Analysis Report

Contents

Descriptive Statistics

This report starts with some descriptive statistics for the variables of interest. The tables below show the minimum and maximum values, the mean, standard deviation, skewness and kurtosis.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
UI in % (unexpected Inflation)	189	-0.011	0.009	0.000	0.002	-0.652	5.248
Unemployment variation (%)	338	-7.640	12.280	0.039	1.123	4.977	63.763
Real Risk Free Rate in %	324	-2.740	12.817	1.672	2.902	1.579	2.495
TERM in %	324	-1.769	4.964	0.780	0.992	1.158	2.728
Real GDP - normed to 100	338	87.075	138.393	107.831	8.176	0.913	1.103
CRE Price (ALL)	226	85.943	218.178	122.154	27.230	1.709	2.361
CRE Price (Retail)	128	72.108	110.389	95.314	11.506	-0.688	-0.773
CRE Price (Office)	102	86.455	149.547	113.594	17.232	0.595	-0.766
CRE Price (Industry)	76	80.899	135.824	102.779	14.859	0.416	-0.540
Valid N (listwise)	0						

Descriptive Statistics

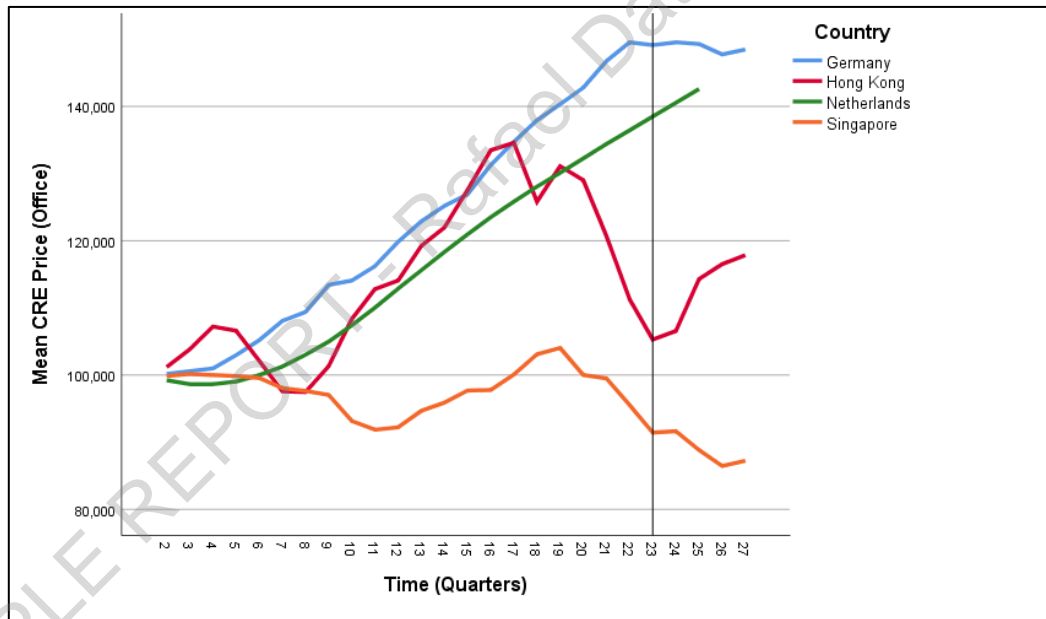|	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
WUI	526	0.047	1.922	0.243	0.184	2.694	14.952
EPU	486	61.479	459.830	152.700	65.139	1.549	2.789
Volatility	357	10.849	68.300	23.206	9.432	1.653	3.962
Business Confidence	432	94.715	103.968	100.014	1.524	-0.563	0.703
CRE Price (ALL)	441	65.669	293.123	119.881	52.040	2.031	3.115
CRE Price (Retail)	239	74.305	303.043	123.611	65.334	1.762	1.501
CRE Price (Office)	209	58.295	279.477	122.397	54.016	1.258	0.686
CRE Price (Industry)	157	50.17	172.36	98.996	33.939	0.927	-0.491
Valid N (listwise)	0						

In order to better visualize the evolution of the real estate prices over time (before and after the pandemic), the following line graphs were created. They show the prices from period 2 (1st Quarter, 2015) to period 27 (2nd Quarter, 2021). The vertical black line represents the second quarter of 2020, which is established as the cut-off point for the pandemic onset on this study. Period 1 was the fourth quarter of 2014, which was manually assigned a value of 100 (the following prices were normed to 100). This initial value was, therefore, not considered for the analyses, since it does not reflect a real phenomenon but it is rather a reference value.
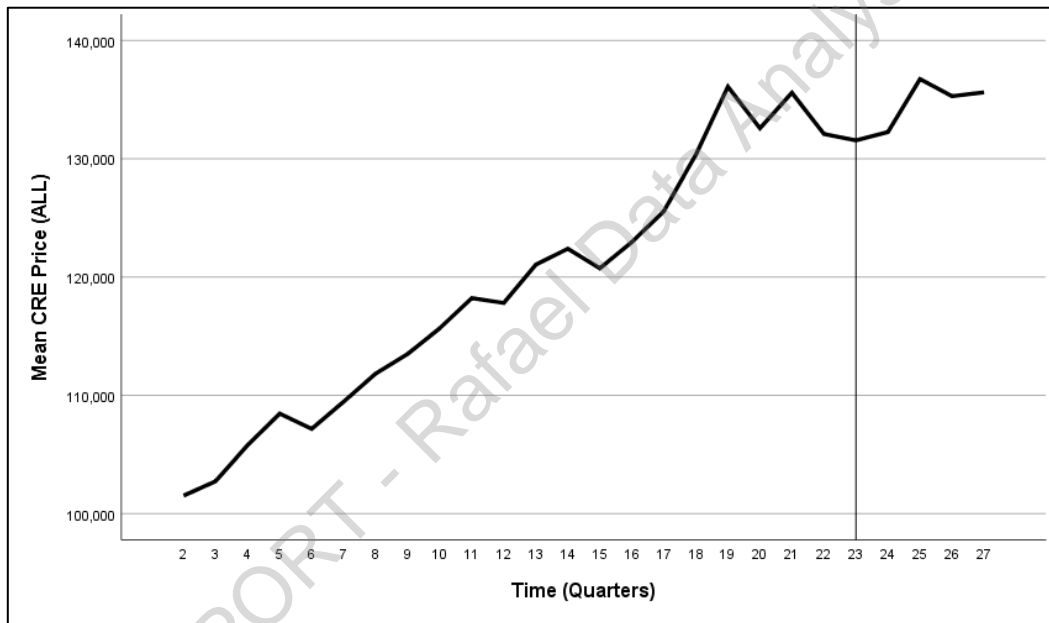
The graph below shows the price evolution per price category. While the overall and the office categories showed an increase in values. The industry prices remained fairly constant and the retail prices dropped on the period.

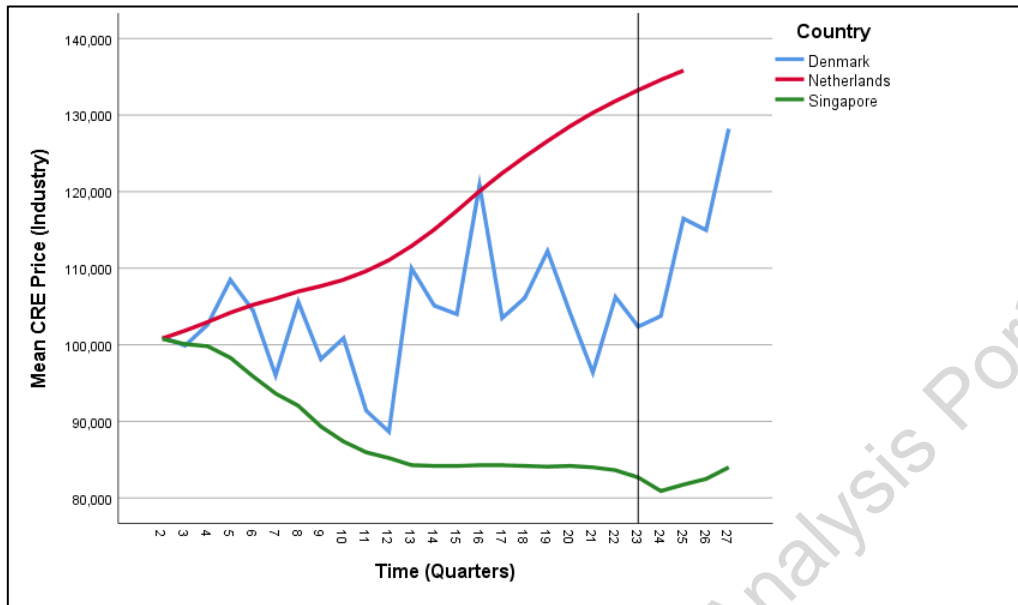The office prices show a fairly clear drop after the pandemic onset, while the pattern of the other prices is not very clear. The following four graphs show the price evolution for separate countries.

The correlation between macroeconomic variables and Real Estate Prices

The level of association between macroeconomic variables and price values was measures using cross-correlation analysis, which is used to measure correlations across time. Correlation coefficients are indicators of associations between variables (Pallant, 2010). Values between 0.10 and 0.29 indicate a small degree of association, while values between 0.30 and 0.49 are considered medium and values higher than 0.50 represent a high degree of association (Cohen, 1988).

There are several different statistics available, depending on the level of measurement and the nature of your data. Pearson' coefficient 'r' is designed for interval level (continuous) variables, whereas Spearman's 'rho' is designed for use with ordinal level or ranked data and is particularly useful when the data does not meet the criteria for Pearson correlation (Pallant, 2010). The Pearson's method was used in this analysis. A 'Covid Pandemic' variable was created to represent quarters when the pandemic was already in place. A value of 1 was assigned to second quarter of 2020 onwards, while the earlier periods were labelled as 0.

The correlation between macroeconomic variables and Real Estate Prices (all)

The table below shows the coefficients for different period lags. Correlations occurring on negative lags mean that a change on the macroeconomic variable (or covid pandemic) is associated with a change in prices on a **future** period, while correlation in positive lags mean that this relationship occurs on a **previous** period. For example, unemployment shows a moderate negative correlation with the price on lag 5, indicating that an increase on unemployment is associated with a decrease on the prices five quarters before (r =-.362). Perhaps a clearer conclusion is that a price decrease is associated with unemployment increase five quarters **after.** A strong negative correlation was measured between GDP and Prices at time lag 0, indicating these variables are strongly contemporaneously associated. The coefficient is positive, meaning that when GDP increases, the prices are expected to increase as well. The pandemic onset is weakly correlated with the prices on lag 0 (r = .223). That is, the onset of the pandemic (Pandemic = 1) is associated with an increase on the overall real estate prices.

Price (All) - Cross Correlation						
Lag	Unemployment in %	Inflation in %	Real Risk Free Rate in %	Term in %	Real GDP - normed to 100	Covid Pandemic	UI in % (unexpected Inflation)
-5	-0.057	0.110	-0.008	-0.069	0.380	0.265	-0.016
-4	-0.077	0.092	-0.013	-0.083	0.424	0.258	0.015
-3	-0.096	0.113	-0.022	-0.090	0.488	0.234	-0.021
-2	-0.122	0.121	-0.035	-0.100	0.550	0.234	0.022
-1	-0.147	0.082	-0.030	-0.115	0.607	0.220	-0.006
0	-0.174	0.079	-0.027	-0.117	0.666	0.223	0.025
1	-0.191	0.075	-0.007	-0.137	0.647	0.174	-0.030
2	-0.224	0.042	0.007	-0.150	0.623	0.095	-0.040
3	-0.265	0.014	0.024	-0.161	0.601	0.001	-0.028
4	-0.301	-0.006	0.043	-0.154	0.594	-0.081	0.015
5	-0.362	-0.009	0.052	-0.134	0.591	-0.158	-0.025

The correlation between macroeconomic variables and Real Estate Prices (retail)

This section presents the same information, but this time considering prices for retail. Unemployment is moderately correlated with the prices on lag 0 (r = .422). Term in % is strongly correlated with retail prices in various lags. This pattern of association was not observed for the overall prices. When the Term increases, the prices are expected to decrease. Unexpected inflation is poorly correlated with the prices.

	Price (Retail) - Cross Correlation					
Lag	Unemployment in %	Real Risk Free Rate in %	Term in %	Real GDP - normed to 100	Covid Pandemic	UI in % (unexpected Inflation)
-5	0.340	0.057	-0.536	-0.149	-0.140	-0.013
-4	0.389	-0.025	-0.532	-0.062	-0.132	0.011
-3	0.410	-0.127	-0.545	0.028	-0.115	0.046
-2	0.415	-0.159	-0.563	0.134	-0.115	0.011
-1	0.421	-0.085	-0.556	0.249	-0.139	0.051
0	0.422	-0.165	-0.518	0.363	-0.158	0.019
1	0.463	-0.197	-0.431	0.371	-0.153	-0.011
2	0.334	-0.167	-0.340	0.364	-0.166	-0.011
3	0.162	-0.119	-0.234	0.439	-0.175	-0.039
4	0.160	-0.166	-0.153	0.413	-0.074	0.032
5	0.115	-0.196	-0.092	0.340	0.041	0.027

The correlation between macroeconomic variables and Real Estate Prices (office)

For the prices related to office, the pattern of associations does not differ much from what was observed for retail (table below). The onset of the pandemic is poorly correlated to an increase in prices 5 quarters ahead (r = .187). Real Risk free rate is moderately associated with prices on lag 0 (r = - 0.280).

Price (Office) - Cross Correlation					
Lag	Unemployment in %	Real Risk Free Rate in %	Term in %	Real GDP - normed to 100	Covid Pandemic	UI in % (unexpected Inflation)
-5	0.300	-0.014	-0.504	-0.087	0.187	-0.064
-4	0.350	-0.100	-0.541	0.006	0.161	-0.002
-3	0.364	-0.210	-0.597	0.110	0.130	-0.005
-2	0.386	-0.252	-0.660	0.211	0.104	-0.022
-1	0.400	-0.194	-0.680	0.319	0.072	-0.040
0	0.400	-0.280	-0.644	0.440	0.054	-0.068
1	0.450	-0.238	-0.568	0.452	-0.014	0.024
2	0.362	-0.168	-0.468	0.473	-0.091	-0.059
3	0.226	-0.165	-0.341	0.525	-0.165	-0.084
4	0.190	-0.193	-0.222	0.502	-0.102	-0.044
5	0.111	-0.190	-0.094	0.534	-0.040	0.009

The correlation between macroeconomic variables and Real Estate Prices (industry)

The onset of the pandemic is poorly correlated with prices for industry, on all lag periods. The association between unemployment and the prices for industry is poor in most period lags, which is different from the other prices, where the correlation was moderate.

Price (Industry) - Cross Correlation					
Lag	Unemployment in %	Real Risk Free Rate in %	Term in %	Real GDP - normed to 100	Covid Pandemic	UI in % (unexpected Inflation)
-5	0.176	-0.054	-0.215	-0.048	-0.010	0.045
-4	0.213	-0.068	-0.249	-0.020	-0.001	0.020
-3	0.054	-0.172	-0.273	0.076	0.000	0.050
-2	0.159	-0.333	-0.312	0.192	0.001	0.002
-1	0.120	-0.205	-0.309	0.237	0.003	0.049
0	-0.040	-0.281	-0.328	0.360	0.009	0.021
1	0.225	-0.365	-0.240	0.327	-0.033	-0.047
2	0.046	-0.220	-0.178	0.289	-0.073	-0.016
3	-0.035	-0.280	-0.115	0.374	-0.119	-0.143
4	0.030	-0.313	-0.044	0.340	-0.058	0.029
5	-0.096	-0.341	-0.011	0.368	-0.003	-0.011

The effect of the pandemic and macroeconomic variables on Real Estate Prices

Multiple Regression analysis is a technique used to explore the relationships between a continuous dependent variable and two or more independent (or predictor) variables (Pallant, 2010). The objective of multiple regression analysis is to use the independent variables whose values are known to predict the single dependent value selected by the researcher. Each independent variable is weighted by the regression analysis procedure to ensure maximal prediction from the set of independent variables. The weights denote the relative contribution of the independent variables to the overall prediction and facilitate interpretation as to the influence of each variable in making the prediction, although correlation among the independent variables complicates the interpretative process. The set of weighted independent variables forms the regression variate, a linear combination of the independent variables that best predicts the dependent variable (Hair et al., 2014).

The sections below present the results of several models that were executed, including the tests of assumptions.

The effect of the pandemic onset on the overall real estate prices (with unexpected inflation)

The first tested model included the unexpected inflation as predictor variable. A second modelling approach is presented later without this variable. The excessive number of missing values on this variable reduces the sample size from 226 to 156, which justifies the evaluation of two models. The low correlations between unexpected inflation and prices presented earlier also provide evidence that the exclusion of this variable will not be harmful to the conclusions based on the model.

A hierarchical approach was used, with three models:

1. Time (quarters), the onset of the pandemic and fixed effects for countries;
2. The variables from model 1 with the inclusion of the macroeconomic variables;
3. The variables of models 1 and 2 with the inclusion of an interaction term for the pandemic onset and time (Pandemic Onset * Time). This was included to evaluate

if the effect of time on the prices while controlling for macroeconomic factors (the price evolution) depends on the existence of the pandemic or not. A significant interaction would provide evidence that the price evolution across time is significantly affected by the pandemic.

Next figure shows the R-squares for the models. This value means the total variance in prices that is explained by all the variables that were inserted in the model. Time and the pandemic explain 79.9% of the variance on prices. Model 2 explained 86.7% and Model 3: 87.7%. The change statistics illustrate whether the inclusion of the additional variables on each step significantly improved the explanatory power of the model (i.e. the R^2) or not. In this case, both steps led to a significant increase on the R^2 ($p < .05$).

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					F Change	Sig. F Change
1	0.894[a]	0.799	0.790	11.711	84.264	0.000
2	0.931[b]	0.867	0.856	9.699	14.559	0.000
3	0.937[c]	0.877	0.866	9.356	11.662	0.001

a. Predictors: (Constant), UnitedStates, Covid Pandemic, Japan, Iceland, Germany, Denmark, Time (Quarters)
b. Predictors: (Constant), UnitedStates, Covid Pandemic, Japan, Iceland, Germany, Denmark, Time (Quarters), UI in % (unexpected Inflation), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %
c. Predictors: (Constant), UnitedStates, Covid Pandemic, Japan, Iceland, Germany, Denmark, Time (Quarters), UI in % (unexpected Inflation), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %, Interaction Term: Time x Pandemic
d. Dependent Variable: CRE Price (ALL)

The ANOVA test for the models were all significant ($p < 0.05$) (table below), meaning that the models are valid and the regression coefficients can be interpreted.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80900.943	7	11557.278	84.264	0.000[b]
	Residual	20298.975	148	137.155		
	Total	101199.918	155			
2	Regression	87748.567	12	7312.381	77.737	0.000[c]
	Residual	13451.351	143	94.065		
	Total	101199.918	155			
3	Regression	88769.454	13	6828.420	78.005	0.000[d]
	Residual	12430.464	142	87.538		
	Total	101199.918	155			

a. Dependent Variable: CRE Price (ALL)

b. Predictors: (Constant), UnitedStates, Covid Pandemic, Japan, Iceland, Germany, Denmark, Time (Quarters)

c. Predictors: (Constant), UnitedStates, Covid Pandemic, Japan, Iceland, Germany, Denmark, Time (Quarters), UI in % (unexpected Inflation), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %

d. Predictors: (Constant), UnitedStates, Covid Pandemic, Japan, Iceland, Germany, Denmark, Time (Quarters), UI in % (unexpected Inflation), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %, Interaction Term: Time x Pandemic

Next, we look at beta coefficients and their significance (columns 'Beta' and 'Sig.', below).

A p-value (Sig,) of less than 0.05 indicated the model is significant at the 95% confidence level (or 5% significance level). This means that the regression variate (set of independent variables) has a significant effect on the outcome variable.

While the t-statistics is not directly interpretable (same as the F-statistic), the p-value represents the results of the significance test of the variable. Values below 0.05 represent statistical significance of the predictor. That is, the variable significantly influences the outcome variable. The beta coefficient refers to the absolute change in the outcome variable that happens for a one-unit change on the independent variable. So, negative beta coefficients indicate an inverse relationship between the variables, whereas positive values represent the opposite.

Without having any controlling macroeconomic variable, the effect of time ($\beta = 1.773$, $p < 0.001$) and the pandemic ($\beta = -7.938$, $p < 0.05$) on the overall price were significant. The effect of pandemic, in this case, was negative. This means that the onset of the pandemic makes the prices decrease. Nevertheless, when controlling for macroeconomic variables (Model 2), the effect of the pandemic itself is not significant ($p = .987$), which

indicates that the variation on the macroeconomic variables are the determinants for the price drop, not the pandemic in isolation. Particularly, the unemployment variation, Real Risk Free Rate and Real GDP (normed to 100) showed significant effects on the price ($p < .05$). TERM and Unexpected Inflation did not show any effect on prices. Time was still a significant predictor of prices ($\beta = .576$, $p < 0.05$), even controlling for macroeconomic variables.

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1 (Constant)	87.445	3.115		28.070	0.000		
Time (Quarters)	1.773	0.171	0.522	10.358	0.000	0.533	1.875
Covid Pandemic	-7.938	3.258	-0.123	-2.437	0.016	0.533	1.875
Denmark	-4.678	3.248	-0.068	-1.440	0.152	0.600	1.667
Germany	7.473	3.248	0.109	2.301	0.023	0.600	1.667
Iceland	54.319	3.248	0.795	16.723	0.000	0.600	1.667
Japan	2.268	3.248	0.033	0.698	0.486	0.600	1.667
UnitedStates	9.557	3.248	0.140	2.942	0.004	0.600	1.667
2 (Constant)	-83.508	32.261		-2.589	0.011		
Time (Quarters)	0.573	0.252	0.169	2.273	0.025	0.169	5.929
Covid Pandemic	0.062	3.752	0.001	0.017	0.987	0.276	3.626
Denmark	-8.378	3.411	-0.123	-2.456	0.015	0.373	2.680
Germany	9.039	4.062	0.132	2.225	0.028	0.263	3.800
Iceland	56.440	4.359	0.826	12.949	0.000	0.229	4.376
Japan	8.994	4.181	0.132	2.151	0.033	0.248	4.026
UnitedStates	12.619	2.977	0.185	4.239	0.000	0.490	2.041
Unemployment variation (%)	1.970	0.930	0.067	2.117	0.036	0.928	1.077
Real Risk Free Rate in %	-4.451	1.123	-0.315	-3.963	0.000	0.147	6.787
TERM in %	-0.740	2.089	-0.017	-0.354	0.724	0.418	2.392
Real GDP - normed to 100	1.753	0.312	0.407	5.626	0.000	0.178	5.620
UI in % (unexpected Inflation)	439.882	391.620	0.035	1.123	0.263	0.966	1.036
3 (Constant)	-105.550	31.784		-3.321	0.001		
Time (Quarters)	0.460	0.245	0.136	1.875	0.063	0.166	6.039
Covid Pandemic	-36.522	11.308	-0.565	-3.230	0.002	0.028	35.393
Denmark	-3.547	3.582	-0.052	-0.990	0.324	0.315	3.175
Germany	13.568	4.137	0.199	3.280	0.001	0.236	4.235
Iceland	44.695	5.432	0.654	8.228	0.000	0.137	7.303
Japan	12.974	4.198	0.190	3.090	0.002	0.229	4.362
UnitedStates	14.102	2.904	0.206	4.855	0.000	0.479	2.088

|							
Unemployment variation (%)	1.921	0.898	0.065	2.140	0.034	0.928	1.077
Real Risk Free Rate in %	-2.096	1.284	-0.148	-1.631	0.105	0.105	9.537
TERM in %	-1.532	2.028	-0.035	-0.755	0.451	0.413	2.424
Real GDP - normed to 100	1.948	0.306	0.452	6.366	0.000	0.172	5.822
UI in % (unexpected Inflation)	391.953	378.050	0.031	1.037	0.302	0.964	1.037
Interaction Term: Time x Pandemic	0.301	0.088	0.647	3.415	0.001	0.024	41.503

a. Dependent Variable: CRE Price (ALL)

The results of model 3 indicate that the pandemic is a significant moderator of the effect of time on the prices. Moderation refers to the effect in which a third independent variable (the moderator variable) causes the relationship between a dependent/independent variable pair to change, depending on the value of the moderator variable. It is also known as an interactive effect and is similar to the interaction effect seen in analysis of variance methods.

The interaction term was significant ($\beta = .301$, $p < 0.05$), which indicates that the evolution of prices across time significantly changed when the pandemic was present (from the second quarter of 2020 onwards).

The columns 'VIF' and 'Tolerance' are indicators of multicollinearity. Multicollinearity refers to an excessive correlation between independent variables. When the values of Variance Inflation Factors (VIFs) are below 10.0, multicollinearity can be assumed to be absent (Hair et al., 2014). The only value above 10 is demonstrated between the interaction factor and 'Covid Pandemic', which is expected since the interaction term is a direct transformation of the 'Pandemic' variable.

Lastly, violations of the assumptions of normality, linearity and homoscedasticity of residuals (errors) were examined for the regression model. The next figure shows a P-P plot, which is used to assess the normality of residuals. The observations should follow a diagonal pattern to suggest normality of residuals (Tabachnick and Fidell, 2014).
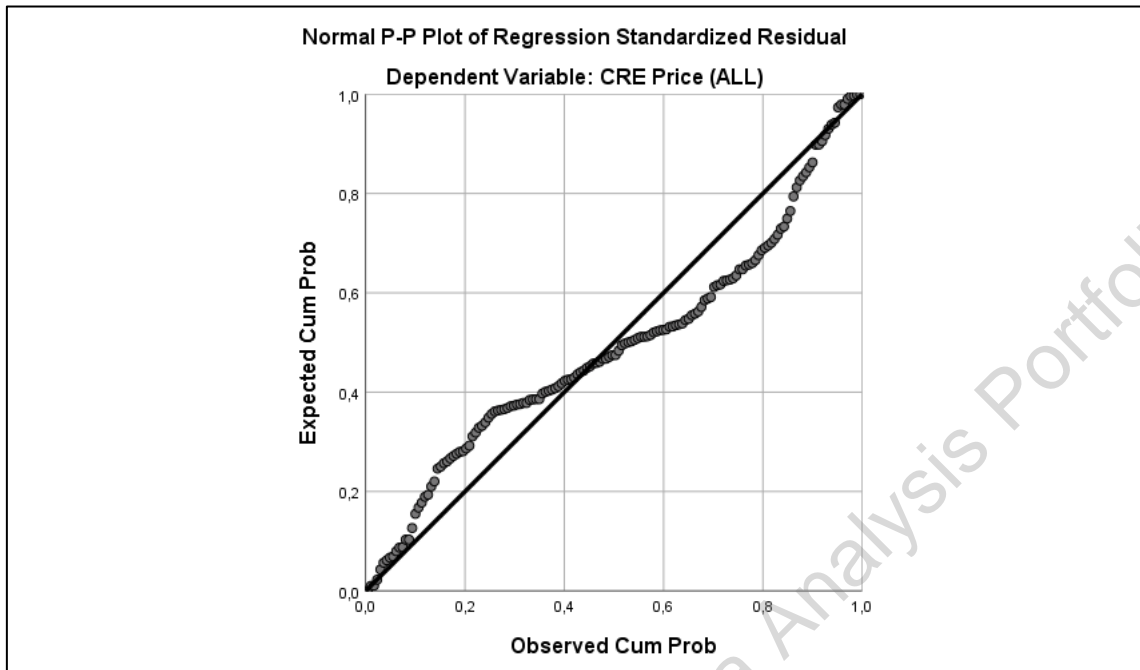
The graph suggests that a small degree of non-normality might be present on the residuals. An additional histogram of residuals was plotted, which shows a figure that is close to a bell-curve, which indicates that there are no substantial departs from normality.
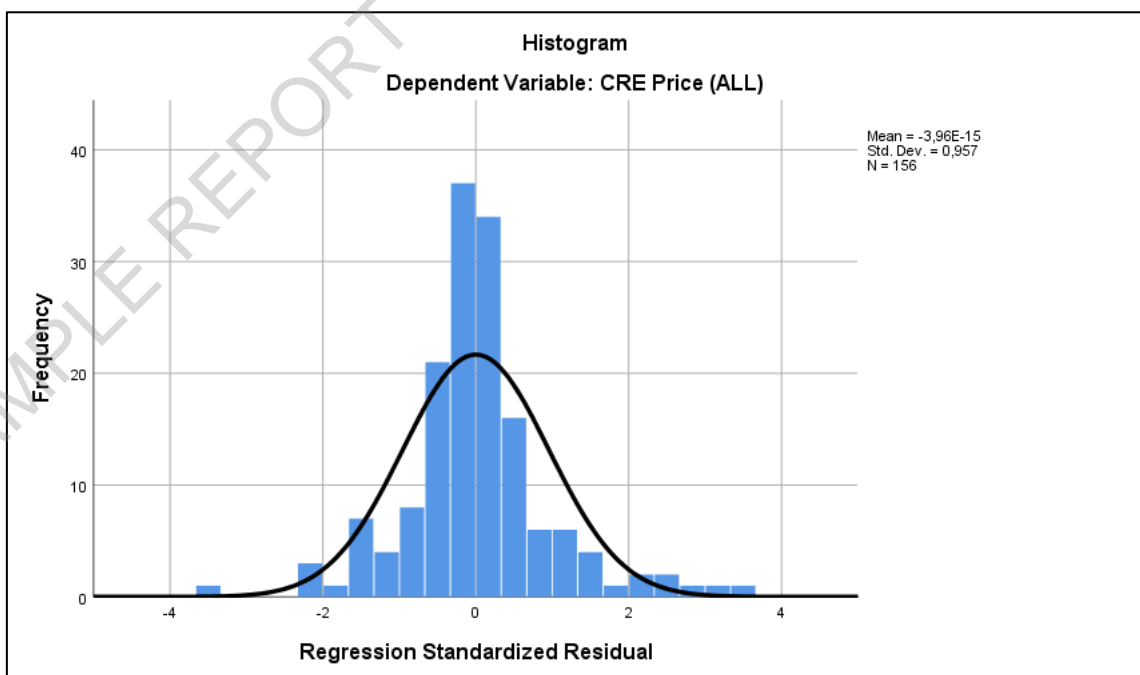
The next figure shows a scatterplot of standardized residuals and standardized predicted values of the dependent variable. If points are well distributed along the X and Y axes, this would suggest homoscedasticity and linearity. Nonlinearity is indicated when most of the residuals are above the zero line on the plot at some predicted values and below the zero line at other predicted values. Lack of homoscedasticity is indicated if values are more dispersed for a given predicted values than at other values (Tabachnick and Fidell, 2014).
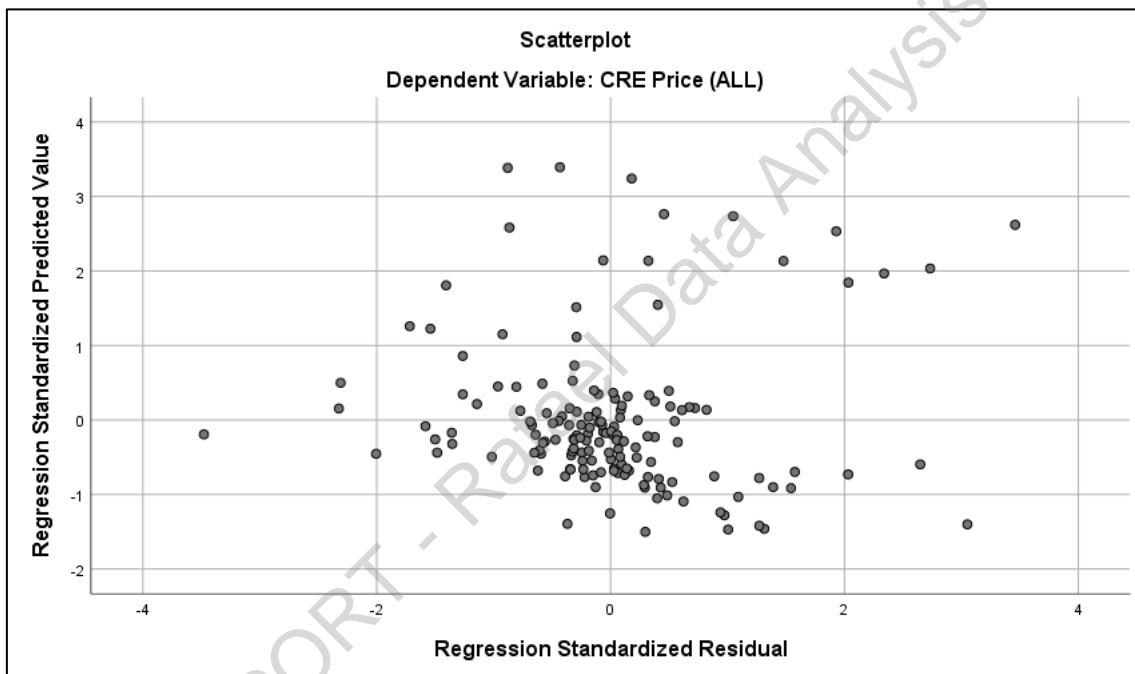
The figure shows that some degree of lack of homoscedasticity might be present for the model, which needs to be taken in consideration when examining the results.

Hierarchical models – without unexpected inflation

The exact same models were executed for a larger sample size (without unexpected inflation) and the results are shown here.

Similarly to the first model, the change on the R-squares are significant (table below).

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					F Change	Sig. F Change
1	0.855[a]	0.731	0.718	14.448	58.414	0.000
2	0.909[b]	0.827	0.816	11.695	29.285	0.000
3	0.935[c]	0.874	0.865	10.010	78.012	0.000

a. Predictors: (Constant), UnitedStates, Covid Pandemic, Indonesia, SouthKorea, Japan, Brazil, Iceland, Denmark, Germany, Time (Quarters)
b. Predictors: (Constant), UnitedStates, Covid Pandemic, Indonesia, SouthKorea, Japan, Brazil, Iceland, Denmark, Germany, Time (Quarters), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %
c. Predictors: (Constant), UnitedStates, Covid Pandemic, Indonesia, SouthKorea, Japan, Brazil, Iceland, Denmark, Germany, Time (Quarters), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %, Interaction Term: Time x Pandemic
d. Dependent Variable: CRE Price (ALL)

All three models are valid according to the F-tests ($p < .05$).

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	121943.569	10	12194.357	58.414	0.000[b]
1	Residual	44883.099	215	208.759		
	Total	166826.668	225			
	Regression	137966.186	14	9854.728	72.048	0.000[c]
2	Residual	28860.481	211	136.780		
	Total	166826.668	225			
	Regression	145783.434	15	9718.896	96.989	0.000[d]
3	Residual	21043.234	210	100.206		
	Total	166826.668	225			

a. Dependent Variable: CRE Price (ALL)
b. Predictors: (Constant), UnitedStates, Covid Pandemic, Indonesia, SouthKorea, Japan, Brazil, Iceland, Denmark, Germany, Time (Quarters)
c. Predictors: (Constant), UnitedStates, Covid Pandemic, Indonesia, SouthKorea, Japan, Brazil, Iceland, Denmark, Germany, Time (Quarters), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %

d. Predictors: (Constant), UnitedStates, Covid Pandemic, Indonesia, SouthKorea, Japan, Brazil, Iceland, Denmark, Germany, Time (Quarters), Unemployment variation (%), TERM in %, Real GDP - normed to 100, Real Risk Free Rate in %, Interaction Term: Time x Pandemic

Different from the model where unexpected inflation was present, the pandemic now shows a significant positive effect on prices while controlling for the macroeconomic variables (Model 2) (β = 10.520, p < 0.01). The interaction effect remains significant (β = .453, p < 0.001), meaning that the effect of time on prices depends on the pandemic.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	121.172	3.597		33.685	0.000		
	Time (Quarters)	1.788	0.179	0.489	9.966	0.000	0.521	1.920
	Covid Pandemic	-7.074	3.305	-0.104	-2.141	0.033	0.530	1.886
	Brazil	-48.987	4.007	-0.575	-12.224	0.000	0.565	1.770
	Denmark	-38.788	4.007	-0.456	-9.679	0.000	0.565	1.770
	Germany	-26.637	4.007	-0.313	-6.647	0.000	0.565	1.770
	Iceland	20.209	4.007	0.237	5.043	0.000	0.565	1.770
	Indonesia	-35.896	4.466	-0.358	-8.038	0.000	0.632	1.583
	Japan	-31.842	4.007	-0.374	-7.946	0.000	0.565	1.770
	SouthKorea	-34.110	4.007	-0.401	-8.512	0.000	0.565	1.770
	UnitedStates	-24.554	4.007	-0.288	-6.127	0.000	0.565	1.770
2	(Constant)	-90.953	25.348		-3.588	0.000		
	Time (Quarters)	0.175	0.232	0.048	0.757	0.450	0.205	4.886
	Covid Pandemic	10.520	3.206	0.155	3.282	0.001	0.369	2.708
	Brazil	9.475	8.274	0.111	1.145	0.253	0.087	11.517
	Denmark	-27.634	5.706	-0.325	-4.842	0.000	0.183	5.478
	Germany	-9.110	6.257	-0.107	-1.456	0.147	0.152	6.586
	Iceland	21.950	3.965	0.258	5.535	0.000	0.378	2.645
	Indonesia	-32.609	4.356	-0.325	-7.487	0.000	0.435	2.298
	Japan	-12.437	6.466	-0.146	-1.923	0.056	0.142	7.034
	SouthKorea	-23.309	4.749	-0.274	-4.908	0.000	0.264	3.793
	UnitedStates	-6.100	5.030	-0.072	-1.213	0.227	0.235	4.257
	Unemployment variation (%)	1.829	0.642	0.085	2.851	0.005	0.928	1.078
	Real Risk Free Rate in %	-1.816	0.865	-0.203	-2.099	0.037	0.088	11.382
	TERM in %	-6.591	1.441	-0.267	-4.574	0.000	0.240	4.170
	Real GDP - normed to 100	2.071	0.227	0.715	9.111	0.000	0.133	7.521
3	(Constant)	-92.266	21.697		-4.253	0.000		
	Time (Quarters)	0.313	0.199	0.085	1.572	0.117	0.203	4.916

Covid Pandemic	-50.832	7.468	-0.747	-6.806	0.000	0.050	20.061
Brazil	9.087	7.082	0.107	1.283	0.201	0.087	11.518
Denmark	-14.704	5.099	-0.173	-2.884	0.004	0.168	5.970
Germany	1.828	5.497	0.021	0.333	0.740	0.144	6.938
Iceland	23.290	3.397	0.274	6.855	0.000	0.377	2.650
Indonesia	-28.426	3.758	-0.283	-7.564	0.000	0.428	2.335
Japan	-0.165	5.706	-0.002	-0.029	0.977	0.134	7.477
SouthKorea	-13.890	4.202	-0.163	-3.306	0.001	0.247	4.054
UnitedStates	1.724	4.396	0.020	0.392	0.695	0.225	4.437
Unemployment variation (%)	1.656	0.550	0.077	3.013	0.003	0.926	1.079
Real Risk Free Rate in %	-0.460	0.756	-0.051	-0.608	0.544	0.084	11.872
TERM in %	-4.014	1.267	-0.163	-3.167	0.002	0.227	4.403
Real GDP - normed to 100	1.961	0.195	0.677	10.059	0.000	0.132	7.552
Interaction Term: Time x Pandemic	0.453	0.051	0.928	8.832	0.000	0.054	18.359

a. Dependent Variable: CRE Price (ALL)

The assumptions related to the regression residuals are similar to the previous model. A small degree of non-normality is present, as well as a small degree of lack of homoscedasticity (figures below).

Histogram
Dependent Variable: CRE Price (ALL)

Mean = 1,04E-14
Std. Dev. = 0,966
N = 226

Scatterplot
Dependent Variable: CRE Price (ALL)
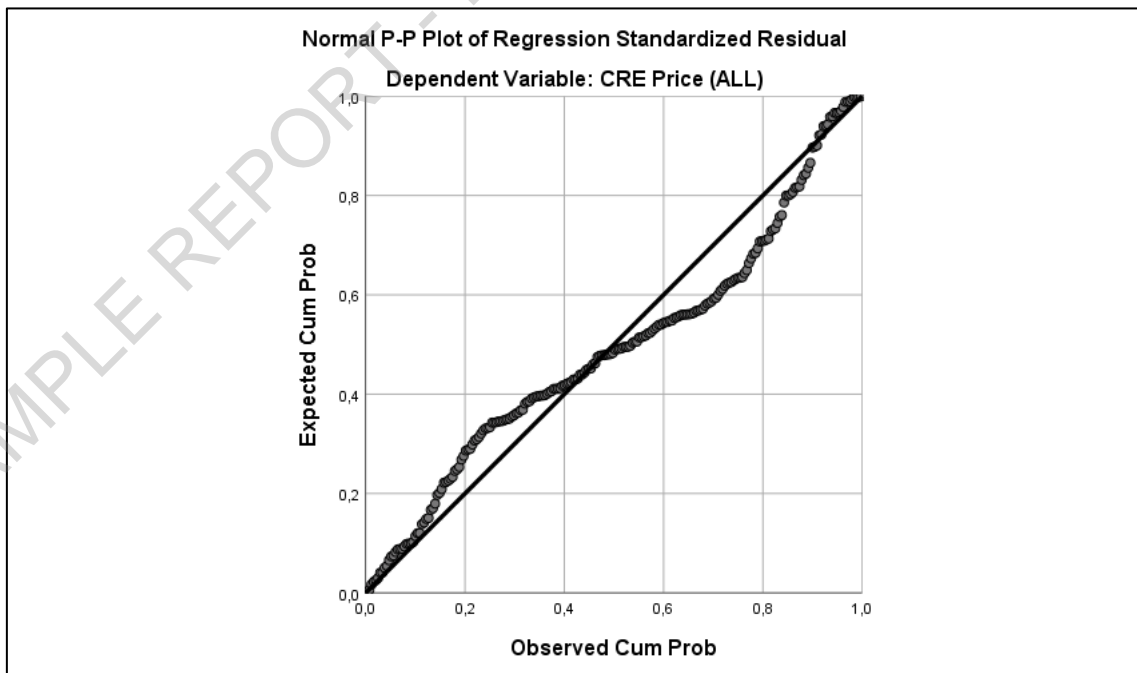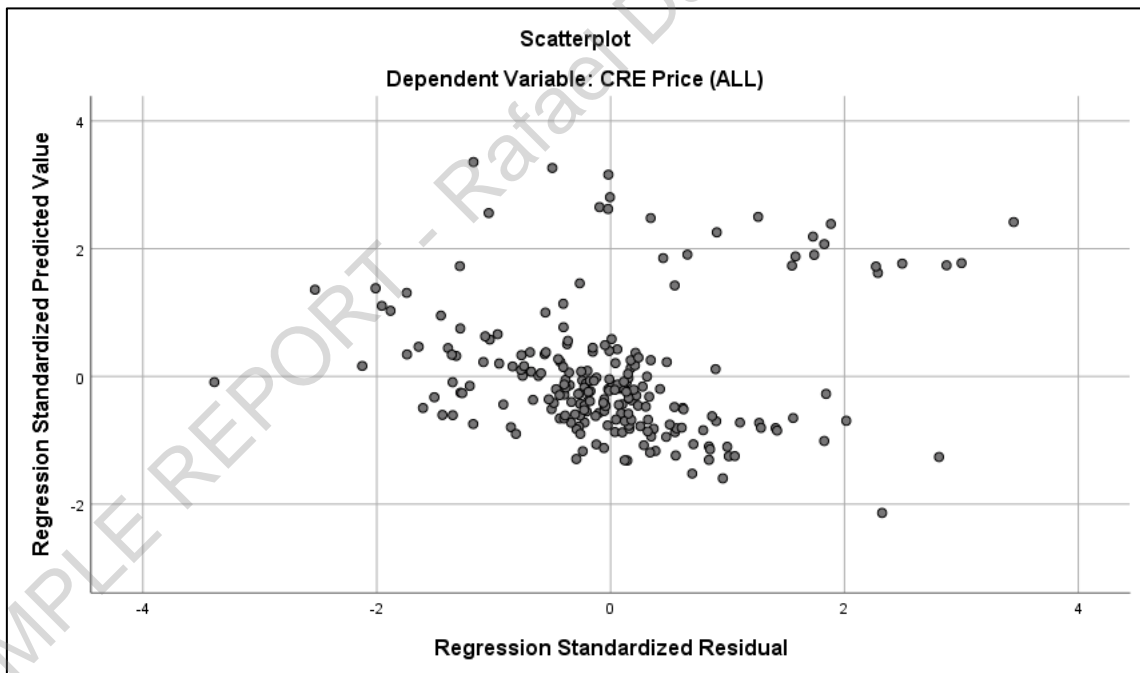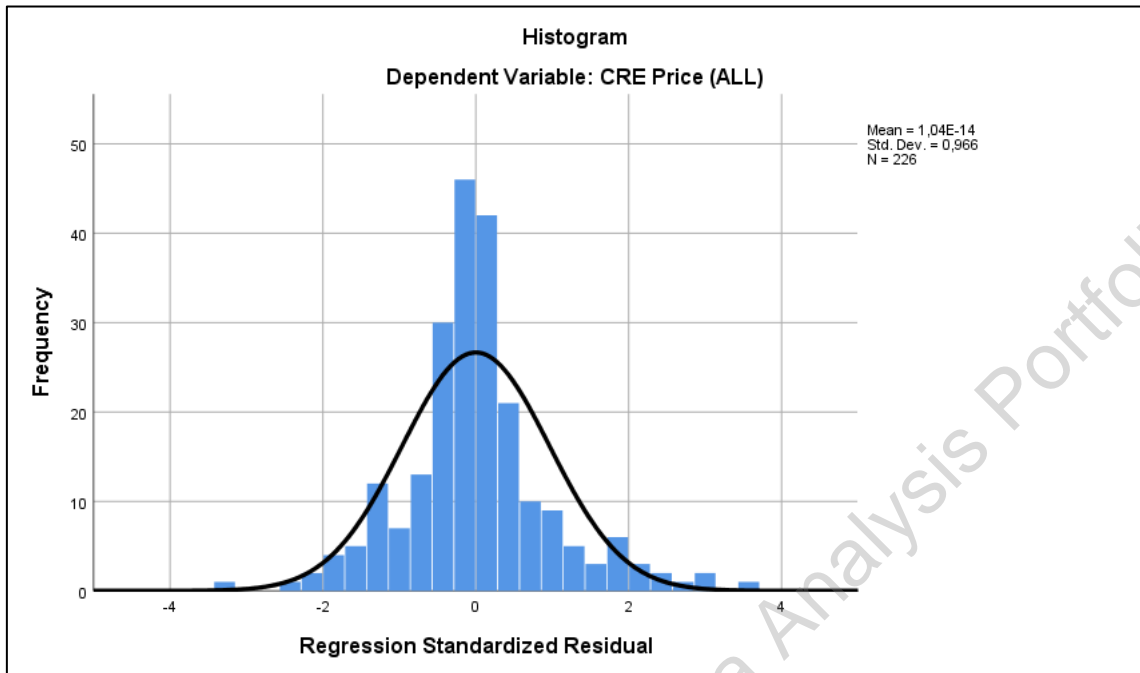
The correlations between uncertainty measure and Real Estate prices

This section presents the results of cross-correlations that were measured between the price variables and the uncertainty measures. The table below shows the coefficients for the overall price.

Price (All) - Cross Correlation				
Lag	WUI	EPU	Volatility	Business Confidence
-5	0.103	0.218	-0.085	0.010
-4	0.097	0.207	-0.099	0.020
-3	0.104	0.209	-0.164	0.062
-2	0.103	0.231	-0.186	0.064
-1	0.107	0.231	-0.241	0.111
0	0.091	0.265	-0.319	0.114
1	0.068	0.159	-0.351	0.193
2	0.022	0.170	-0.392	0.236
3	0.003	0.102	-0.404	0.292
4	-0.059	0.074	-0.401	0.316
5	-0.099	0.064	-0.381	0.326

Volatility showed the highest correlation with prices, especially 3 quarters before the price. So, a variation in price is associated with a moderate variation in volatility 3 quarters later. The relationship is negative, which means that when price increases, volatility is expected to decrease, and vice versa. EPU is also moderately correlated with price, but positively. They are contemporaneously associated (lag 0). Business Confidence shows a moderate association with price at lag 5 (five quarters before the change on price). Table below shows the coefficients for retail.

Price (Retail) - Cross Correlation				
Lag	WUI	EPU	Volatility	Business Confidence
-5	0.151	0.661	-0.088	-0.039
-4	0.117	0.662	-0.061	-0.040
-3	0.106	0.674	-0.068	-0.032

Lag	WUI	EPU	Volatility	Business Confidence
-2	0.115	0.687	-0.025	-0.022
-1	0.142	0.684	-0.057	0.000
0	0.109	0.696	-0.020	0.024
1	0.099	0.637	-0.044	0.052
2	0.073	0.606	-0.041	0.109
3	0.071	0.574	-0.054	0.135
4	0.003	0.544	-0.052	0.155
5	-0.052	0.526	-0.038	0.164

EPU is strongly associated with retail prices at lag 0 (r = .696), while the other three measures show weak associations. The table below shows the results for office prices.

Price (Office) - Cross Correlation				
Lag	WUI	EPU	Volatility	Business Confidence
-5	0.193	0.593	-0.084	-0.052
-4	0.164	0.604	-0.087	-0.037
-3	0.174	0.635	-0.097	-0.005
-2	0.197	0.648	-0.096	0.027
-1	0.222	0.677	-0.112	0.065
0	0.231	0.705	-0.127	0.101
1	0.183	0.608	-0.161	0.148
2	0.165	0.590	-0.149	0.214
3	0.156	0.534	-0.141	0.255
4	0.076	0.511	-0.126	0.285
5	-0.018	0.493	-0.085	0.300

A similar pattern is shown for office prices, compared to retail. EPU is also strongly associated with these prices. WUI shows a moderate correlation at lag 0 (r = .231).

With regards to prices for industry, the association with EPU is now only moderate and at lag -4 and -5. This means that an increase on EPU would only be associated with a decrease on prices 4 or 5 quarters later. Business Confidence, however, shows a strong negative association with industry prices at lags -2 and -4.

Price (Industry) - Cross Correlation				
Lag	WUI	EPU	Volatility	Business Confidence

-5	0.116	0.336	-0.150	-0.304
-4	0.118	0.250	-0.088	-0.452
-3	0.103	0.186	-0.221	-0.190
-2	0.226	0.229	-0.065	-0.400
-1	0.197	0.062	-0.175	-0.042
0	0.142	0.002	0.071	-0.202
1	0.110	-0.200	0.021	0.099
2	-0.003	-0.265	0.220	0.048
3	0.133	-0.355	0.157	0.171
4	-0.016	-0.418	0.260	0.240
5	0.056	-0.403	0.275	0.247

The effect of uncertainty measures on Real Estate prices (Pre-Pandemic)

A regression model was executed to examine the effect/impact of the uncertainty measures on the overall real estate prices, only considering the pre-pandemic period (until first quarter of 2020). The resulting model was valid, $F(9) = 70.303$, $p < .001$, and explained 76.8% of the prices (tables below).

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.876[a]	0.768	0.757	7.508

a. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Germany, South Korea, EPU, Brazil, Volatility
b. Dependent Variable: CRE Price (ALL)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35666.694	9	3962.966	70.303	0.000[b]
	Residual	10766.593	191	56.370		
	Total	46433.287	200			

a. Dependent Variable: CRE Price (ALL)
b. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Germany, South Korea, EPU, Brazil, Volatility
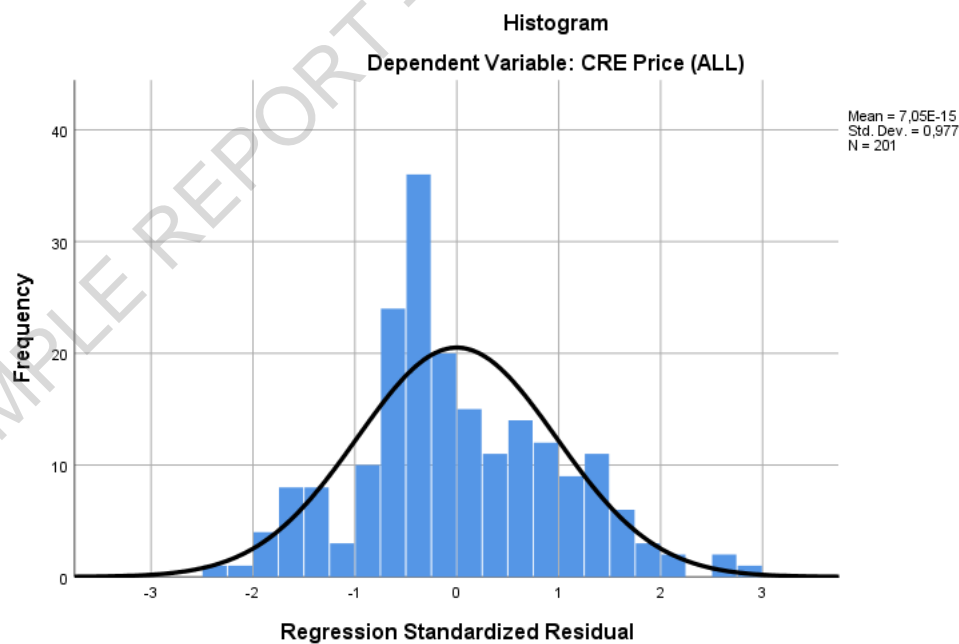
The countries were coded as dummy variables and included as fixed effects on the model. Only Business Confidence was a significant predictor of the price, while controlling for time ($\beta = -1.019$, $p < .05$) (table below).
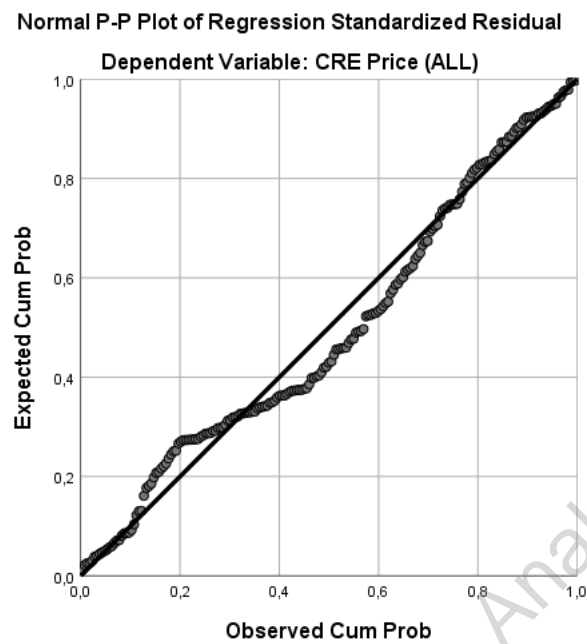
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	172.007	50.898		3.379	0.001		
	Time periods	0.788	0.049	0.690	16.201	0.000	0.670	1.493
	WUI	1.995	2.689	0.030	0.742	0.459	0.753	1.328
	EPU	0.010	0.011	0.041	0.913	0.362	0.594	1.683
	Volatility	-0.022	0.081	-0.014	-0.267	0.789	0.439	2.279
	Business Confidence	-1.019	0.498	-0.093	-2.047	0.042	0.587	1.704
	Brazil	-7.951	2.074	-0.194	-3.833	0.000	0.475	2.105
	Germany	18.857	1.757	0.509	10.730	0.000	0.540	1.852
	South Korea	12.675	1.987	0.320	6.379	0.000	0.483	2.069
	United States	2.930	1.713	0.082	1.711	0.089	0.534	1.874

a. Dependent Variable: CRE Price (ALL)

An examination of the residuals show that they have a small degree of non-normality (figures below).

Histogram
Dependent Variable: CRE Price (ALL)

Mean = 7,05E-15
Std. Dev. = 0,977
N = 201

Normal P-P Plot of Regression Standardized Residual

Dependent Variable: CRE Price (ALL)

The assumption of homoscedasticity seems to hold for this model, as the residual points are nicely spread across the graph shown in the figure below.

Scatterplot

Dependent Variable: CRE Price (ALL)
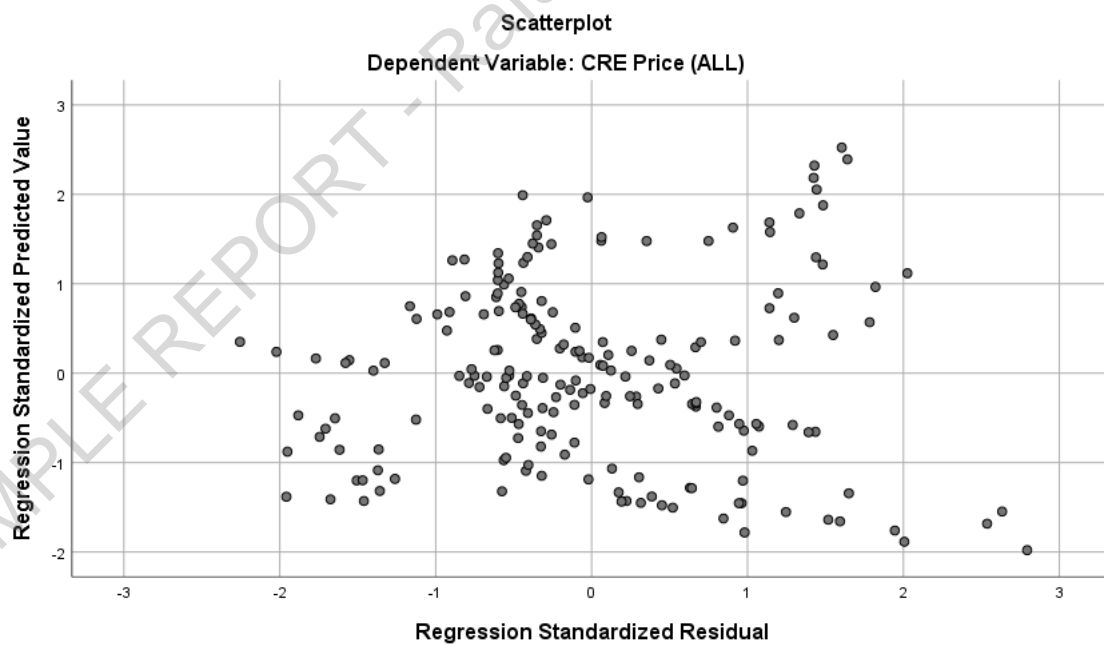
The effect of uncertainty measures on Real Estate prices (whole period)

The model was executed again for the whole Covid period, following a hierarchical fashion. Model 1 included time, the uncertainty measures and the countries' fixed effects. Model 2 added the pandemic period as predictor (a dummy variable) and model 3 evaluated whether the effect of EPU was moderated by the covid pandemic.

All three models were significant ($p < .001$) and explained between 77.9% and 78.5% of the variance on the overall price (tables below). From model 2 to model 3, there was a significant increase on the R^2 ($p = .019$), indicating that the examined moderation might be occurring to some extent.

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					F Change	Sig. F Change
1	0.883[a]	0.779	0.770	8.110	83.552	0.000
2	0.883[b]	0.779	0.769	8.126	0.163	0.687
3	0.886[c]	0.785	0.774	8.039	5.619	0.019

a. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Japan, Volatility, Germany, EPU, Brazil
b. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Japan, Volatility, Germany, EPU, Brazil, Pandemic
c. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Japan, Volatility, Germany, EPU, Brazil, Pandemic, Interaction_Pandemic_X_EPU
d. Dependent Variable: CRE Price (ALL)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	49463.069	9	5495.897	83.552	0.000[b]
	Residual	14010.689	213	65.778		
	Total	63473.758	222			
2	Regression	49473.834	10	4947.383	74.918	0.000[c]
	Residual	13999.924	212	66.037		
	Total	63473.758	222			
3	Regression	49836.964	11	4530.633	70.102	0.000[d]
	Residual	13636.795	211	64.629		
	Total	63473.758	222			

a. Dependent Variable: CRE Price (ALL)
b. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Japan, Volatility, Germany, EPU, Brazil

c. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Japan, Volatility, Germany, EPU, Brazil, Pandemic
d. Predictors: (Constant), United States, Business Confidence, WUI, Time periods, Japan, Volatility, Germany, EPU, Brazil, Pandemic, Interaction_Pandemic_X_EPU

The table below shows the models' coefficients. EPU was a significant predictor of prices in Model 1 (β = .028, p < .001), while the other three uncertainty measures were not. This means that an increase of one-unit on EPU is expected to increase the overall real estate prices by 0.028 (normed to 100). When the effects are controlled for the onset of the pandemic (Model 2), the effect of EPU is still present (β = .029, p < .01). The pandemic itself does not show a significant effect on prices while controlling for the uncertainty measures (p > .05). The EPU measure was selected to be tested in Model 3 since it was the only significant predictor of prices overall. The results of Model 3 indicate that there is an interaction effect occurring between EPU and the pandemic as the product term was significant (β = .053, p < .01). This indicates that the effect of EPU on prices changes from the pre to the post pandemic periods.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	154.342	47.592		3.243	0.001		
	Time periods	0.749	0.044	0.652	17.054	0.000	0.710	1.409
	WUI	4.082	2.724	0.054	1.499	0.135	0.812	1.232
	EPU	0.028	0.011	0.114	2.666	0.008	0.564	1.772
	Volatility	-0.080	0.080	-0.047	-0.997	0.320	0.457	2.188
	Business Confidence	-0.723	0.472	-0.062	-1.532	0.127	0.636	1.572
	Brazil	-23.438	2.424	-0.522	-9.668	0.000	0.355	2.817
	Germany	6.562	1.957	0.160	3.354	0.001	0.456	2.192
	Japan	-13.090	2.005	-0.316	-6.527	0.000	0.441	2.268
	United States	-8.947	1.789	-0.223	-5.000	0.000	0.522	1.915
2	(Constant)	152.949	47.810		3.199	0.002		
	Time periods	0.760	0.052	0.661	14.657	0.000	0.511	1.956
	WUI	3.766	2.839	0.049	1.326	0.186	0.750	1.334
	EPU	0.029	0.011	0.115	2.681	0.008	0.562	1.779
	Volatility	-0.070	0.085	-0.041	-0.822	0.412	0.414	2.418
	Business Confidence	-0.713	0.474	-0.061	-1.505	0.134	0.634	1.576
	Brazil	-23.591	2.459	-0.526	-9.595	0.000	0.347	2.886
	Germany	6.518	1.963	0.159	3.320	0.001	0.455	2.199
	Japan	-13.145	2.014	-0.318	-6.527	0.000	0.439	2.279

United States	-8.962	1.793	-0.223	-4.998	0.000	0.522	1.915
Pandemic	-0.953	2.361	-0.017	-0.404	0.687	0.598	1.673
3 (Constant)	168.777	47.767		3.533	0.001		
Time periods	0.777	0.052	0.676	15.001	0.000	0.501	1.995
WUI	3.906	2.810	0.051	1.390	0.166	0.749	1.334
EPU	0.017	0.012	0.069	1.471	0.143	0.464	2.156
Volatility	-0.076	0.084	-0.045	-0.901	0.369	0.413	2.420
Business Confidence	-0.857	0.473	-0.073	-1.813	0.071	0.624	1.603
Brazil	-23.300	2.435	-0.519	-9.567	0.000	0.346	2.893
Germany	6.407	1.943	0.156	3.298	0.001	0.454	2.200
Japan	-13.075	1.993	-0.316	-6.562	0.000	0.439	2.279
United States	-9.369	1.782	-0.233	-5.257	0.000	0.517	1.933
Pandemic	-12.241	5.304	-0.216	-2.308	0.022	0.116	8.631
Interaction_Pandemic_X_EPU	0.053	0.022	0.223	2.370	0.019	0.115	8.683

a. Dependent Variable: CRE Price (ALL)

The graph below helps visualizing the relationship between EPU and prices before and after the pandemic. The blue dots represent the data points before the pandemic, while the red dots represent the post period. The lines are bivariate linear trends generated by SPSS. The graph shows that while the relationship is positive for the pre-pandemic period (ascending line), it is actually negative for the post period. This indicates that EPU had a negative impact on prices before the pandemic but a positive impact after its onset.
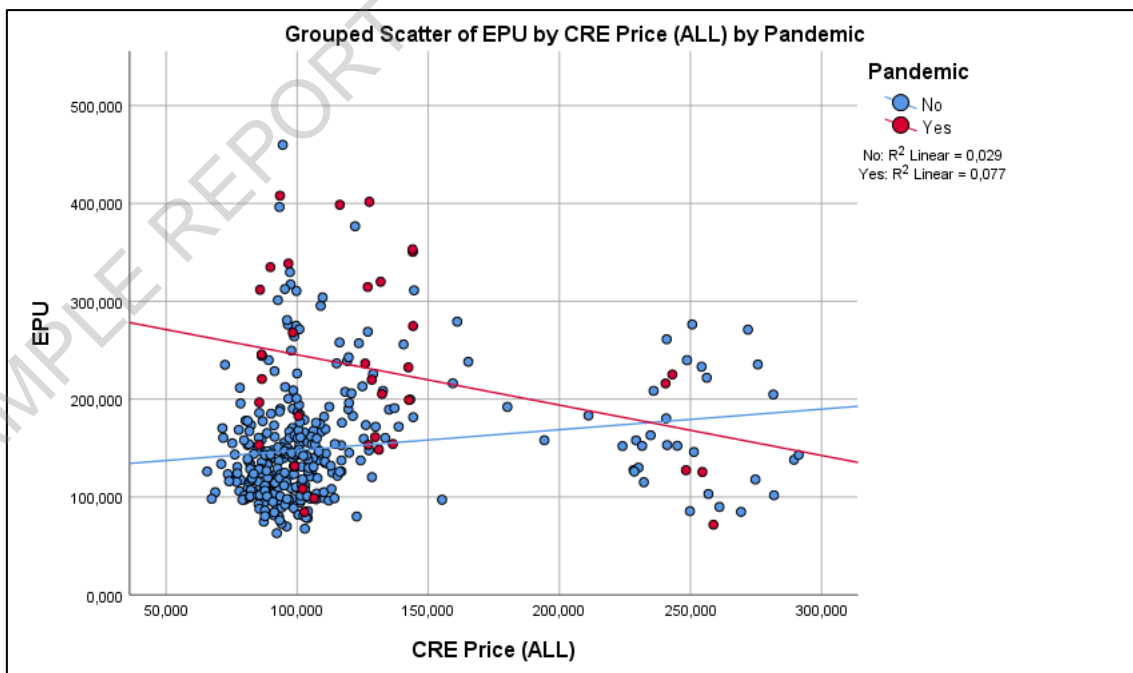
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