**Note on the Commercial Property Price Index Forecasts**

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Moody's Analytics has added six new U.S. commercial property price indexes to its global macroeconomic model. The historical data were estimated by Moody's Analytics using sales transactions. A whitepaper accompanies the release of these proprietary CPPIs that describes the construction of the indexes in great detail. While we have not removed the RCA CPPIs from the global model, these new proprietary indexes are very much intended to be their replacement. We have not received historical data updates for the RCA series since June of 2017; they have been forecasted ever since. The Moody's CPPIs have a similar historical pattern to the RCA series and will be updated continuously by Moody's Analytics. Lastly, all linkages between the RCA series and the rest of the model have been severed. Series that previously referenced RCA regressors now reference Moody's CPPI variables instead.

Commercial property prices are determined in large part by models of discounted future cash flows. As such, they depend on commercial rents and interest rates. Rents, in turn, are a function of vacancy rates for the particular property type. And vacancy rates are a function of absorption and supply. Absorption is a function of the demand side of the economy. Variables such as employment growth, the unemployment rate, retail sales, and income growth are all positively correlated with absorption. The supply side is influenced by factors such as the rate of inflation, growth in construction costs, and the vacancy rate. If construction costs are growing at a slow rate or if the office market is exceptionally tight, however, commercial developers would be expected to bring more building supply online. There are six new CPPI Indexes:

1. FCPPAPTI.IUSA – Apartments
2. FCPPINDI.IUSA – Industrial
3. FCPPOFFI.IUSA – Office
4. FCPPRETI.IUSA – Retail
5. FCPPCOMI.IUSA – Commercial
6. FCPPI.IUSA – Total

In terms of the apartment CPPI, we had median asking rents and the rental vacancy rate available at our disposal. These terms represent the intersection of the supply and demand sides of the multi-family market. As such, we used these two variables, combined with the BAA spread with the 10-year Treasury to forecast apartment prices. The interest rate term was used because, as mentioned earlier, future cash flows are discounted.

We did not have vacancy rates or median asking rent for the industrial, office or retail sectors, however. As such, we used reduced-form models to forecast these time series. For instance, the industrial property price index relies on the unemployment rate and manufacturing GDP to proxy for the rate of industrial real estate absorption. We include the CPI index on the left hand side of the equation to capture supply side constraints. And finally, we use a corporate spread to discount future cash flows in the same way that we do for apartments.

For the office CPPI, we also don't have vacancy rates or rents. We use office-using employment instead of manufacturing GDP to proxy office absorption. We retain the unemployment rate. We also use office construction put in place to proxy the supply side of the office market. And lastly, we use the same corporate spread measure.

The retail CPPI uses retail employment, the unemployment rate, and a corporate spread measure in the absence of retail rents and vacancy rates.

The commercial measure does not include apartments, and thus is a function of the retail, industrial and office components. Total is then a function of the commercial and apartment CPPIs. All dependent variables are non-stationary if they are not transformed. We used differenced log transformations to ensure stationarity in our regressions.

**Equation specifications**

Dependent Variable: DLOG(FCPPAPTI_US)
Method: Least Squares
Date: 09/25/19 Time: 16:43
Sample (adjusted): 2002Q2 2019Q1
Included observations: 68 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(@MOVAV(FHRENTQ_US,4)) | 0.862061 | 0.289443 | 2.978341 | 0.0041 |
| D(@MOVAV(FHVACRQ_US,4)) | -0.116037 | 0.026114 | -4.443441 | 0.0000 |
| D(@MOVAV(FRBAAC_US-FRGT10Y_US,4)) | -0.064366 | 0.017178 | -3.747009 | 0.0004 |

| | | | |
|---|---|---|---|
| R-squared | 0.272480 | Mean dependent var | 0.013397 |
| Adjusted R-squared | 0.250095 | S.D. dependent var | 0.037277 |
| S.E. of regression | 0.032281 | Akaike info criterion | -3.985563 |
| Sum squared resid | 0.067734 | Schwarz criterion | -3.887643 |
| Log likelihood | 138.5091 | Hannan-Quinn criter. | -3.946764 |
| Durbin-Watson stat | 1.718627 | | |

Mnemonics referenced in the above equation, for example FET, can be defined using the Mnemonic 411 feature on DataBuffet.
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Dependent Variable: DLOG(FCPPINDI_US/FCPIU_US)
Method: Least Squares
Date: 09/25/19 Time: 16:58
Sample (adjusted): 2002Q2 2019Q1
Included observations: 68 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(@MOVAV(FRBAAC_US-FRGT10Y_US,2)) | -0.019876 | 0.019376 | -1.025836 | 0.3088 |
| DLOG(@MOVAV(FGDPMF$Q_US(-1),4)) | 0.575485 | 0.601182 | 0.957256 | 0.3420 |
| D(FLBR_US) | -0.042044 | 0.023244 | -1.808841 | 0.0751 |

| | | | |
|---|---|---|---|
| R-squared | 0.142230 | Mean dependent var | 0.006486 |
| Adjusted R-squared | 0.115837 | S.D. dependent var | 0.049840 |
| S.E. of regression | 0.046864 | Akaike info criterion | -3.240012 |
| Sum squared resid | 0.142756 | Schwarz criterion | -3.142093 |
| Log likelihood | 113.1604 | Hannan-Quinn criter. | -3.201213 |
| Durbin-Watson stat | 2.855897 | | |

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Dependent Variable: DLOG(FCPPOFFI_US/FCPIU_US)
Method: Least Squares
Date: 09/25/19 Time: 16:42
Sample (adjusted): 2002Q2 2019Q1
Included observations: 68 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(@MOVAV(FEOFC_US(-1),4)) | 2.269026 | 1.000152 | 2.268682 | 0.0267 |
| D(FLBR_US) | -0.023761 | 0.022668 | -1.048239 | 0.2985 |
| D(@MOVAV(FRBAAC_US-FRGT10Y_US,4)) | -0.032652 | 0.024118 | -1.353850 | 0.1805 |
| D(@MOVAV(FCPNCOFF_US(-4),4)) | -0.002014 | 0.001978 | -1.018627 | 0.3122 |

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|---|---|---|---|
| R-squared | 0.325538 | Mean dependent var | 0.002868 |
| Adjusted R-squared | 0.293922 | S.D. dependent var | 0.038845 |
| S.E. of regression | 0.032641 | Akaike info criterion | -3.949462 |
| Sum squared resid | 0.068189 | Schwarz criterion | -3.818903 |
| Log likelihood | 138.2817 | Hannan-Quinn criter. | -3.897730 |
| Durbin-Watson stat | 2.235372 | | |

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Dependent Variable: DLOG(FCPPRETI_US/FCPIU_US)
Method: Least Squares
Date: 09/25/19 Time: 17:04
Sample (adjusted): 2002Q2 2019Q1
Included observations: 68 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(@MOVAV(FRBAAC_US-FRGT10Y_US,4)) | -0.020692 | 0.021599 | -0.957987 | 0.3416 |
| DLOG(@MOVAV(FERT_US,4)) | 2.337027 | 1.491711 | 1.566675 | 0.1220 |
| D(FLBR_US) | -0.016563 | 0.025087 | -0.660204 | 0.5115 |

| | | | |
|---|---|---|---|
| R-squared | 0.235190 | Mean dependent var | 0.004413 |
| Adjusted R-squared | 0.211657 | S.D. dependent var | 0.034226 |
| S.E. of regression | 0.030389 | Akaike info criterion | -4.106346 |
| Sum squared resid | 0.060028 | Schwarz criterion | -4.008426 |
| Log likelihood | 142.6158 | Hannan-Quinn criter. | -4.067547 |
| Durbin-Watson stat | 1.893412 | | |

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Dependent Variable: DLOG(FCPPCOMI_US)
Method: Least Squares
Date: 09/25/19 Time: 16:57
Sample (adjusted): 2002Q2 2019Q1
Included observations: 68 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(FCPPOFFI_US) | 0.303224 | 0.031287 | 9.691636 | 0.0000 |
| DLOG(FCPPINDI_US) | 0.123011 | 0.022278 | 5.521738 | 0.0000 |
| DLOG(FCPPRETI_US) | 0.525873 | 0.034712 | 15.14972 | 0.0000 |

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|---|---|---|---|
| R-squared | 0.920264 | Mean dependent var | 0.010264 |
| Adjusted R-squared | 0.917811 | S.D. dependent var | 0.029794 |
| S.E. of regression | 0.008541 | Akaike info criterion | -6.644657 |
| Sum squared resid | 0.004742 | Schwarz criterion | -6.546738 |
| Log likelihood | 228.9184 | Hannan-Quinn criter. | -6.605859 |
| Durbin-Watson stat | 2.229286 | | |

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Dependent Variable: DLOG(FCPPI_US)
Method: Least Squares
Date: 09/25/19 Time: 17:33
Sample (adjusted): 2002Q2 2019Q1
Included observations: 68 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(FCPPAPTI_US) | 0.362538 | 0.036638 | 9.895222 | 0.0000 |
| DLOG(FCPPOFFI_US) | 0.201733 | 0.035343 | 5.707902 | 0.0000 |
| DLOG(FCPPINDI_US) | 0.117315 | 0.025032 | 4.686647 | 0.0000 |
| DLOG(FCPPRETI_US) | 0.281775 | 0.042141 | 6.686430 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.902888 | Mean dependent var | 0.010020 |
| Adjusted R-squared | 0.898336 | S.D. dependent var | 0.029754 |
| S.E. of regression | 0.009487 | Akaike info criterion | -6.420784 |
| Sum squared resid | 0.005760 | Schwarz criterion | -6.290225 |
| Log likelihood | 222.3067 | Hannan-Quinn criter. | -6.369053 |
| Durbin-Watson stat | 2.458742 | | |

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