USA – West, Southwest, Midwest, Northeast, and Southeast. I also decided to demonstrate a comparative analysis of the determinants of the housing price fluctuations across five regions of the US. In this regard, the research question that I answered in this paper is as follows:

Research Question

What are the factors that contribute to the housing price fluctuations in five regions of the US and how their impact varies across the five regions of the US?

After collecting the proper data, I applied different techniques to test the usability of the dataset, and corrected the dataset with appropriate methods. Thereafter, I used the appropriate regression models to answer to my research question, and demonstrated my research findings with proper graphs, charts and theoretical analyses.

CHAPTER II

LITERATURE REVIEW

Real estate market plays a major role on the economy of any country, as residential housing is considered to be the most valuable asset of a household and a fundamental part of the household's portfolio (Panagiotidis & Printzis, 2015). Therefore, identifying the determinants of housing prices has always been a major area of research in most of the economies of the world. A number of research have been conducted on housing price variability in the US. However, only a few of the existing research have focused on building a comparative analysis on the determinants of housing price variability across various regions of the US. My research is focused building a comparative analysis on the determinants of housing price variability across various regions of the US. I examined the factors that contribute most to the housing price variability in general, and I followed the existing research on the determinants of housing price. For example, Algieri (Algieri, 2013), suggests that real income, long-run interest rates, stock prices and inflation plays a key role in explaining real house prices. Zimmer (Zimmer, 2014) analyzes that there exists time-varying correlation in housing prices. In other words, the housing price from the previous period plays a key role in forecasting the housing price of the next period. In a related paper, Luan (Luan, 2017) suggests that spatial differentials in the jumbo/conforming spread predict differences in future housing price appreciation rates during the boom and bust period. Zhang, Hua and Zhao identify some key monetary and price variables, such as mortgage rate, producer price, broad money supply and real effective exchange rate, in interpreting housing price dynamics (Zhang, Hua, & Zhao, 2012)

Following the guidelines from the existing research, I analyzed the suggested variables in details and shortlisted the five independent variables for my research purpose. Those core variables are GDP Growth Rate, Inflation, Interest, Income and Unemployment Rate. Out of these five independent variables, data for the first three independent variables, i.e. GDP Growth Rate, Inflation and Interest, data has been collected at the national level. For the other two independent variables, i.e. for the Income and Unemployment Rate, data has been collected at state level. Finally, using those independent variables, I examined various regressions analyses for the home price index of the five different regions.

CHAPTER III

DATA AND METHODOLOGY

The dependent variables in this study are based on the home price index data of five cities representing the five regions of the US - California from the West, Texas from the Southwest, Minnesota from the Midwest, New York from the Northeast and Florida from the Southeast. My set of independent variables include GDP Growth Rate, Inflation, Interest, Income and Unemployment Rate. Out of these five independent variables, GDP Growth Rate (Analysis, 2018), Inflation (Cleveland, 2018) and Interest (Louis, 2018) are at the national level, and the data was collected from the FRED website. The Percentage Change in Income was found available at state level and the data was collected from the Bureau of Economic Analysis Website (Analysis B. p., n.d.). Finally, the Unemployment Rate data, such as Unemployment Rate in New York (Statistics, Unemployment Rate in New York (NYUR), 2018), Unemployment Rate in Florida (Statistics, Unemployment Rate in Florida (FLUR), 2018), Unemployment Rate in Minnesota (Statistics, Unemployment Rate in Minnesota (MNUR), 2018), Unemployment Rate in California (Statistics, Unemployment Rate in California (CAUR), 2018) and Unemployment Rate in Texas (Statistics, Unemployment Rate in Texas (TXUR), 2018), were also collected at state level from the FRED website.

A summary statistics of the independent variables has been shown on the next page:

Table 1: Summary Statistics of the Independent Variables

Variable	Obs.	Mean	Stdv.	Min	Max	Skewness	Kurtosis
GDP Gr. Rate	283	.7810251	.9479606	-2.59243	3.98603	-0.8986	-0.0206
Inflation	140	2.913034	.9684349	.09581	5.14942	0.027	3.1094
Interest	254	1.06689	1.539767	-4.13	3.71	-0.9645	4.24
Income_NY	252	1.474603	1.185566	-2.8	5.1	-0.7804	5.1780
Income_FL	252	2.22381	1.633388	-3.2	12	1.4125	10.4332
Income_MN	252	1.640873	1.475928	-4.6	9.2	0.1834	7.7696
Income_CA	252	1.836905	1.138719	-2	7.4	0.4067	6.4355
Income_TX	252	1.906746	1.397862	-4.5	7.5	-0.2151	6.3514
UNRATE_NY	168	6.579167	1.54884	4	10.3	0.3146	2.1616
UNRATE_FL	168	6.230952	1.900424	3.2	11.2	0.7211	2.9726
UNRATE_MN	168	4.883333	1.337872	2.5	8.9	0.7868	3.3913
UNRATE_CA	168	7.32619	1.967802	4.5	12.3	0.7852	2.8230
UNRATE_TX	168	6.039286	1.28948	3.9	9.2	0.3785	2.2191

Change in New York Home Price Index

Data for the Change in New York Home Price Index has been collected at the state level. The data was collected from the FRED website (LLC, 2018). Descriptive statistics of the Percentage Change in New York Home Price Index has been shown below:

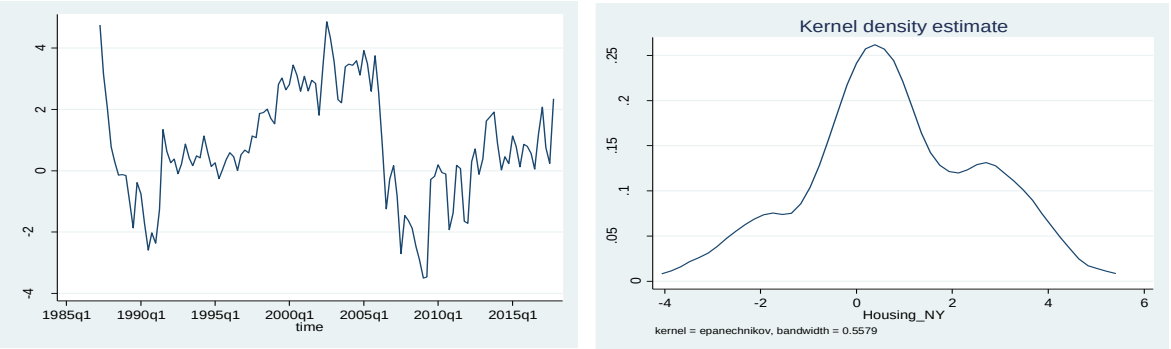
Table 2: Summary Statistics of the Percentage Change in New York Home Price Index

Variable	Obs.	Mean	Stdv.	Min	Max	Skewness	Kurtosis
Housing_NY	123	.7851439	1.801798	-3.5030	4.85382	-0.0297	2.6671

Here, the table above shows that the quarterly values of the New York Home Price Index change approximately 0.79% on an average over the previous quarter. The fluctuations in the change of New York Home Price Index and the density of the data values are shown below.

The skewness and kurtosis calculated above and the graphs below show that the dataset is slightly negatively skewed, and can be regarded as Platykurtic since it has kurtosis of less than 3 (2.667).

Figure 1: Fluctuation and Density of the Change in New York Home Price Index

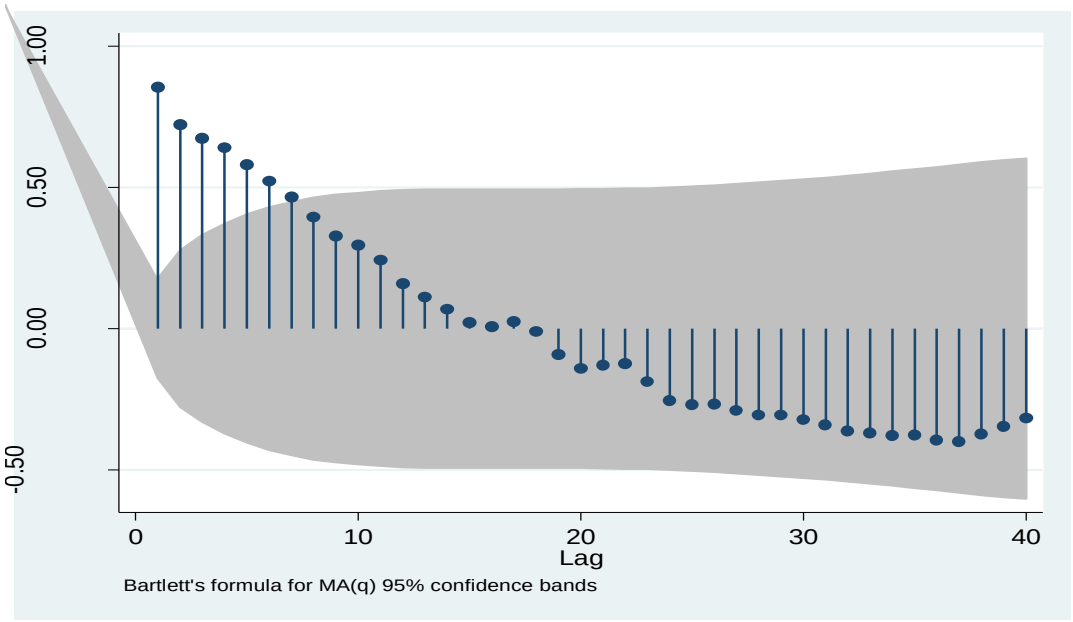


Autocorrelation Analysis of the Change in New York Home Price Index

Table 3: Autocorrelation Statistics of the Change in New York Home Price Index

LAG	AC	PAC	Q	Prob>Q [Autocorrelation] [Partial	Autocor]
1	0.8553	0.8605	92.195	0.0000 ------ ------	
2	0.7225	-0.1119	158.52	0.0000 -----	
3	0.6748	0.2878	216.87	0.0000 ----- --	
4	0.6407	-0.0379	269.9	0.0000 -----	
5	0.5802	-0.0780	313.76	0.0000 ----	
6	0.5218	-0.0362	349.53	0.0000 ----	
7	0.4662	-0.0668	378.35	0.0000 ---	
8	0.3951	-0.1353	399.21	0.0000 --- -	
9	0.3286	-0.0548	413.78	0.0000 --	
10	0.2958	0.0148	425.69	0.0000 --	
11	0.2428	-0.0723	433.77	0.0000 -	
12	0.1603	-0.1547	437.33	0.0000 - -	
13	0.1109	0.0550	439.05	0.0000	
14	0.0680	-0.1646	439.7	0.0000 -	
15	0.0219	0.0137	439.77	0.0000	
16	0.0067	0.0910	439.78	0.0000	
17	0.0244	0.1996	439.87	0.0000 -	
18	-0.0105	-0.1292	439.88	0.0000 -	
19	-0.0915	-0.1579	441.12	0.0000 -	
20	-0.1425	0.0088	444.15	0.0000 -	

Figure 2: Autocorrelation Trend in the Change in New York Home Price Index



Based on the figure and table shown above, it can be concluded that the autocorrelation in the change in the quarterly values of the New York Home Price Index is pretty insignificant, other than the autocorrelation values at the very beginning.

Seasonality Analysis of the Change in New York Home Price Index

Figure 3: Seasonality Trend in the Change in New York Home Price Index

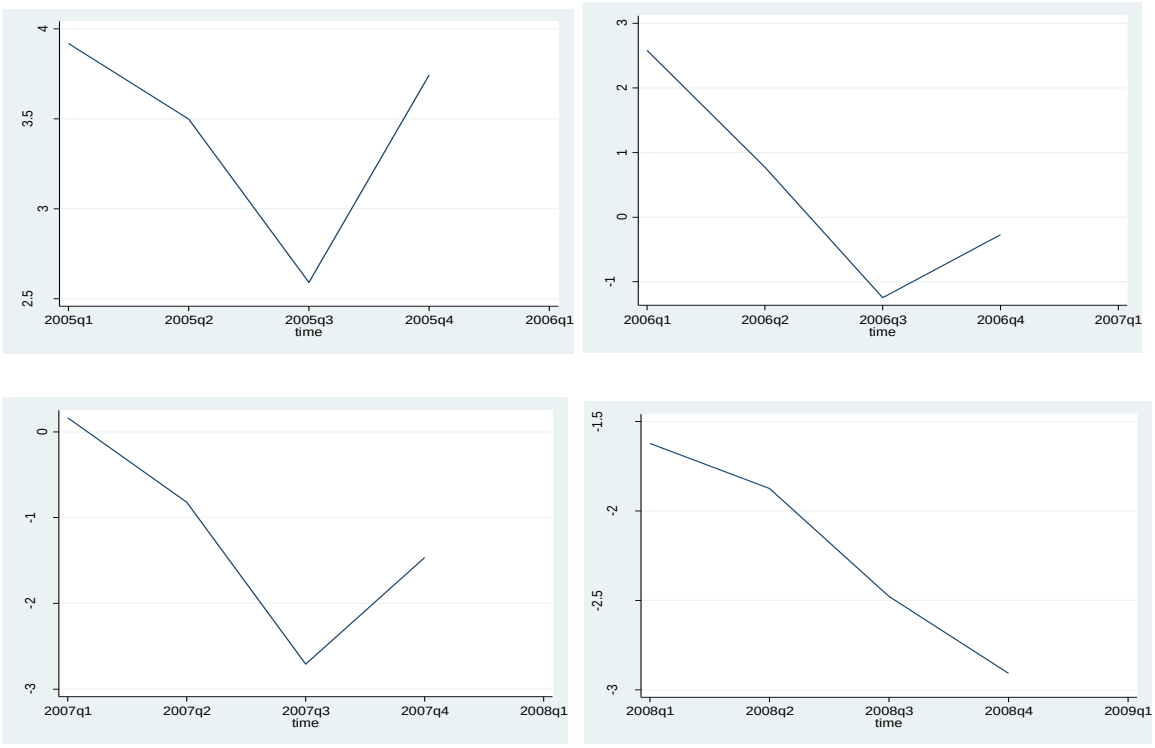


Table 4: Seasonality Statistics of the Change in New York Home Price Index

Source	SS	df	MS	Number of obs =	123
Model	.238499632	3	.079499877	Prob > F =	0.9950
Residual	395.831397	119	3.32631426	R-squared =	0.0006
				Adj R-squared =	-0.0246
Total	396.069896	122	3.24647456	Root MSE =	1.8238
Housing_NY	Coef.	Std. Err.	t / P>t	[95% Conf.	Interval]
q					
1	-.0643185	.4670949	-0.14 / 0.891	-.989213	.860576
2	.0189932	.4632504	0.04 / 0.967	-.8982888	.9362753
3	-.0873329	.4632504	-0.19 / 0.851	-1.004615	.8299491
_cons	.8180552	.3275675	2.50 / 0.014	.1694388	1.466672

The figures and table above shows that there is a slight level of seasonality in the Change in New York Home Price Index as the values tend to drop at quarter 3. But, since none of the regression coefficients are significant, we can conclude that there exists no seasonality in the Change in New York Home Price Index.

Correlation Analysis of the Change in New York Home Price Index

Table 5: Correlation Statistics of the Change in New York Home Price Index

	Housin~Y	GDP_Gr~h	Inflat~n	Interest	Income~Y	UNRATE~Y
Housing_NY	1.0000					
GDP_Growth	0.4104	1.0000				
Inflation	-0.1410	-0.0233	1.0000			
Interest	0.0688	-0.0204	-0.4668	1.0000		
Income_NY	0.0814	0.3074	0.1102	-0.1963	1.0000	
UNRATE_NY	-0.2552	-0.0328	-0.5310	0.7340	-0.1851	1.0000

The correlation matrix above shows that none of the correlations above are high enough to pose multicolinearity threat. However, the correlation between Interest Rate and Unemployment Rate is comparatively higher than the other correlation values.

Change in Florida Home Price Index

Data for the Change in Florida Home Price Index has been collected at the state level. The data was collected from the FRED website (LLC, S&P/Case-Shiller FL-Miami Home Price Index (MIXRNSA), 2018) Descriptive statistics of the Change in Florida Home Price Index has been shown below:

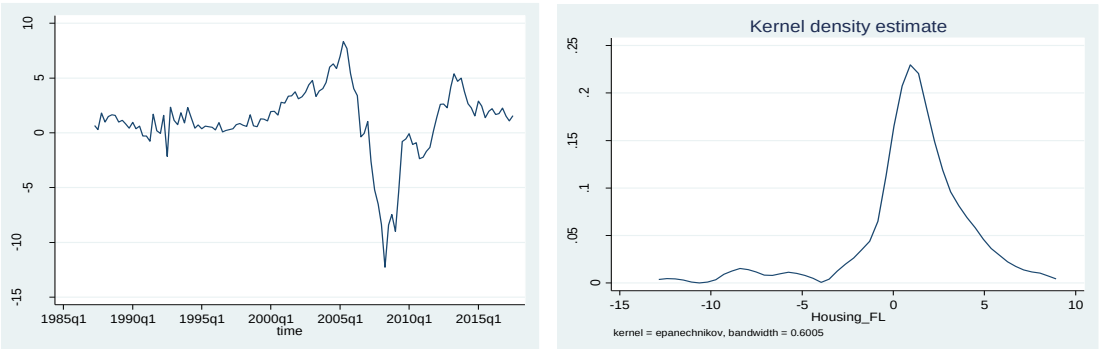
Table 6: Summary Statistics of the Change in Florida Home Price Index

Variable	Obs.	Mean	Stdv.	Min	Max	Skewness	Kurtosis
Housing_FL	122	1.09267	3.145338	-12.2542	8.33424	-1.3481	6.8939

Here, the table above shows that the quarterly values of the Florida Home Price Index change approximately 1.09% on an average over the previous quarter. The fluctuations in the change of Florida Home Price Index and the density of the data values are shown below.

The skewness and kurtosis calculated above and the graphs below show that the dataset is negatively skewed, and can be regarded as Leptokurtic since it has kurtosis of more than 3 (6.89397).

Figure 4: Fluctuation and Density of the Change in Florida Home Price Index

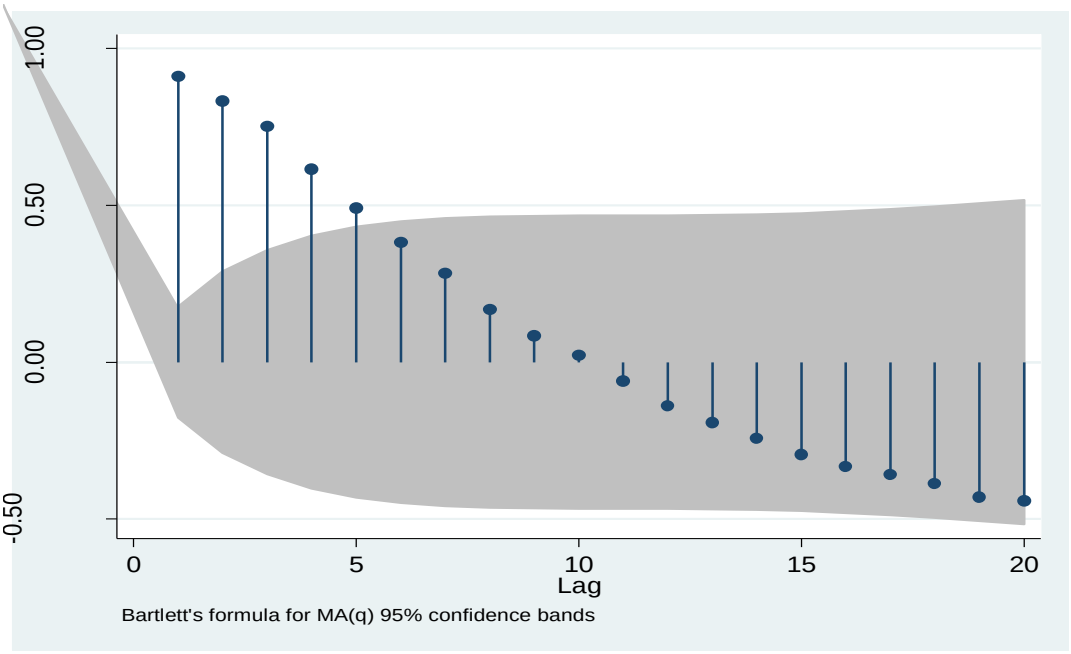


Autocorrelation Analysis of the Change in Florida Home Price Index

Table 7: Autocorrelation Statistics of the Change in Florida Home Price Index

LAG	AC	PAC	Q	Prob>Q [Autocorrelation] [Partial	Autocor]
1	0.9103	0.9105	103.61	0.0000 ------- -------	
2	0.8318	0.0178	190.82	0.0000 ------	
3	0.7511	-0.0538	262.53	0.0000 ------	
4	0.6151	-0.3701	311.04	0.0000 ---- --	
5	0.4906	-0.0632	342.15	0.0000 ---	
6	0.3812	0.0257	361.1	0.0000 ---	
7	0.2832	0.1192	371.65	0.0000 --	
8	0.1677	-0.2119	375.39	0.0000 - -	
9	0.0843	0.0338	376.34	0.0000	
10	0.0210	0.0122	376.4	0.0000	
11	-0.0608	-0.0800	376.9	0.0000	
12	-0.1405	-0.2121	379.62	0.0000 - -	
13	-0.1933	0.0368	384.8	0.0000 -	
14	-0.2428	0.0354	393.06	0.0000 -	
15	-0.2952	-0.0070	405.38	0.0000 --	
16	-0.3342	-0.1616	421.32	0.0000 -- -	
17	-0.3595	-0.0399	439.94	0.0000 --	
18	-0.3880	-0.0264	461.84	0.0000 ---	
19	-0.4306	-0.1990	489.07	0.0000 --- -	
20	-0.4422	-0.0030	518.07	0.0000 ---	

Figure 5: Autocorrelation Trend in the Change in Florida Home Price Index



Based on the figure and table shown above, it can be concluded that the autocorrelation in the change in the quarterly values of the Florida Home Price Index is pretty insignificant, other than the autocorrelation values at the very beginning.

Seasonality Analysis of the Change in Florida Home Price Index

Figure 6: Seasonality Trend in the Change in Florida Home Price Index

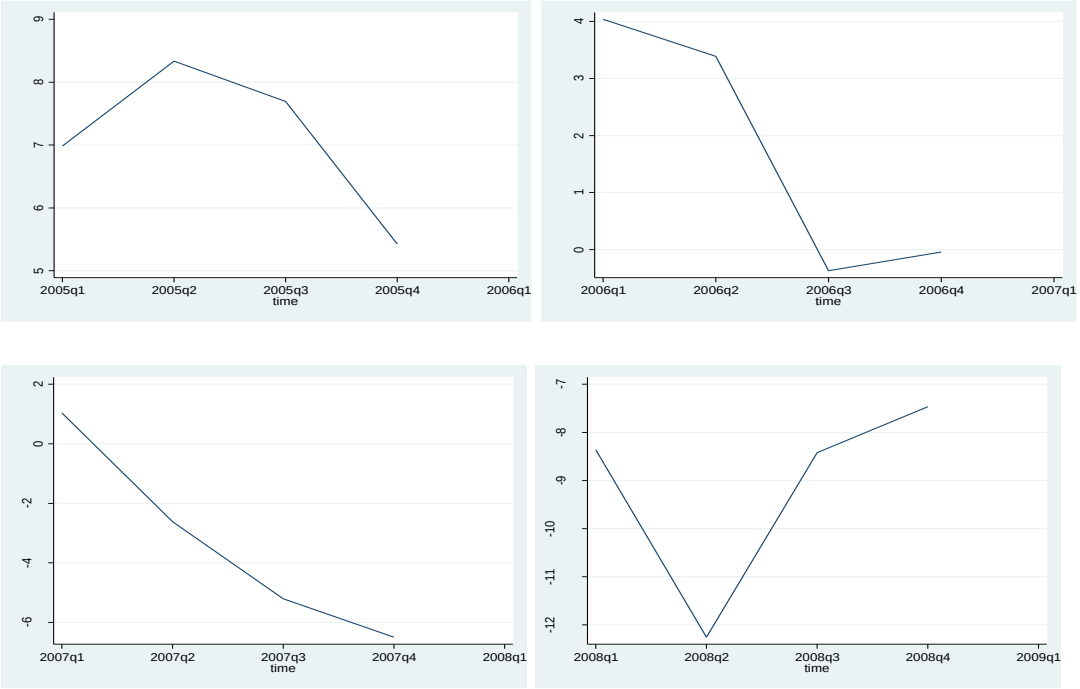


Table 8: Seasonality Statistics of the Change in Florida Home Price Index

Source	SS	df	MS	Number of obs =	122
				F(3, 118) =	0.00
Model	.092162848	3	.030720949	Prob > F =	0.9998
Residual	1196.97914	118	10.143891	R-squared =	0.0001
				Adj R-squared =	-0.0253
Total	1197.0713	121	9.89315123	Root MSE =	3.1849
Housing_FL	Coef.	Std. Err.	t / P>t	[95% Conf.	Interval]
q					
1	.0075513	.8223499	0.01 / 0.993	-1.620925	1.636028
2	-.0561416	.8156911	-0.07 / 0.945	-1.671432	1.559149
3	-.0444804	.8156911	-0.05 / 0.957	-1.659771	1.57081
_cons	1.116381	.5814892	1.92 / 0.057	-.0351259	2.267888

The figures and table above show that there is a slight level of seasonality in the Change in Florida Home Price Index as the values tend mostly to drop at quarter 3. But, since none of the regression coefficients are significant, we can conclude that there exists no seasonality in the Change in Florida Home Price Index

Correlation Analysis of the Change in Florida Home Price Index

Table 9: Correlation Statistics of in the Change in Florida Home Price Index

	Housin~L	GDP_Gr~h	Inflat~n	Interest	Income~L	UNRATE~L
Housing_FL	1.0000					
GDP_Growth	0.4154	1.0000				
Inflation	0.0530	-0.0233	1.0000			
Interest	0.0377	-0.0204	-0.4668	1.0000		
Income_FL	0.4884	0.5334	0.2040	-0.1275	1.0000	
UNRATE_FL	-0.3780	-0.2330	-0.3992	0.6521	-0.2656	1.0000

The correlation matrix above shows that none of the correlations above are high enough to pose multicolinearity threat. However, the correlation between Interest Rate and Unemployment Rate is comparatively higher than the other correlation values.

Change in Minnesota Home Price Index

Data for the Change in Minnesota Home Price Index has been collected at the state level. The data was collected from the FRED website (LLC, S&P/Case-Shiller MN-Minneapolis Home Price Index (MNXRSA), 2018). Descriptive statistics of the Change in Minnesota Home Price Index has been shown below:

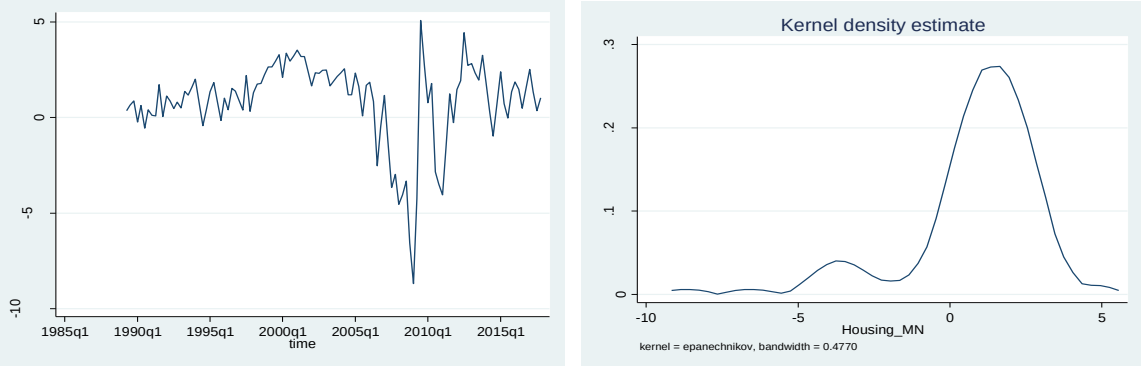
Table 10: Summary Statistics of the Change in Minnesota Home Price Index

Variable	Obs.	Mean	Stdv.	Min	Max	Skewness	Kurtosis
Housing_MN	115	.8506317	2.143345	-8.68217	5.07235	-1.6905	6.9343

Here, the table above shows that the quarterly values of the Minnesota Home Price Index change approximately 0.85% on an average over the previous quarter. The fluctuations in the change of Minnesota Home Price Index and the density of the data values are shown below.

The skewness and kurtosis calculated above, and the graphs below show that the dataset is negatively skewed, and can be regarded as Leptokurtic since it has kurtosis of more than 3 (6.93434).

Figure 7: Fluctuation and Density of the Change in Minnesota Home Price Index

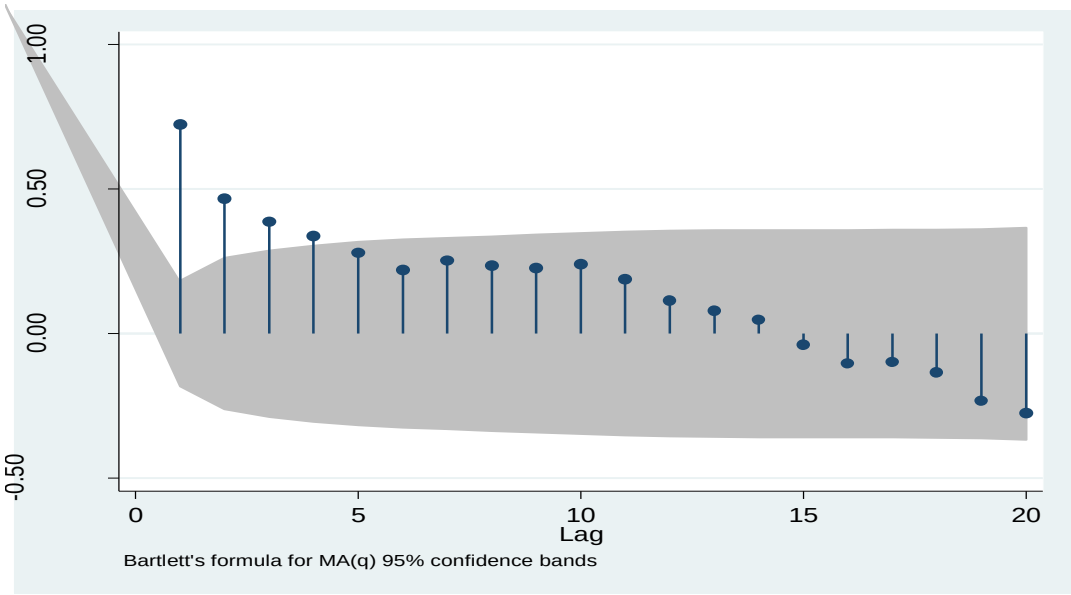


Autocorrelation Analysis of the Change in Minnesota Home Price Index

Table 11: Autocorrelation Statistics of the Change in Minnesota Home Price Index

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.7245	0.7246	61.957	0.0000	-----	-----
2	0.4667	-0.1234	87.89	0.0000	---	
3	0.3857	0.2048	105.76	0.0000	---	-
4	0.3380	0.0070	119.6	0.0000	--	
5	0.2796	0.0217	129.16	0.0000	--	
6	0.2211	-0.0071	135.2	0.0000	-	
7	0.2528	0.1762	143.16	0.0000	--	-
8	0.2351	-0.0890	150.11	0.0000	-	
9	0.2270	0.1346	156.65	0.0000	-	-
10	0.2412	0.0125	164.11	0.0000	-	
11	0.1885	-0.0814	168.71	0.0000	-	
12	0.1149	-0.0449	170.43	0.0000		
13	0.0786	0.0107	171.25	0.0000		
14	0.0475	-0.0933	171.55	0.0000		
15	-0.0389	-0.1198	171.75	0.0000		
16	-0.1031	-0.0363	173.2	0.0000		
17	-0.0982	-0.0063	174.52	0.0000		
18	-0.1334	-0.1367	176.99	0.0000	-	-
19	-0.2334	-0.1684	184.62	0.0000	-	-
20	-0.2746	-0.0303	195.3	0.0000	--	

Figure 8: Autocorrelation Trend in the Change in Minnesota Home Price Index



Based on the figure and table shown above, it can be concluded that the autocorrelation in the change in the quarterly values of the Minnesota Home Price Index is pretty insignificant, other than the few autocorrelation values at the very beginning.

Seasonality Analysis of the Change in Minnesota Home Price Index

Figure 9: Seasonality Trend in the Change in Minnesota Home Price Index

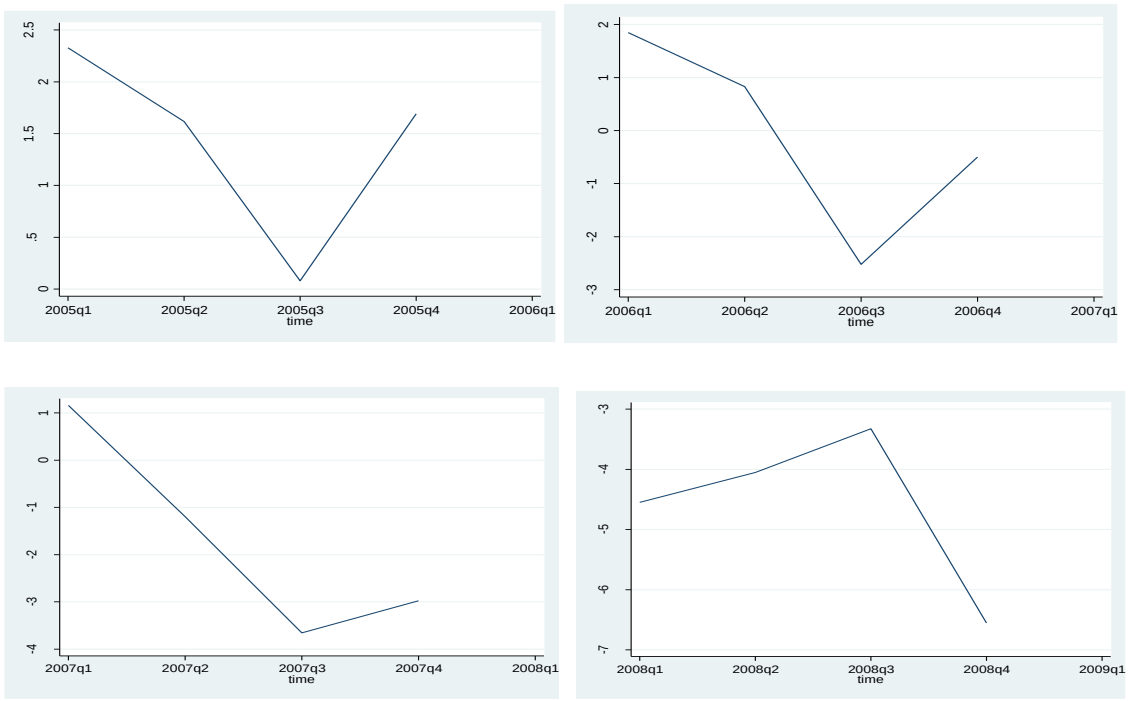


Table 12: Seasonality Statistics of the Change in Minnesota Home Price Index

reg Housing_MN	b4.q				
Source	SS	df		MS Number of obs =	115
				F(3, 111) =	0.01
Model	.080585661	3	.026861887	Prob > F =	0.9994
Residual	523.62717	111	4.71736189	R-squared =	0.0002
				Adj R-squared =	-0.0269
Total	523.707755	114	4.59392768	Root MSE =	2.1719
Housing_MN	Coef.	Std. Err.	t / P>t	[95% Conf.	Interval]
q					
1	.0592187	.5754519	0.10 / 0.918	-1.081078	1.199515
2	.0590145	.5703817	0.10 / 0.918	-1.071235	1.189264
3	.0143083	.5703817	0.03 / 0.980	-1.115941	1.144558
_cons	.8177231	.4033208	2.03 / 0.045	.0185161	1.61693

The figures and table above show that there is a slight level of seasonality in the Change in Minnesota Home Price Index as the values tend to drop at quarter 3. But, since none of the regression coefficients are significant, we can conclude that there exists no seasonality in the Change in Minnesota Home Price Index.

Correlation Analysis of the Change in Minnesota Home Price Index

Table 13: Correlation Statistics of the Change in Minnesota Home Price Index

	Housin~N	GDP_Gr~h	Inflat~n	Interest	Income~N	UNRATE~N
Housing_MN	1.0000					
GDP_Growth	0.5284	1.0000				
Inflation	0.0057	-0.0968	1.0000			
Interest	-0.0421	-0.0182	-0.4897	1.0000		
Income_MN	0.2600	0.5117	0.0951	-0.1777	1.0000	
UNRATE_MN	-0.4446	-0.3724	-0.4256	0.6097	-0.3073	1.0000

The correlation matrix above shows that none of the correlations above are high enough to pose multicolinearity threat. However, the correlation between Interest Rate and Unemployment Rate is comparatively higher than the other correlation values.

Change in California Home Price Index

Data for the Change in California Home Price Index has been collected at the state level. The data was collected from the FRED website (LLC, S&P/Case-Shiller CA-San Francisco Home Price Index (SFXRSA), 2018). Descriptive statistics of the Change in Minnesota Home Price Index has been shown below:

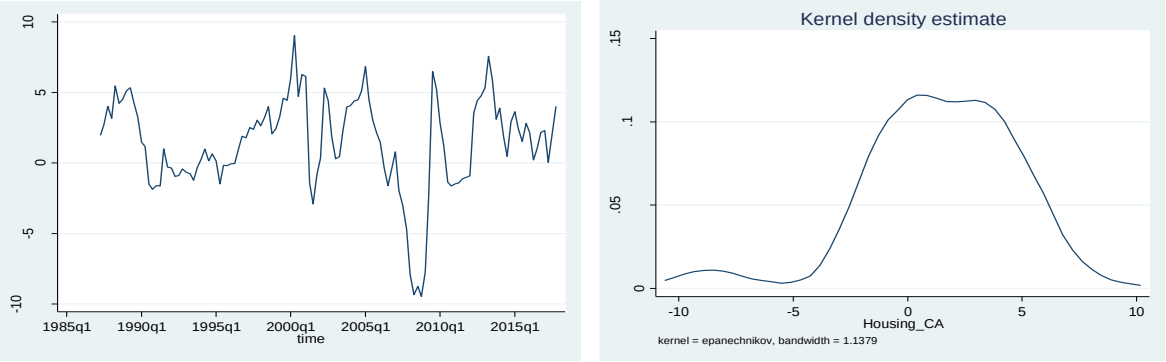
Table 14: Summary Statistics of the Change in California Home Price Index

Variable	Obs.	Mean	Stdv.	Min	Max	Skewness	Kurtosis
Housing_CA	123	1.422242	3.316975	-9.47893	9.03983	-0.8680	4.6305

Here, the table above shows that the quarterly values of the California Home Price Index change approximately 1.42% on an average over the previous quarter. The fluctuations in the change of California Home Price Index and the density of the data values are shown below.

The skewness and kurtosis calculated above, and the graphs below show that the dataset is slightly negatively skewed, and can be regarded as Leptokurtic since it has kurtosis of more than 3 (4.630536).

Figure 10: Fluctuation and Density of the Change in California Home Price Index

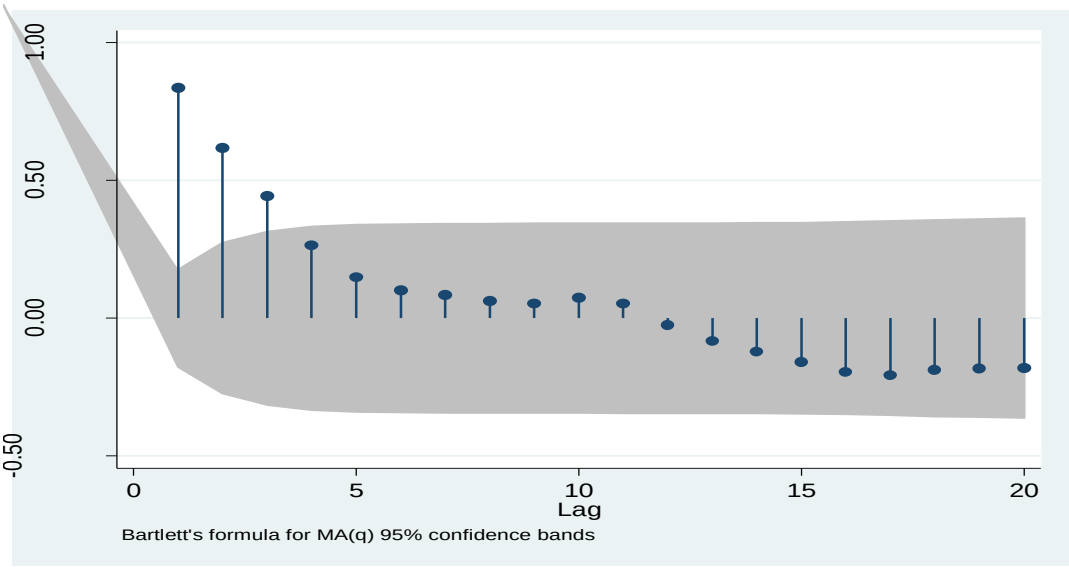


Autocorrelation Analysis of the Change in California Home Price Index

Table 15: Autocorrelation Statistics of the Change in California Home Price Index

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.8361	0.8403	88.092	0.0000	------	------
2	0.6188	-0.2805	136.74	0.0000	----	--
3	0.4436	0.0366	161.95	0.0000	---	
4	0.2640	-0.1804	170.96	0.0000	--	-
5	0.1486	0.1370	173.83	0.0000	-	-
6	0.1014	0.0264	175.18	0.0000		
7	0.0841	0.0352	176.12	0.0000		
8	0.0623	-0.0810	176.64	0.0000		
9	0.0528	0.0594	177.01	0.0000		
10	0.0747	0.0896	177.77	0.0000		
11	0.0528	-0.1607	178.15	0.0000	-	
12	-0.0242	-0.1545	178.24	0.0000	-	
13	-0.0832	0.0376	179.2	0.0000		
14	-0.1227	0.0104	181.33	0.0000		
15	-0.1588	-0.0411	184.92	0.0000	-	
16	-0.1957	-0.1747	190.42	0.0000	-	-
17	-0.2074	0.0522	196.66	0.0000	-	
18	-0.1882	0.1078	201.85	0.0000	-	
19	-0.1822	-0.1128	206.76	0.0000	-	
20	-0.1805	-0.1135	211.62	0.0000	-	

Figure 11: Autocorrelation Trend in the Change in California Home Price Index



Based on the figure and table shown above, it can be concluded that the autocorrelation in the change in the quarterly values of the California Home Price Index is pretty insignificant, other than the few autocorrelation values at the very beginning.

Seasonality Analysis of the Change in California Home Price Index

Figure 12: Seasonality Trend in the Change in California Home Price Index

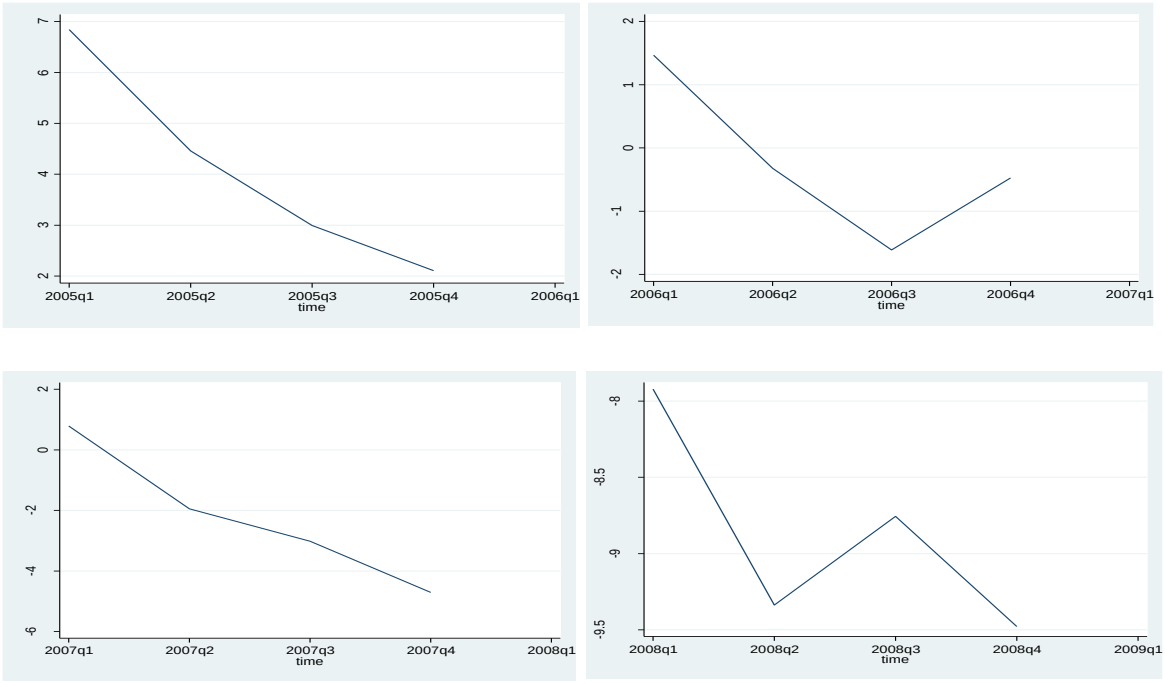


Table 16: Seasonality Statistics of the Change in California Home Price Index

Source	SS	df	MS	Number of obs =	123
				F(3, 119) =	0.01
Model	.425399585	3	.141799862	Prob > F =	0.9981
Residual	1341.85815	119	11.2761189	R-squared =	0.0003
				Adj R-squared =	-0.0249
Total	1342.28355	122	11.0023242	Root MSE =	3.358
Housing_CA	Coef.	Std. Err.	t / P>t	[95% Conf.	Interval]
q					
1	-.1100254	.8600095	-0.13 / 0.898	-1.81293	1.592879
2	-.1393645	.8529311	-0.16 / 0.870	-1.828253	1.549524
3	-.1456377	.8529311	-0.17 / 0.865	-1.834527	1.543251
_cons	1.520907	.6031134	2.52 / 0.013	.3266827	2.715132

The figures and table above show that there is almost no seasonality in the Change in California Home Price Index. Again, since none of the regression coefficients are significant, we can conclude that there exists no seasonality in the Change in California Home Price Index.

Correlation Analysis of the Change in California Home Price Index

Table 17: Correlation Statistics of the Change in California Home Price Index

	Housin~A	GDP_Gr~h	Inflat~n	Interest	Income~A	UNRATE~A
Housing_CA	1.0000					
GDP_Growth	0.5545	1.0000				
Inflation	0.0324	-0.0233	1.0000			
Interest	-0.1501	-0.0204	-0.4668	1.0000		
Income_CA	0.4636	0.5158	0.1588	-0.2218	1.0000	
UNRATE_CA	-0.3156	-0.1592	-0.5686	0.7040	-0.2788	1.0000

The correlation matrix above shows that none of the correlations above are high enough to pose multicolinearity threat. However, the correlation between Interest Rate and Unemployment Rate is comparatively higher than the other correlation values.

Change in Texas Home Price Index

Data for the Change in Texas Home Price Index has been collected at the state level. The data was collected from the FRED website (LLC, S&P/Case-Shiller TX-Dallas Home Price Index (DAXRNSA), 2018). Descriptive statistics of the Change in Texas Home Price Index has been shown below:

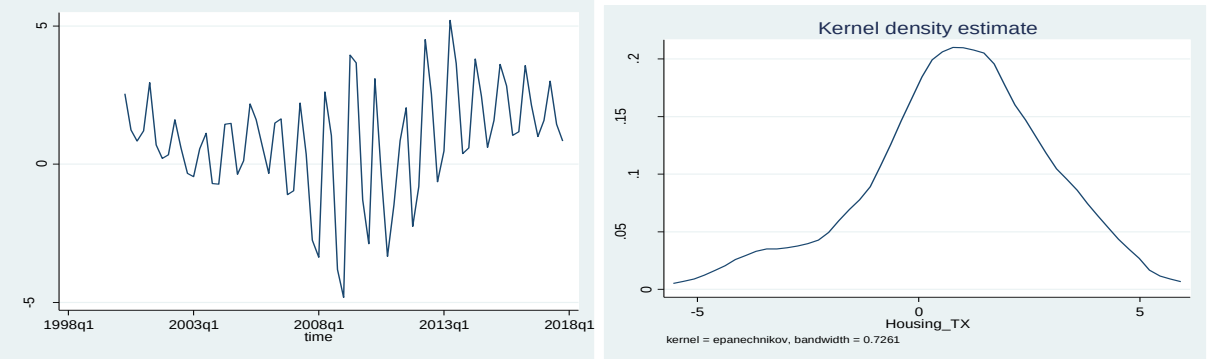
Table 18: Summary Statistics of the Change in Texas Home Price Index

Variable	Obs.	Mean	Stdv.	Min	Max	Skewness	Kurtosis
Housing_TX	71	.8377431	2.015737	-4.81415	5.19688	-0.4723	3.2827

Here, the table above shows that the quarterly values of the Texas Home Price Index change approximately 0.84% on an average over the previous quarter. The fluctuations in the change of Texas Home Price Index and the density of the data values are shown below.

The skewness and kurtosis calculated above, and the graphs below show that the dataset is slightly negatively skewed, and can be regarded as slightly Leptokurtic since it has kurtosis of more than 3 (3.282761).

Figure 13: Fluctuation and Density of the Change in Texas Home Price Index

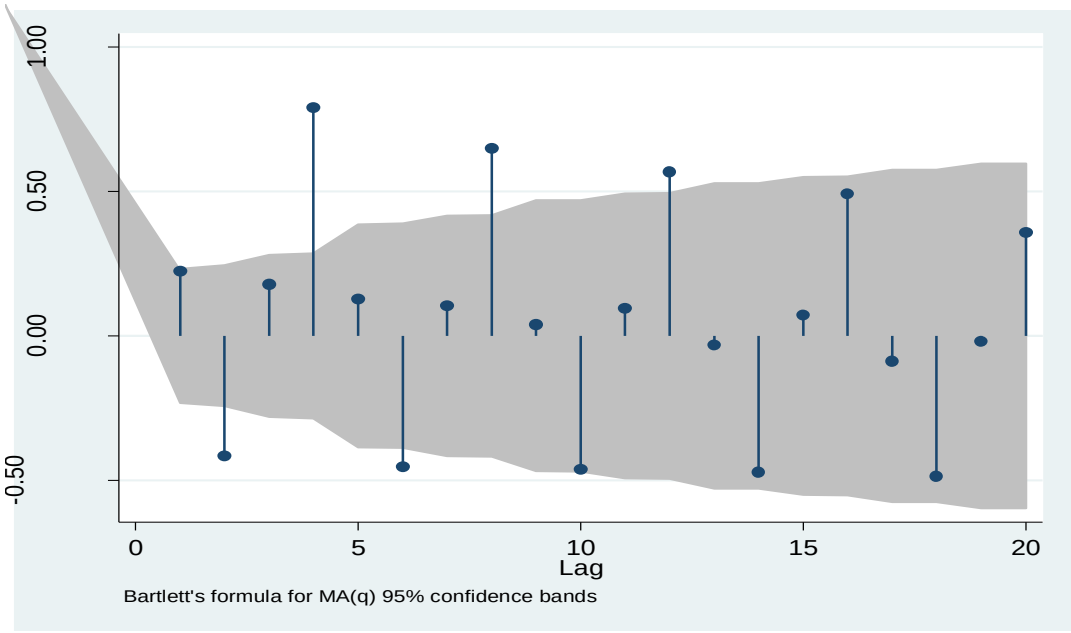


Autocorrelation Analysis of the Change in Texas Home Price Index

Table 19: Autocorrelation Statistics of the Change in Texas Home Price Index

LAG	AC	PAC	Q	Prob>Q [Autocorrelation] [Partial	Autocor]
1	0.2231	0.2231	3.6864	0.0549 - -	
2	-0.4173	-0.4925	16.767	0.0002 --- ---	
3	0.1789	0.6072	19.206	0.0002 - ----	
4	0.7904	0.5700	67.535	0.0000 ------ ----	
5	0.1264	-0.2177	68.79	0.0000 - -	
6	-0.4540	-0.1038	85.223	0.0000 ---	
7	0.1030	-0.0007	86.082	0.0000	
8	0.6481	0.0792	120.64	0.0000 -----	
9	0.0398	-0.1269	120.77	0.0000 -	
10	-0.4637	0.0462	139.04	0.0000 ---	
11	0.0953	0.1099	139.82	0.0000	
12	0.5683	0.0319	168.19	0.0000 ----	
13	-0.0325	-0.1242	168.29	0.0000	
14	-0.4725	-0.0186	188.59	0.0000 ---	
15	0.0718	-0.0516	189.07	0.0000	
16	0.4921	0.0255	211.89	0.0000 ---	
17	-0.0881	-0.0585	212.63	0.0000	
18	-0.4861	-0.0355	235.74	0.0000 ---	
19	-0.0202	-0.2882	235.78	0.0000 --	
20	0.3569	-0.0673	248.73	0.0000 --	

Figure 14: Autocorrelation Trend in the Change in Texas Home Price Index



Based on the figure and table shown above, it can be concluded that the autocorrelation in the change in the quarterly values of the Texas Home Price Index is not much significant, other than the few autocorrelation values at the very beginning.

Seasonality Analysis of the Change in Texas Home Price Index

Figure 15: Seasonality Trend in the Change in Texas Home Price Index

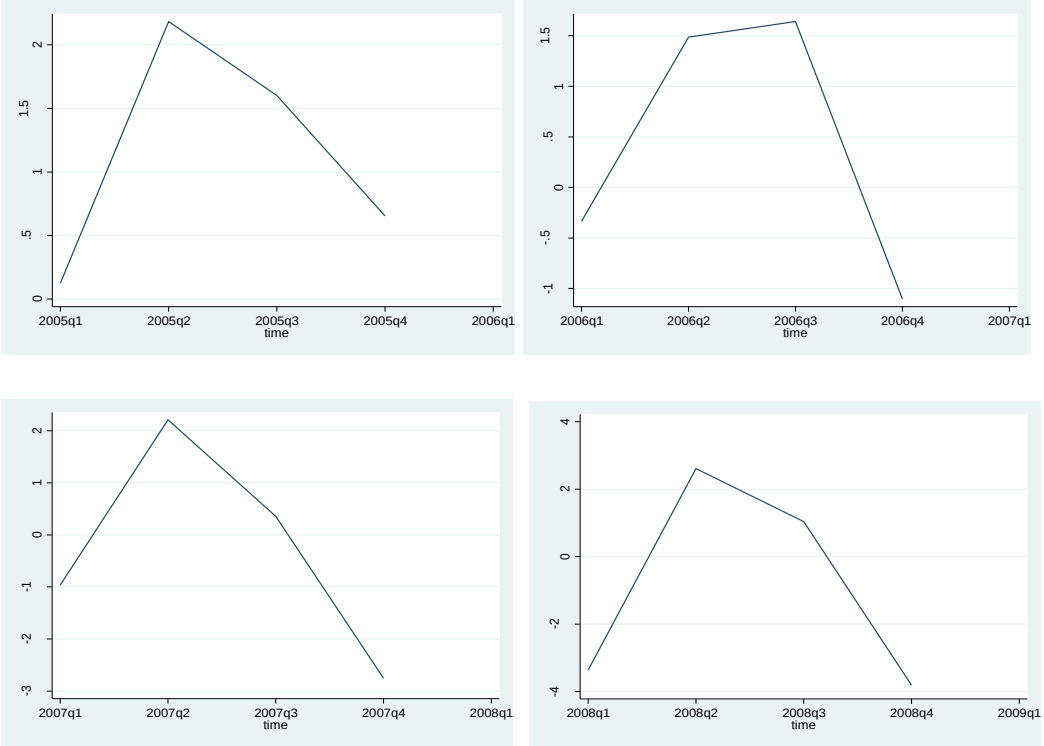


Table 20: Seasonality Statistics of the Change in Texas Home Price Index

Source	SS	df	MS		Number of obs =	71
					F(3, 67) =	23.50
Model	145.841899	3	48.6139664		Prob > F =	0.0000
Residual	138.58173	67	2.06838404		R-squared =	0.5128
					Adj R-squared =	0.4909
Total	284.42363	70	4.06319471		Root MSE =	1.4382
Housing_TX	Coef.	Std. Err.		t / P>t	[95% Conf.	Interval]
q						
1	.097063	.4863948		0.20 / 0.842	-.873785	1.067911
2	3.342275	.4793959		6.97 / 0.000	2.385397	4.299153
3	2.280892	.4793959		4.76 / 0.000	1.324013	3.23777
_cons	-.6110889	.3389841		-1.80 / 0.076	-1.287704	.0655262

The figures and table above show that there exists seasonality in the Change in Texas Home Price Index. Additionally, the regression coefficients of quarter 2 and quarter 3 are significant, which also demonstrate the seasonality in the Change in Texas Home Price Index.

Correlation Analysis of the Change in Texas Home Price Index

Table 21: Correlation Statistics of the Change in Texas Home Price Index

Housin~X	GDP_Gr~h	Inflat~n	Interest	Income~X	UNRATE~X	
Housing_TX	1.0000					
GDP_Growth	0.4243	1.0000				
Inflation	0.1450	-0.0683	1.0000			
Interest	-0.0880	-0.0003	-0.6377	1.0000		
Income_TX	0.0601	0.3226	0.1378	-0.3211	1.0000	
UNRATE_TX	-0.1171	0.0853	-0.8426	0.8371	-0.1913	1.0000

The correlation matrix above shows that none of the correlations above are high enough to pose multicolinearity threat. However, the correlation between Interest Rate and Unemployment Rate is comparatively higher than the other correlation values.

Methodology

In terms of the methodology, I used the following regression model to identify the factors that are significant in determining the Home Price Index Fluctuations in each state:

$$Home\ Price\ Index\ Fluctuation = \beta 0 + \beta 1 GDP\ Grwoth\ Rate + \beta 2 Inflation + \beta 3 Interest\ Rate + \beta 4 Household\ Income + \beta 5 Unemplomen t\ Rate$$

Keeping the Home Price Index Fluctuations as the dependent variables, I identified the best model for each of the independent variables that best explains the Home Price Index Fluctuations of a state. Then using the best five models from each of the five independent variables, I came up with twenty-six combined models for explaining the Home Price Index Fluctuations in that state. Afterwards, based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), I figured out the best model to explain the Home Price Index Fluctuations in that state, in other words, the independent variables that best explain the Home Price Index Fluctuations.

After identifying the best combined model to explain the Home Price Index Fluctuations in the state, I forecasted the Change in Home Price Index for the state for the next four quarters, in other words, for one additional year.

CHAPTER IV

RESULTS AND DISCUSION

Change in New York Home Price Index

Based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the best Autoregressive model for the Change in New York Home Price Index is the **AR4** model, the best GDP Growth Model is the **GDP_Growth1** model, the best Inflation model is the **Inflation1** model, the best Interest model is the **Interest1** model, the best Income model is the **Income2** model and the best Unemployment Rate model is the **UNRATE1** model. Using these models, I came up with the following models to explain the Home Price Index Fluctuations in New York.

Table 22: Regression Models for the Change in Texas Home Price Index

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
GDP_Growth1	119	-236.781	-141.6839	6	295.3677	312.0425
Inflation1	119	-236.781	-140.1626	6	292.3252	308.9999
Interest1	119	-236.781	-140.9493	6	293.8986	310.5733
Income2	93	-193.5233	-102.8181	7	219.6362	237.3644
UNRATE1	119	-236.781	-140.2416	6	292.4832	309.158
Combined1	119	-236.781	-139.0995	7	292.199	311.6528
Combined2	119	-236.781	-139.8896	7	293.7792	313.2331
Combined3	93	-193.5233	-100.4606	8	216.9212	237.182
Combined4	119	-236.781	-139.5992	7	293.1984	312.6523
Combined5	119	-236.781	-139.7391	7	293.4782	312.9321
Combined6	93	-193.5233	-102.3663	8	220.7325	240.9933

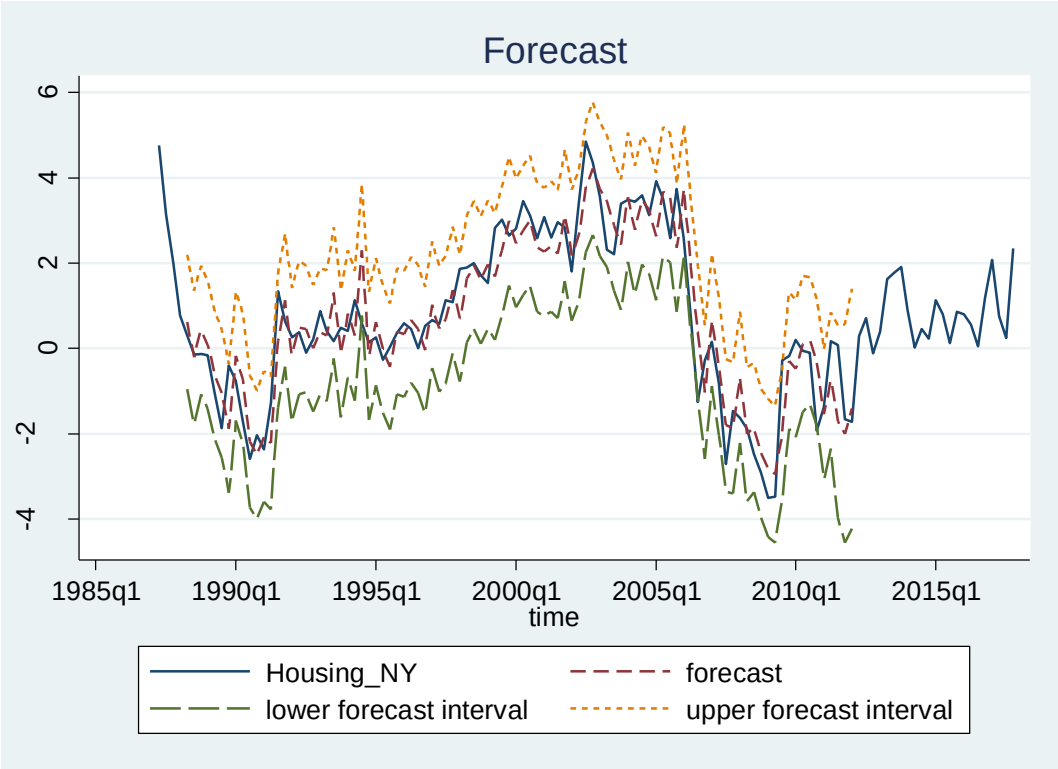
Combined7	119	-236.781	-139.3863	7	292.7726	312.2265
Combined8	93	-193.5233	-102.4226	8	220.8451	241.1059
Combined9	119	-236.781	-140.1541	7	294.3082	313.7621
Combined10	93	-193.5233	-101.6699	8	219.3398	239.6006
Combined11	119	-236.781	-138.611	8	293.2221	315.4551
Combined12	93	-193.5233	-100.0522	9	218.1044	240.8978
Combined13	119	-236.781	-138.5464	8	293.0928	315.3258
Combined14	93	-193.5233	-100.1818	9	218.3636	241.157
Combined15	119	-236.781	-139.3953	8	294.7907	317.0237
Combined16	93	-193.5233	-99.84677	9	217.6935	240.4869
Combined17	93	-193.5233	-102.2055	9	222.411	245.2044
Combined18	119	-236.781	-139.3663	8	294.7326	316.9656
Combined19	93	-193.5233	-101.6526	9	221.3051	244.0985
Combined20	93	-193.5233	-101.5728	9	221.1455	243.9389
Combined21	93	-193.5233	-99.95872	10	219.9174	245.2434
Combined22	119	-236.781	-138.4564	9	294.9128	319.9249
Combined23	93	-193.5233	-99.77665	10	219.5533	244.8793
Combined24	93	-193.5233	-99.83083	10	219.6617	244.9877
Combined25	93	-193.5233	-101.5581	10	223.1162	248.4422
Combined26	93	-193.5233	-99.76371	11	221.5274	249.386

Here, the best model among all combined models for the Change in New York Home Price Index is the **Combined3** model as it has one of the lowest AICs (216.9212) and the lowest BIC (237.182). However, in the **Combined3** regression model the dependent variable is the Change in New York Home Price Index and the independent variables are the up to the fourth lagged values of the for

the Change in New York Home Price Index, the first lagged values of the GDP Growth Rate and up to the second lagged values of the percentage change in the new York Income values.

Forecast for the Change in New York Home Price Index

Figure 16: Forecast for the Change in New York Home Price Index



The graph above shows the actual values for the change in the quarterly values of the New York Home Price Index along with the forecasted values. In addition, the graph also shows the upper forecast and lower forecast for the change in the quarterly values of the New York Home Price Index. However, since the Income data for New York was available up to the first quarter of 2011, the forecasted values could not go beyond 2012.

Change in Florida Home Price Index

Based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the best Autoregressive model for the Change in Florida Home Price Index is the **AR3** model, the best GDP Growth Model is the **GDP_Growth2** model, the best Inflation model is the **Inflation1** model, the best Interest model is the **Interest1** model, the best Income model is the **Income2** model and the best Unemployment Rate model is the **UNRATE1** model. Using these models, I came up with the following models to explain the Home Price Index Fluctuations in Florida.

Table 23: Regression Models for the Change in Florida Home Price Index

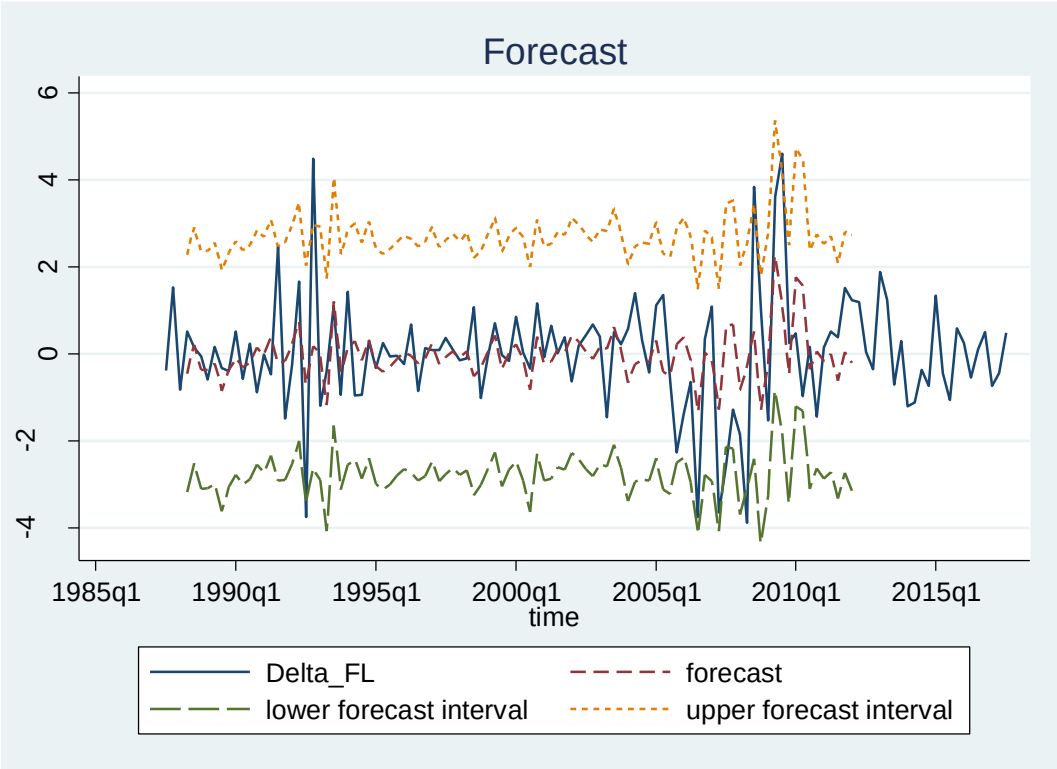
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
GDP_Growth2	118	-201.7555	-192.2066	6	396.4132	413.0374
Inflation1	118	-201.7555	-194.9973	5	399.9945	413.8479
Interest1	118	-201.7555	-193.66	5	397.32	411.1735
Income2	93	-165.526	-157.6437	6	327.2874	342.483
UNRATE1	118	-201.7555	-193.2292	5	396.4583	410.3118
Combined1	118	-201.7555	-191.8052	7	397.6105	417.0053
Combined2	118	-201.7555	-190.798	7	395.5959	414.9907
Combined3	93	-165.526	-156.2774	8	328.5549	348.8157
Combined4	118	-201.7555	-190.9721	7	395.9442	415.339
Combined5	118	-201.7555	-193.6288	6	399.2576	415.8817
Combined6	93	-165.526	-157.6345	7	329.2689	346.9971
Combined7	118	-201.7555	-193.1403	6	398.2806	414.9047
Combined8	93	-165.526	-156.5716	7	327.1432	344.8714
Combined9	118	-201.7555	-192.8266	6	397.6533	414.2774
Combined10	93	-165.526	-157.2765	7	328.5531	346.2813
Combined11	118	-201.7555	-190.7802	8	397.5603	419.7258
Combined12	93	-165.526	-156.2318	9	330.4636	353.257
Combined13	118	-201.7555	-190.8864	8	397.7729	419.9384
Combined14	93	-165.526	-155.2076	9	328.4152	351.2086

Combined15	118	-201.7555	-190.5105	8	397.0211	419.1865
Combined16	93	-165.526	-155.9828	9	329.9656	352.759
Combined17	93	-165.526	-156.4688	8	328.9376	349.1984
Combined18	118	-201.7555	-192.8179	7	399.6358	419.0306
Combined19	93	-165.526	-157.2741	8	330.5483	350.8091
Combined20	93	-165.526	-156.5709	8	329.1418	349.4026
Combined21	93	-165.526	-155.1719	10	330.3438	355.6698
Combined22	118	-201.7555	-190.5044	9	399.0088	423.945
Combined23	93	-165.526	-155.9798	10	331.9597	357.2857
Combined24	93	-165.526	-155.2024	10	330.4048	355.7308
Combined25	93	-165.526	-156.4675	9	330.935	353.7284
Combined26	93	-165.526	-155.1691	11	332.3383	360.1968

Here, the best model the Change in Florida Home Price Index is the **Income2** model as it has one of the lowest AICs (327.2874), one of the lowest BICs (342.483). However, in the **Income2** regression model, the dependent variable is the Change in Florida Home Price Index and the independent variables are the up to the third lagged values of the Change in Florida Home Price Index and up to the second lagged values of the percentage change in the Florida Income.

Forecast for the Change in Florida Home Price Index

Figure 17: Forecast for the Change in Florida Home Price Index



The graph above shows the actual values for the change in the quarterly values of the Florida Home Price Index along with the forecasted values. In addition, the graph also shows the upper forecast and lower forecast for the change in the quarterly values of the Florida Home Price Index. However, since the Income data for Florida was available up to the first quarter of 2011, the forecasted values could not go beyond 2012.

Change in Minnesota Home Price Index

Based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the best Autoregressive model for the Change in Minnesota Home Price Index is the **AR3** model, the best GDP Growth Model is the **GDP_Growth2** model, the best Inflation model is the **Inflation1** model, the best Interest model is the **Interest1** model, the best Income model is the **Income2** model and the best Unemployment Rate model is the **UNRATE1** model. Using these models, I came up with the following models to explain the Home Price Index Fluctuations in Minnesota.

Table 24: Regression Models for the Change in Minnesota Home Price Index

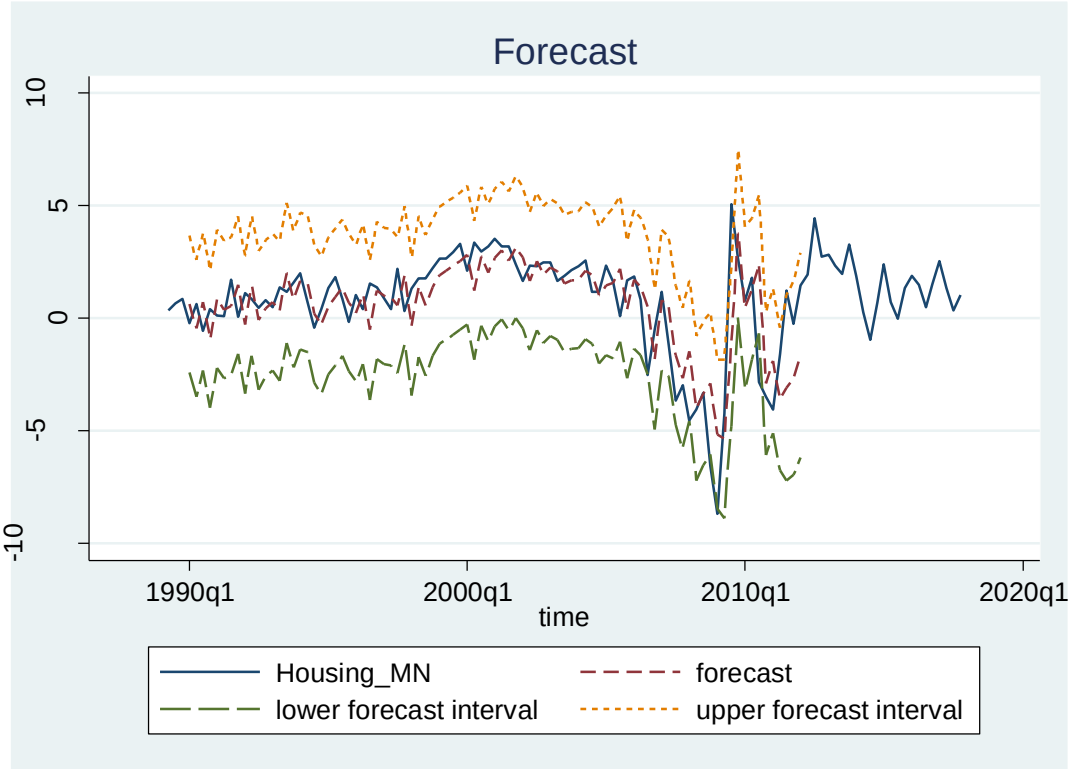
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
GDP_Growth2	112	-245.2665	-197.4511	6	406.9023	423.2133
Inflation1	112	-245.2665	-199.9536	5	409.9072	423.4997
Interest1	112	-245.2665	-200.0667	5	410.1333	423.7258
Income2	86	-195.4816	-155.6474	6	323.2949	338.021
UNRATE1	112	-245.2665	-200.2518	5	410.5035	424.096
Combined1	112	-245.2665	-197.2623	7	408.5245	427.554
Combined2	112	-245.2665	-197.3529	7	408.7058	427.7353
Combined3	86	-195.4816	-153.3865	8	322.7729	342.4077
Combined4	112	-245.2665	-197.2335	7	408.467	427.4965
Combined5	112	-245.2665	-199.894	6	411.788	428.099
Combined6	86	-195.4816	-155.633	7	325.2661	342.4465
Combined7	112	-245.2665	-199.6417	6	411.2835	427.5945
Combined8	86	-195.4816	-155.6253	7	325.2506	342.431
Combined9	112	-245.2665	-199.5928	6	411.1857	427.4967
Combined10	86	-195.4816	-154.7861	7	323.5722	340.7527
Combined11	112	-245.2665	-197.2448	8	410.4895	432.2375
Combined12	86	-195.4816	-153.2588	9	324.5176	346.6067
Combined13	112	-245.2665	-196.5242	9	411.0484	435.5149
Combined14	86	-195.4816	-153.3853	9	324.7706	346.8597

Combined15	112	-245.2665	-196.5823	8	409.1647	430.9127
Combined16	86	-195.4816	-152.2528	9	322.5056	344.5948
Combined17	86	-195.4816	-155.5841	8	327.1681	346.8029
Combined18	112	-245.2665	-199.2183	7	412.4366	431.4661
Combined19	86	-195.4816	-154.6651	8	325.3302	344.965
Combined20	86	-195.4816	-153.6337	8	323.2673	342.9021
Combined21	86	-195.4816	-153.244	10	326.488	351.0315
Combined22	112	-245.2665	-196.2074	9	410.4147	434.8812
Combined23	86	-195.4816	-152.2101	10	324.4202	348.9636
Combined24	86	-195.4816	-151.2874	10	322.5747	347.1182
Combined25	86	-195.4816	-153.6062	9	325.2125	347.3016
Combined26	86	-195.4816	-151.2734	11	324.5468	351.5446

Here, the best model among all combined models for the Change in Minnesota Home Price Index is the **Income2** model, as it has one of the lowest AICs (323.2949) and one of the lowest BICs (338.021). However, in the **Income2** regression model, the dependent variable is the Change in Minnesota Home Price Index and the independent variables are up to the third lagged values of the Change in Minnesota Home Price Index and up to the second lagged values of the percentage change in the Minnesota Income.

Forecast for the Change in Minnesota Home Price Index

Figure 18: Forecast for the Change in Minnesota Home Price Index



The graph above shows the actual values for the change in the quarterly values of the Minnesota Home Price Index along with the forecasted values. In addition, the graph also shows the upper forecast and lower forecast for the change in the quarterly values of the Minnesota Home Price Index. However, since the Income data for Minnesota was available up to the first quarter of 2011, the forecasted values could not go beyond 2012.

Change in California Home Price Index

Based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the best Autoregressive model for the Change in California Home Price Index is the **AR4** model, the best GDP Growth Model is the **GDP_Growth1** model, the best Inflation model is the **Inflation1** model, the best Interest model is the **Interest1** model, the best Income model is the **Income1** model and the best Unemployment Rate model is the **UNRATE1** model. Using these models, I came up with the following models to explain the Home Price Index Fluctuations in California.

Table 25: Regression Models for the Change in California Home Price Index

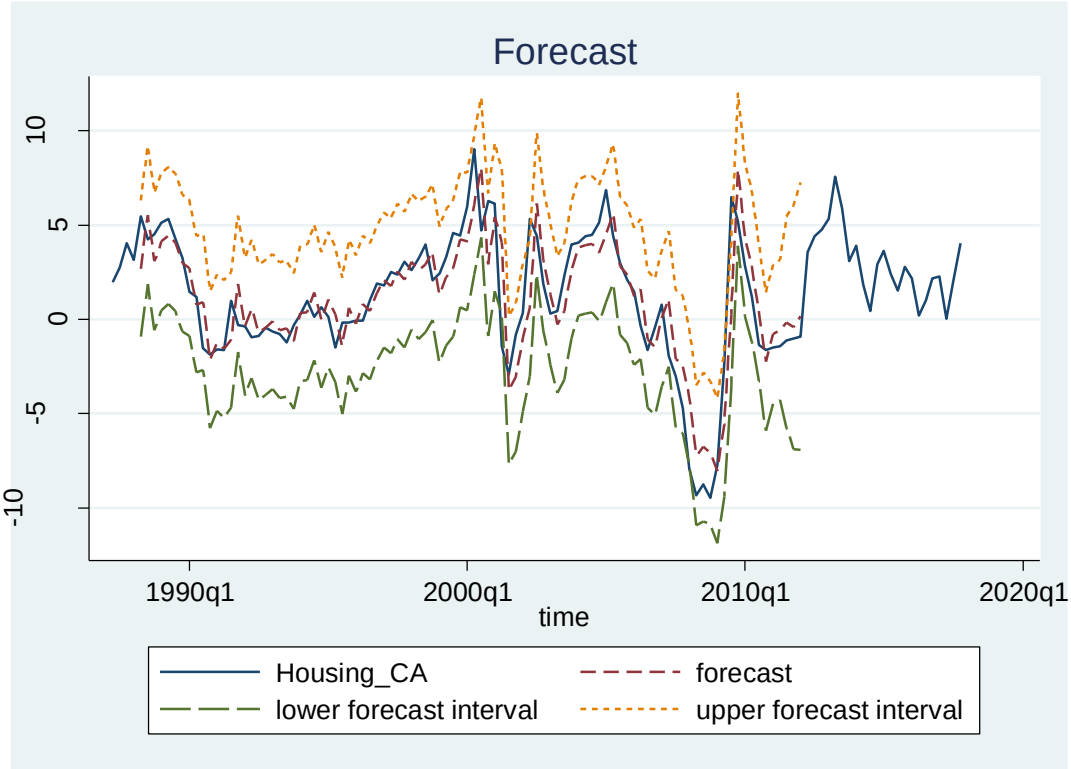
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541
GDP_Growth1	119	-312.4794	-232.9901	6	477.9803	494.655
Inflation1	119	-312.4794	-232.887	6	477.7739	494.4487
Interest1	119	-312.4794	-232.8588	6	477.7177	494.3924
Income1	93	-249.6868	-184.4278	6	380.8556	396.0512
UNRATE1	119	-312.4794	-233.5152	6	479.0305	495.7052
Combined1	119	-312.4794	-232.3916	7	478.7831	498.237
Combined2	119	-312.4794	-232.3889	7	478.7778	498.2316
Combined3	93	-249.6868	-184.4276	7	382.8553	400.5835
Combined4	119	-312.4794	-232.974	7	479.948	499.4019
Combined5	119	-312.4794	-232.6206	7	479.2412	498.6951
Combined6	93	-249.6868	-184.086	7	382.172	399.9002
Combined7	119	-312.4794	-232.5663	7	479.1325	498.5864
Combined8	93	-249.6868	-183.6319	7	381.2639	398.9921
Combined9	119	-312.4794	-232.2975	7	478.595	498.0489
Combined10	93	-249.6868	-184.2881	7	382.5762	400.3044
Combined11	119	-312.4794	-232.1591	8	480.3181	502.5511
Combined12	93	-249.6868	-184.0823	8	384.1645	404.4253
Combined13	119	-312.4794	-232.0768	8	480.1536	502.3866
Combined14	93	-249.6868	-183.6212	8	383.2423	403.5031

Combined15	119	-312.4794	-231.8579	8	479.7158	501.9488
Combined16	93	-249.6868	-184.2863	8	384.5726	404.8334
Combined17	93	-249.6868	-183.5746	8	383.1492	403.41
Combined18	119	-312.4794	-231.7512	8	479.5024	501.7354
Combined19	93	-249.6868	-183.4543	8	382.9085	403.1693
Combined20	93	-249.6868	-182.0662	8	380.1325	400.3932
Combined21	93	-249.6868	-183.5594	9	385.1188	407.9122
Combined22	119	-312.4794	-231.3333	9	480.6666	505.6787
Combined23	93	-249.6868	-183.452	9	384.9039	407.6973
Combined24	93	-249.6868	-182.054	9	382.108	404.9014
Combined25	93	-249.6868	-181.5016	9	381.0032	403.7966
Combined26	93	-249.6868	-181.4701	10	382.9402	408.2662

Here, the best model among all combined models for the Change in California Home Price Index is the **Income1** model, as it has the lowest AIC (380.8556) and the lowest BIC (396.0512). However, in the **Income1** regression model, the dependent variable is the Change in California Home Price Index and the independent variables are up to the fourth lagged values of the Change in California Home Price Index and the first lagged values of the percentage change in California Income.

Forecast for the Change in California Home Price Index

Figure 19: Forecast for the Change in California Home Price Index



The graph above shows the actual values for the change in the quarterly values of the California Home Price Index along with the forecasted values. In addition, the graph also shows the upper forecast and lower forecast for the change in the quarterly values of the California Home Price Index. However, since the Income data for California was available up to the first quarter of 2011, the forecasted values could not go beyond 2012.

Texas Home Price Index

Based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the best Autoregressive model for the Change in Texas Home Price Index is the **AR4** model, the best GDP Growth Model is the **GDP_Growth1** model, the best Inflation model is the **Inflation1** model, the best Interest model is the **Interest1** model, the best Income model is the **Income3** model and the best Unemployment Rate model is the **UNRATE1** model. Using these models, I came up with the following models to explain the Home Price Index Fluctuations in Texas.

Table 26: Regression Models for the Change in Texas Home Price Index

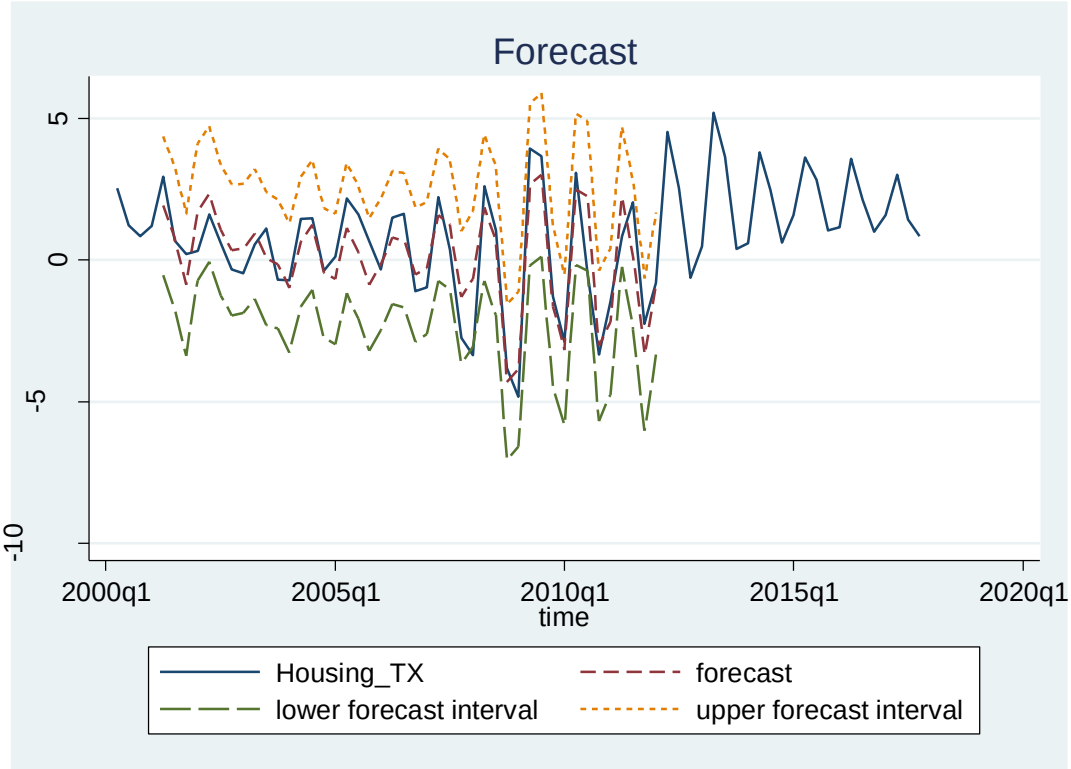
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718
GDP_Growth1	67	-143.1117	-103.5704	6	219.1408	232.3689
Inflation1	67	-143.1117	-103.4599	6	218.9198	232.1479
Interest1	67	-143.1117	-103.3199	6	218.6397	231.8679
Income3	41	-86.75893	-60.22651	8	136.453	150.1616
UNRATE1	67	-143.1117	-102.9356	6	217.8711	231.0993
Combined1	67	-143.1117	-103.4597	7	220.9194	236.3522
Combined2	67	-143.1117	-103.3198	7	220.6396	236.0725
Combined3	41	-86.75893	-59.80338	9	137.6068	153.0289
Combined4	67	-143.1117	-102.9201	7	219.8402	235.2731
Combined5	67	-143.1117	-103.3174	7	220.6347	236.0676
Combined6	41	-86.75893	-58.34135	9	134.6827	150.1048
Combined7	67	-143.1117	-102.8398	7	219.6796	235.1125
Combined8	41	-86.75893	-59.45644	9	136.9129	152.335
Combined9	67	-143.1117	-102.9302	7	219.8605	235.2933
Combined10	41	-86.75893	-58.42977	9	134.8595	150.2817
Combined11	67	-143.1117	-103.3174	8	222.6347	240.2723
Combined12	41	-86.75893	-58.21932	10	136.4386	153.5744
Combined13	67	-143.1117	-102.8223	8	221.6446	239.2821
Combined14	41	-86.75893	-59.26477	10	138.5295	155.6653

Combined15	67	-143.1117	-102.9134	8	221.8268	239.4644
Combined16	41	-86.75893	-58.3383	10	136.6766	153.8123
Combined17	41	-86.75893	-58.30515	10	136.6103	153.746
Combined18	67	-143.1117	-102.8397	8	221.6794	239.3169
Combined19	41	-86.75893	-58.15842	10	136.3168	153.4526
Combined20	41	-86.75893	-58.38239	10	136.7648	153.9005
Combined21	41	-86.75893	-58.20171	11	138.4034	157.2527
Combined22	67	-143.1117	-102.8219	9	223.6438	243.486
Combined23	41	-86.75893	-58.07525	11	138.1505	156.9998
Combined24	41	-86.75893	-58.27799	11	138.556	157.4053
Combined25	41	-86.75893	-58.14283	11	138.2857	157.135
Combined26	41	-86.75893	-58.05181	12	140.1036	160.6665

Here, the best model among all combined models for the Change in Texas Home Price Index is the **Combined6** model, as it has one of the lowest AICs (134.6827) and one of the lowest BICs (150.1048). However, in the **Combined6** regression model, the dependent variable is the Change in Texas Home Price Index and the independent variables are up to the fourth lagged values of the Change in Texas Home Price Index, the first lagged values of Inflation and up to the third lagged of the percentage change in Texas Income.

Forecast for the Change in Texas Home Price Index

Figure 20: Forecast for the Change in Texas Home Price Index



The graph above shows the actual values for the change in the quarterly values of the Texas Home Price Index along with the forecasted values. In addition, the graph also shows the upper forecast and lower forecast for the change in the quarterly values of the Texas Home Price Index. However, since the Income data for Texas was available up to the first quarter of 2011, the forecasted values could not go beyond 2012.

As shown in the regression analyses, the five independent variables – GDP Growth, Inflation, Income, Interest Rate, Income and Unemployment Rate – pretty well explain the home price indices for the five states representing the five regions of the USA. However, the impact of those five independent variables are not the same on the change in housing price index of all the five states. Additionally, within a particular independent variable, different lagged values cast different impact. So based on the regression outputs, an analysis of the impact of the five macroeconomic variables on the change in housing price indices of the five states from the five regions has been illustrated below:

Change in New York Home Price Index

From the regression outputs, we saw that the **Combined3** regression model best explains the Change in New York Home Price Index. The model incorporates Change in New York Home Price Index as the dependent variable. On the other hand, the independent variables are the up to the fourth lagged values of the for the Change in New York Home Price Index, the first lagged values of the GDP Growth Rate and up to the second lagged values of the percentage change in the new York Income values. Therefore, the model to explain the Change in New York Home Price Index looks like the following:

$$Change\ in\ the\ New\ York\ Home\ Price\ Index = \beta 0 + \beta 1L(1/$$

$$4).\ Change\ in\ New\ York\ Home\ price\ Index + \beta 2L.GDP\ Growth\ Rate + \beta 3L(1/$$

$$2).\ Percentage\ Change\ in\ the\ New\ York\ Income$$

Change in Florida Home Price Index

From the regression outputs, we saw that the **Income2** regression model best explains the Change in Florida Home Price Index. The model incorporates Change in Florida Home Price Index as the dependent variable. On the other hand, the independent variables are up to the third lagged values of the Change in Florida Home Price Index and up to the second lagged values of the percentage change in the Florida Income. Therefore, the model to explain the Change in Florida Home Price Index looks like the following:

$$Change\ in\ the\ Florida\ Home\ Price\ Index = \beta 0 + \beta 1 L(1/$$
$$3).\ Change\ in\ Florida\ Home\ price\ Index + \beta 2 L(1/$$
$$2).\ Percentage\ Change\ in\ the\ Florida\ Income$$

Change in Minnesota Home Price Index

From the regression outputs, we saw that the **Income2** regression model best explains the Change in Minnesota Home Price Index. The model incorporates Change in Minnesota Home Price Index as the dependent variable. On the other hand, the independent variables are up to the third lagged values of the Change in Minnesota Home Price Index and up to the second lagged values of the percentage change in the Minnesota Income. Therefore, the model to explain the Change in Minnesota Home Price Index looks like the following:

$$Change\ in\ the\ Minnesota\ Home\ Price\ Index$$
$$= \beta 0 + \beta 1 L(1/4).\ Change\ in\ Minnesota\ Home\ price\ Index$$
$$+ \beta 2 L(1/2).\ Percentage\ Change\ in\ the\ Minnesota\ Income$$

Change in California Home Price Index

From the regression outputs, we saw that the **Income1** regression model best explains the Change in California Home Price Index. The model incorporates Change in California Home Price Index as the dependent variable. On the other hand, the independent variables are up to the fourth lagged values of the Change in California Home Price Index and the first lagged values of the percentage change in California Income. Therefore, the model to explain the Change in California Home Price Index looks like the following:

$$Change\ in\ the\ California\ Home\ Price\ Index$$
$$= \beta 0 + \beta 1L(1/4).Change\ in\ California\ Home\ price\ Index$$
$$+ \beta 2L.Percentage\ Change\ in\ the\ California\ Income$$

Change in Texas Home Price Index

From the regression outputs, we saw that the **Combined6** regression model best explains the Change in Texas Home Price Index. The model incorporates Change in Texas Home Price Index as the dependent variable. On the other hand, the independent variables are up to the fourth lagged values of the Change in Texas Home Price Index, the first lagged values of Inflation and up to the third lagged values of the percentage change in Texas Income. Therefore, the model to explain the Change in Texas Home Price Index looks like the following:

$$Change\ in\ the\ Texas\ Home\ Price\ Index$$
$$= \beta 0 + \beta 1L(1/4).Change\ in\ Texas\ Home\ price\ Index + \beta 2L.Inflation$$
$$+ \beta 3L(1/3).Percentage\ Change\ in\ the\ Texas\ Income$$

From the analysis of the impact of the five macroeconomic variables on the change in housing price indices of the five states, it can be concluded that Income casts the most significant impact on the housing price fluctuations across the five regions of the USA, as Income is a significant determinant of the home price index of all the five states – New York, Florida, Minnesota, California and Texas. Other than that GDP Growth Rate casts significant impact on determining home price index of New York, while Inflation casts significant impact on determining home price index of Texas.

Comparative Analysis of the Models

Based on the analyses of the impact of the five macroeconomic variables on the change in housing price indices of the five states from the five regions, some interesting results have come out. First, lagged values of the home price indices play role in determining the home price index fluctuations in all the states from all the regions. Second, GDP Growth Rate plays role in determining the home price index fluctuations only in New York. Third, inflation plays role in determining the home price index fluctuations only in Texas, Fourth, interest rate doesn't play role in determining the home price index fluctuations in any state. Fifth, percentage change in income plays role in determining the home price index fluctuations in all the states from all the regions. Sixth, Unemployment Rate doesn't play role in determining the home price index fluctuations in any state.

To summarize, among all the independent variables, percentage change in income is the most important factor in determining the home price index fluctuations. GDP Growth Rate and Inflation play role too, but in a limited manner. However, interest rate and unemployment rate are the least influential factors in determining the home price index fluctuations

CHAPTER V

LIMITATIONS AND FURTHER RESEARCH

There were actually a number of limitations that I had to face while working my thesis, such as lack of data on GDP Growth Rate, Inflation and Interest Rate at the regional level and at the state level. Though it is understandable that data on those variables are by nature calculated at the national level, but a regional set of data would make the regression results more representative. Additionally, the income data at the Bureau of Economic Analysis at the U.S. Department of Commerce was available only till 2011. Since Percentage Change in Income was found significant in determining the home price index fluctuations in all the states from all the regions, I could not forecast the Home Price Index fluctuations beyond 2012 for any region. Once there limitations are resolved, the regression results would definitely look better and more representative.

However, in terms of further research, a similar research can be conducted at the state level. In other words, with proper regression analyses the determinants for home price index fluctuations can be identified for each state and a similar comparative analysis can be conducted to see which factors play more significant role in determining the home price index fluctuations at which state.

APPENDICES

Appendix A

Regression Models for the Change in New York Home Price Index

Autoregressive Models for the Change in New York Home Price Index

```
. estimates stats ar1 ar2 ar3 ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar1	122	-242.4458	-153.6785	2	311.357	316.965
ar2	121	-240.0337	-151.375	3	308.75	317.1373
ar3	120	-238.2692	-145.1653	4	298.3307	309.4807
ar4	119	-236.781	-142.574	5	295.148	309.0436

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

GDP Growth Models for the Change in New York Home Price Index

```
. estimates stats ar4 GDP_Growth1 GDP_Growth2 GDP_Growth3 GDP_Growth4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-236.781	-142.574	5	295.148	309.0436
GDP_Growth1	119	-236.781	-141.6839	6	295.3677	312.0425
GDP_Growth2	119	-236.781	-140.7548	7	295.5096	314.9635
GDP_Growth3	119	-236.781	-139.818	8	295.636	317.869
GDP_Growth4	119	-236.781	-138.6879	9	295.3757	320.3878

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Inflation Model for the Change in New York Home Price Index

```
. estimates stats ar4 Inflation1 Inflation2 Inflation3 Inflation4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-236.781	-142.574	5	295.148	309.0436
Inflation1	119	-236.781	-140.1626	6	292.3252	308.9999
Inflation2	119	-236.781	-140.0083	7	294.0166	313.4705
Inflation3	119	-236.781	-139.5921	8	295.1843	317.4173
Inflation4	119	-236.781	-139.5312	9	297.0625	322.0746

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Interest Models for the Change in New York Home Price Index

```
. estimates stats ar4 Interest1 Interest2 Interest3 Interest4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-236.781	-142.574	5	295.148	309.0436
Interest1	119	-236.781	-140.9493	6	293.8986	310.5733
Interest2	119	-236.781	-139.7553	7	293.5106	312.9645
Interest3	119	-236.781	-138.9866	8	293.9733	316.2063
Interest4	119	-236.781	-138.9674	9	295.9348	320.9469

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Income Models for the Change in New York Home Price Index

```
. estimates stats ar4 Income1 Income2 Income3 Income4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-236.781	-142.574	5	295.148	309.0436
Income1	93	-193.5233	-112.0513	6	236.1025	251.2981
Income2	93	-193.5233	-102.8181	7	219.6362	237.3644
Income3	93	-193.5233	-101.7988	8	219.5977	239.8584
Income4	93	-193.5233	-101.7669	9	221.5339	244.3273

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Unemployment Rate Models for the Change in New York Home Price Index

```
. estimates stats ar4 UNRATE1 UNRATE2 UNRATE3 UNRATE4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-236.781	-142.574	5	295.148	309.0436
UNRATE1	119	-236.781	-140.2416	6	292.4832	309.158
UNRATE2	119	-236.781	-139.7267	7	293.4534	312.9073
UNRATE3	119	-236.781	-137.2821	8	290.5642	312.7972
UNRATE4	119	-236.781	-137.0084	9	292.0169	317.029

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Appendix B

Regression Models for the Change in Florida Home Price Index

Autoregressive **Models for the Change in Florida Home Price Index**

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar1	120	-205.0149	-204.7858	2	413.5716	419.1466
ar2	119	-203.1586	-202.9422	3	411.8843	420.2217
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
ar4	117	-200.4698	-194.2733	5	398.5467	412.3575

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

GDP Growth Models for the Change in Florida Home Price Index

```
. estimates stats ar3 GDP_Growth1 GDP_Growth2 GDP_Growth3 GDP_Growth4
```

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
GDP_Growth1	118	-201.7555	-195.3292	5	400.6585	414.5119
GDP_Growth2	118	-201.7555	-192.2066	6	396.4132	413.0374
GDP_Growth3	118	-201.7555	-190.6776	7	395.3552	414.75
GDP_Growth4	118	-201.7555	-190.0017	8	396.0035	418.169

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Inflation Models for the Change in Florida Home Price Index

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
Inflation1	118	-201.7555	-194.9973	5	399.9945	413.8479
Inflation2	118	-201.7555	-194.7479	6	401.4958	418.1199
Inflation3	118	-201.7555	-194.2467	7	402.4933	421.8881
Inflation4	118	-201.7555	-194.2387	8	404.4775	426.643

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Interest Models for the Change in Florida Home Price Index

```
. estimates stats ar3 Interest1 Interest2 Interest3 Interest4
```

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
Interest1	118	-201.7555	-193.66	5	397.32	411.1735
Interest2	118	-201.7555	-193.6302	6	399.2604	415.8845
Interest3	118	-201.7555	-193.4909	7	400.9818	420.3766
Interest4	118	-201.7555	-193.3465	8	402.6931	424.8585

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Income Models for the Change in Florida Home Price Index

```
. estimates stats ar3 Income1 Income2 Income3 Income4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
Income1	93	-165.526	-159.5945	5	329.1891	341.8521
Income2	93	-165.526	-157.6437	6	327.2874	342.483
Income3	93	-165.526	-156.4078	7	326.8155	344.5437
Income4	93	-165.526	-156.1078	8	328.2156	348.4764

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Unemployment Rate Models for the Change in Florida Home Price Index

```
. estimates stats ar3 UNRATE1 UNRATE2 UNRATE3 UNRATE4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	118	-201.7555	-195.5795	4	399.159	410.2418
UNRATE1	118	-201.7555	-193.2292	5	396.4583	410.3118
UNRATE2	118	-201.7555	-192.824	6	397.648	414.2721
UNRATE3	118	-201.7555	-192.2289	7	398.4577	417.8525
UNRATE4	118	-201.7555	-191.9684	8	399.9368	422.1023

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Appendix C

Regression Models for the Change in Minnesota Home Price Index

Autoregressive Models for the Change in Minnesota Home Price Index

```
. estimates stats ar1 ar2 ar3 ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar1	114	-248.6419	-206.1822	2	416.3644	421.8368
ar2	113	-246.9541	-203.9993	3	413.9987	422.1808
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
ar4	111	-243.4475	-198.7406	5	407.4813	421.0289

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

GDP Growth Models for the Change in Minnesota Home Price Index

```
. estimates stats ar3 GDP_Growth1 GDP_Growth2 GDP_Growth3 GDP_Growth4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
GDP_Growth1	112	-245.2665	-199.536	5	409.0719	422.6644
GDP_Growth2	112	-245.2665	-197.4511	6	406.9023	423.2133
GDP_Growth3	112	-245.2665	-197.1388	7	408.2775	427.307
GDP_Growth4	112	-245.2665	-196.9672	8	409.9345	431.6825

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Inflation Models for the Change in Minnesota Home Price Index

```
. estimates stats ar3 Inflation1 Inflation2 Inflation3 Inflation4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
Inflation1	112	-245.2665	-199.9536	5	409.9072	423.4997
Inflation2	112	-245.2665	-199.4616	6	410.9232	427.2342
Inflation3	112	-245.2665	-199.3997	7	412.7995	431.829
Inflation4	112	-245.2665	-198.592	8	413.184	434.932

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Interest Models for the Change in Minnesota Home Price Index

```
. estimates stats ar3 Interest1 Interest2 Interest3 Interest4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
Interest1	112	-245.2665	-200.0667	5	410.1333	423.7258
Interest2	112	-245.2665	-200.0512	6	412.1024	428.4134
Interest3	112	-245.2665	-199.4447	7	412.8894	431.9189
Interest4	112	-245.2665	-199.2561	8	414.5122	436.2601

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Income Models for the Change in Minnesota Home Price Index

```
. estimates stats ar3 Income1 Income2 Income3 Income4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
Income1	86	-195.4816	-157.6218	5	325.2437	337.5154
Income2	86	-195.4816	-155.6474	6	323.2949	338.021
Income3	86	-195.4816	-154.213	7	322.426	339.6065
Income4	86	-195.4816	-154.058	8	324.1159	343.7507

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Unemployment Rate Models for the Change in Minnesota Home Price Index

```
. estimates stats ar3 UNRATE1 UNRATE2 UNRATE3 UNRATE4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar3	112	-245.2665	-200.3008	4	408.6015	419.4755
UNRATE1	112	-245.2665	-200.2518	5	410.5035	424.096
UNRATE2	112	-245.2665	-200.0089	6	412.0177	428.3287
UNRATE3	112	-245.2665	-199.8368	7	413.6737	432.7032
UNRATE4	112	-245.2665	-199.788	8	415.576	437.324

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Appendix D

Regression Models for the Change in California Home Price Index

Autoregressive Models for the Change in California Home Price Index

```
. estimates stats ar1 ar2 ar3 ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar1	122	-319.3814	-245.3819	2	494.7637	500.3718
ar2	121	-317.1816	-238.8482	3	483.6965	492.0838
ar3	120	-314.7476	-236.9986	4	481.9971	493.1471
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

GDP Growth Models for the Change in California Home Price Index

```
. estimates stats ar4 GDP_Growth1 GDP_Growth2 GDP_Growth3 GDP_Growth4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541
GDP_Growth1	119	-312.4794	-232.9901	6	477.9803	494.655
GDP_Growth2	119	-312.4794	-232.9444	7	479.8888	499.3427
GDP_Growth3	119	-312.4794	-230.6976	8	477.3952	499.6282
GDP_Growth4	119	-312.4794	-228.5222	9	475.0444	500.0565

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Inflation Models for the Change in California Home Price Index

```
. estimates stats ar4 Inflation1 Inflation2 Inflation3 Inflation4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541
Inflation1	119	-312.4794	-232.887	6	477.7739	494.4487
Inflation2	119	-312.4794	-232.5441	7	479.0882	498.5421
Inflation3	119	-312.4794	-232.3672	8	480.7343	502.9673
Inflation4	119	-312.4794	-232.366	9	482.7321	507.7442

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Interest Models for the Change in California Home Price Index

```
. estimates stats ar4 Interest1 Interest2 Interest3 Interest4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541
Interest1	119	-312.4794	-232.8588	6	477.7177	494.3924
Interest2	119	-312.4794	-232.8175	7	479.635	499.0889
Interest3	119	-312.4794	-232.6394	8	481.2788	503.5118
Interest4	119	-312.4794	-232.5578	9	483.1156	508.1277

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Income Models for the Change in California Home Price Index

```
. estimates stats ar4 Income1 Income2 Income3 Income4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541
Income1	93	-249.6868	-184.4278	6	380.8556	396.0512
Income2	93	-249.6868	-183.8245	7	381.649	399.3772
Income3	93	-249.6868	-183.2022	8	382.4045	402.6653
Income4	93	-249.6868	-180.225	9	378.45	401.2434

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Unemployment Rate Models for the Change in California Home Price Index

```
. estimates stats ar4 UNRATE1 UNRATE2 UNRATE3 UNRATE4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	119	-312.4794	-233.5293	5	477.0585	490.9541
UNRATE1	119	-312.4794	-233.5152	6	479.0305	495.7052
UNRATE2	119	-312.4794	-233.2184	7	480.4367	499.8906
UNRATE3	119	-312.4794	-232.543	8	481.086	503.3189
UNRATE4	119	-312.4794	-230.882	9	479.764	504.7761

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Appendix E

Regression Models for the Change in Texas Home Price Index

Autoregressive Models for the Change in Texas Home Price Index

```
. estimates stats ar1 ar2 ar3 ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar1	70	-148.029	-146.2223	2	296.4446	300.9416
ar2	69	-146.3889	-134.9447	3	275.8893	282.5916
ar3	68	-144.7635	-117.9059	4	243.8118	252.6898
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

GDP Growth Models for the Change in Texas Home Price Index

```
. estimates stats ar4 GDP_Growth1 GDP_Growth2 GDP_Growth3 GDP_Growth4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718
GDP_Growth1	67	-143.1117	-103.5704	6	219.1408	232.3689
GDP_Growth2	67	-143.1117	-102.9788	7	219.9575	235.3904
GDP_Growth3	67	-143.1117	-100.962	8	217.924	235.5616
GDP_Growth4	67	-143.1117	-100.5823	9	219.1645	239.0068

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Inflation Models for the Change in Texas Home Price Index

```
. estimates stats ar4 Inflation1 Inflation2 Inflation3 Inflation4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718
Inflation1	67	-143.1117	-103.4599	6	218.9198	232.1479
Inflation2	67	-143.1117	-103.3761	7	220.7521	236.185
Inflation3	67	-143.1117	-102.3696	8	220.7392	238.3767
Inflation4	67	-143.1117	-101.2427	9	220.4853	240.3276

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Interest Models for the Change in Texas Home Price Index

```
. estimates stats ar4 Interest1 Interest2 Interest3 Interest4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718
Interest1	67	-143.1117	-103.3199	6	218.6397	231.8679
Interest2	67	-143.1117	-102.9642	7	219.9285	235.3613
Interest3	67	-143.1117	-102.6547	8	221.3094	238.9469
Interest4	67	-143.1117	-100.8193	9	219.6387	239.4809

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Income Models for the Change in Texas Home Price Index

```
. estimates stats ar4 Income1 Income2 Income3 Income4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718
Income1	41	-86.75893	-64.97823	6	141.9565	152.2379
Income2	41	-86.75893	-63.25073	7	140.5015	152.4965
Income3	41	-86.75893	-60.22651	8	136.453	150.1616
Income4	41	-86.75893	-59.7176	9	137.4352	152.8573

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

Unemployment Rate Models for the Change in Texas Home Price Index

```
. estimates stats ar4 UNRATE1 UNRATE2 UNRATE3 UNRATE4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar4	67	-143.1117	-103.5742	5	217.1483	228.1718
UNRATE1	67	-143.1117	-102.9356	6	217.8711	231.0993
UNRATE2	67	-143.1117	-102.8922	7	219.7845	235.2173
UNRATE3	67	-143.1117	-102.0898	8	220.1795	237.8171
UNRATE4	67	-143.1117	-101.6375	9	221.2749	241.1172

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

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