Online Appendix

How Mortgage Finance Reform Could Affect Housing
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Four equation model of:
  (1) Median LTV for non-government first time buyers
  (2) Median LTV for all first time buyers
  (3) House price-to-rent ratio
  (4) Real rents

Notation: $l = \ln$, $dl = \Delta\ln$, $d4l = \Delta_4\ln$, $ddl = \Delta^2\ln$, m4 = 4q average, d79q1 = dummy for 1979q1, ds01q1 = 0/1 step dummy with step in 2001q1 etc.

(1) Non-Government LTV - Log of Median LTV^{NG}

```
lLTV_NG_med = p0 + p1 * lCapReq + p2 * ds01q1_CFMA_m4 + p5 * d89q24_SLBaselI
        + p6 * d4lHPp_Neg(-1) + p7 * d4lHP_Neg(-5) + error term
```

"Systematic" Component:

```
FX_NG = p0 + p1 * lCapReq + p2 * ds01q1_CFMA_m4 + p5 * d89q24_SLBaselI
        + p6 * d4lHP_Neg(-1) + p7 * d4lHP_Neg(-5)
```

(2) Overall LTV - Log of Median LTV - Includes $F^{\text{NG}}(X)$

```
lLTV_ALL_med = a0 + a1 * FX_NG + a2 * d8lHP_Neg(-1) + a3 * lFHA_Size + error term
```

"Systematic" Component:

```
FX_ALL = a0 + a1 * FX_NG + a2 * d8lHP_Neg(-1) + a3 * lFHA_Size
```

(3) HP/Rent Equation - Log of HP/RENT (HPRent) - Includes $F^{\text{All}}(X)$, which incorporates $F^{\text{NG}}(X)$

```
lHPRent = lHPRent(-1) + h0 + h1 * (lHPRent(-1) - lHPRent(-2))
        + h2 * (lHPRent(-2) - lHPRent(-3)) + h3 * (lHPRent(-3) - lHPRent(-4))
        + h4 * (lRent - 2 * lRent(-1) + lRent(-2))
```

```
        - hspeed * (lHPRent(-1) - hh1 * FX_ALL(-2) - hh2 * lUC(-1))
        + h7 * (lUC - lUC(-1)) + h8 * (lUC(-1) - lUC(-2))
        + h9 * d11q1_FDIC + h10 * d86q1_OilBust(-3) + h11 * dFHAPrem + h12 * dTaxCredit;
```

(4) Real Rent Equation - Log of Real Rent (RRent)

```
lRRent = lRRent(-1) + r0 + r1 * (lRRent(-1)- lRRent(-2)) + r2 * dlRPEnergy + r3 * ddlPC
        - rspeed * (lRRent(-1) - rr1 * lRHP(-1) - rr2 * lRY(-3) - rr3 * lUC_m8(-2))
        + r4 * d79q1 + r5 * d80q1 + r6 * d86q1_OilBust(-1);
```

Identities:

```
lRHP    = lHPRent + lRRent;                          ? Log Real HP
lHP     = lRHP + lPC;                                ? Log Nominal HP
lRent   = lRRent + lPC;                              ? Log Nominal Rent

d4lHP   = lHP - lHP(-4);
d8lHP   = lHP - lHP(-8);

d4lHP_neg = d4lHP - pos(d4lHP);                      ? Nominal 4Q HP Falls (log)
d8lHP_neg = d8lHP - pos(d8lHP);                      ? Nominal 8Q HP Falls
```

User Cost of Housing

```
CG = 100 * [(0.92 * exp(lHP(-1) - lHP(-17)))**0.25 - 1];    ? Capital Gain Loss Component
UC = depr + 0.75 + (1 - ty / 100) * (imort + tp) - CG;     ? User Cost Excl. 2009 Tax Credit

lUC = log(UC);
lUC_m8 = log((UC + UC(-1) + UC(-2) + UC(-3) + UC(-4) + UC(-5) + UC(-6) + UC(-7) )/8);
```

NLS Estimates of Equations (1) to (3), with Substitutions for FX_NG and FX_ALL

```
Nonlinear Least Squares
Sample 1983 Q1 to 2013 Q2

Number of observations = 122       Log likelihood = 1108.36
        Schwarz B.I.C. = -1037.53


                          Standard
Parameter   Estimate        Error       t-statistic   P-value

P0          4.55393       .977152E-02   466.041       [.000]
P1          -.044277      .591695E-02   -7.48312      [.000]
P2          .058908       .629108E-02   9.36374       [.000]
P5          -.052445      .011722       -4.47402      [.000]
P6          .478360       .132791       3.60236       [.000]
P7          .623786       .131019       4.76104       [.000]


A0          1.34933       .188517       7.15763       [.000]
A1          .709335       .041432       17.1204       [.000]
A2          -.296334      .052061       -5.69201      [.000]
A3          .010353       .486627E-02   2.12741       [.033]


H0          -.447380      .122826       -3.64238      [.000]
H1          .369356       .070292       5.25457       [.000]
H2          .191951       .075545       2.54088       [.011]
H3          .106349       .064843       1.64009       [.101]
H4          -.475383      .221789       -2.14340      [.032]


HSPEED      .082032       .018000       4.55738       [.000]
HH1         1.40774       .188077       7.48491       [.000]
HH2         -.153757      .018173       -8.46064      [.000]


H7          -.040522      .011115       -3.64566      [.000]
H8          -.782996E-02  .011964       -.654486      [.513]
H9          -.011824      .443856E-02   -2.66403      [.008]
H10         -.013202      .429078E-02   -3.07672      [.002]
H11         .019705       .305373E-02   6.45274       [.000]
H12         .014427       .321824E-02   4.48300       [.000]


Standard Errors computed from quadratic form of analytic first derivatives
(Gauss)
```

```
Equation: LTV_PRI_X_EQN
Dependent variable: LLTV_PRI_MED

        Mean of dep. var. = 4.50711
  Std. dev. of dep. var. = .050526
Sum of squared residuals = .097827
    Variance of residuals = .801858E-03
Std. error of regression = .028317
               R-squared = .683316
             LM het. test = 1.36099 [.243]
            Durbin-Watson = 1.80272


Equation: LTV_ALL_X_EQN
Dependent variable: LLTV_ALL_MED

        Mean of dep. var. = 4.54370
  Std. dev. of dep. var. = .038892
Sum of squared residuals = .038025
    Variance of residuals = .311681E-03
Std. error of regression = .017654
               R-squared = .792254
             LM het. test = 3.67590 [.055]
            Durbin-Watson = 1.71484


Equation: HPRENT_X_EQN
Dependent variable: LHPRENT

        Mean of dep. var. = .628514
  Std. dev. of dep. var. = .106688
Sum of squared residuals = .211634E-02
    Variance of residuals = .173470E-04
Std. error of regression = .416498E-02
               R-squared = .998463
             LM het. test = .410145 [.522]
            Durbin-Watson = 1.89930
```

Estimates of Rent Equation (4) – OLS and NLS

```
Dependent variable: dlRRent
Current sample:  1979:1 to 2013:4
Number of observations:  140

          Mean of dep. var. = .239252E-02
     Std. dev. of dep. var. = .471954E-02
   Sum of squared residuals = .364050E-03
       Variance of residuals = .282209E-05
   Std. error of regression = .167991E-02
                  R-squared = .882416
         Adjusted R-squared = .873301
               LM het. test = .138995E-02 [.970]
             Durbin-Watson = 2.27723 [.770,.995]
                 Durbin's h = -1.91241 [.056]
            Durbin's h alt. = -1.76667 [.077]
Breusch/Godfrey LM: AR/MA1 = 3.12111 [.077]
Breusch/Godfrey LM: AR/MA2 = 8.11337 [.017]
Breusch/Godfrey LM: AR/MA3 = 9.42610 [.024]
Breusch/Godfrey LM: AR/MA4 = 16.3644 [.003]
                  Chow test = .856356 [.585]
            White het. test = 67.7551 [.002]
           Jarque-Bera test = 12.5718 [.002]
           Ramsey's RESET2 = .213720 [.645]
            F (zero slopes) = 96.8091 [.000]
             Schwarz B.I.C. = -674.360
             Log likelihood = 701.539


                    Estimated      Standard
Variable            Coefficient     Error        t-statistic   P-value
C                   .031138        .016588       1.87709       [.063]
dlRRent(-1)         .689507        .043462       15.8646       [.000]
dlRPEnergy          -.019010       .545299E-02   -3.48620      [.001]
ddlPC               -.732626       .061462       -11.9201      [.000]
lRRent(-1)          -.055868       .958647E-02   -5.82780      [.000]
lRHP(-1)            .017152        .567432E-02   3.02275       [.003]
lRY(-3)             .014826        .417054E-02   3.55487       [.001]
lUC_M8(-2)          .304407E-02    .106243E-02   2.86519       [.005]
d79Q1               -.677836E-02   .172068E-02   -3.93935      [.000]
d80Q1               -.012627       .174744E-02   -7.22587      [.000]
d86Q1_OilBust(-1)   .766981E-02    .175964E-02   4.35873       [.000]
```

```
Parameter   Estimate        Error       t-statistic   P-value

R0          .031138         .016588         1.87709     [.061]
R1          .689507         .043462        15.8646      [.000]
R2          -.019010        .545299E-02    -3.48620     [.000]
R3          -.732626        .061462       -11.9201      [.000]
RSPEED      .055868         .958647E-02     5.82780     [.000]
RR1         .307011         .081125         3.78439     [.000]
RR2         .265370         .063548         4.17588     [.000]
RR3         .054487         .014984         3.63633     [.000]
R4          -.677836E-02    .172068E-02    -3.93935     [.000]
R5          -.012627        .174744E-02    -7.22587     [.000]
R6          .766981E-02     .175964E-02     4.35873     [.000]
```