Interest Rates, Debt and Intertemporal Allocation: Evidence from Notched Mortgage Contracts in the UK

Michael Best, SIEPR  James Cloyne, BoE
Ethan Ilzetzki, LSE  Henrik Kleven, LSE

September 2015

The views expressed are those of the authors and do not necessarily reflect the views of the Bank of England, the Monetary Policy Committee, the Financial Policy Committee or the Prudential Regulatory Authority. All charts and estimates use data provided by the Financial Conduct Authority and MoneyFacts.
Our Question

- What is the impact of interest rates on household leverage and intertemporal consumption allocation?
  - Key question in household finance, public finance and macro

- Great Recession has renewed interest in household leverage (e.g. Hall 2011, Mian & Sufi 2014)

- Household debt $\approx$ mortgage debt
  - 89% of all household debt in the UK
  - 74% of all household debt in the US

- Yet we have little causal evidence on mortgage debt
Empirical Challenge

- Difficult to find exogenous variation in interest rates
  - **Time variation** in interest rates is endogenous
  - **Tax variation** in after-tax interest rates could be useful, but compelling quasi-experiments are rare

- We exploit quasi-experimental variation in interest rates due to notched mortgage contracts in the UK
  - Mortgage interest rate follows a step function of the loan-to-value ratio (LTV) at the time of loan origination
  - This creates notches at specific LTV thresholds
This Paper

1. Reduced-form analysis
   - Bunching estimates of LTV responses
   - Mortgage demand elasticities
     - Elasticity $\approx 0.3$ on average, strongly heterogeneous

2. Structural analysis
   - Dynamic model of consumption and debt choices
   - Elasticity of Intertemporal Substitution (EIS)
     - EIS $\approx 0.1$ on average, very homogeneous
   - Robustness and extensions
Contribution to Literature

- **Household Finance**
  - Reduced-form debt responses, but little evidence on mortgages (DeFusco & Paciorek 2014)

- **Consumption/Savings**
  - Reduced-form savings responses (Chetty et al. 2014)
  - Structural EIS (Hall 1988; Attanasio & Weber 1993, 1995)

- **Public Finance**
  - Debate about tax subsidies to mortgages, but little evidence (Poterba & Sinai 2008)

- **Micro-Macro**
  - Role of monetary policy (interest rates), mortgage debt, and housing for business cycles (Mian & Sufi 2009, 2011)
Institutional Setting and Data
UK Mortgage Market

- Interest rate notches at critical LTV thresholds
  - 60%, 70%, 75%, 80%, 85%
  - Notches vary between banks, products, and over time

- Frequent refinancing
  - Typical mortgage is 2-5 year fixed interest rate
  - Penalizing reset rate deters late refinancing
  - Early repayment fee and origination fee deter early refinancing

- Our Focus: Remortgagors
  - House value is given
  - Isolates debt choice from housing choice
### Mortgage Menu in a Large UK Bank

<table>
<thead>
<tr>
<th>Maximum Loan to Valuation (LTV) of 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Year Fixed Standard</td>
</tr>
<tr>
<td>2 Year Fixed Fee Saver*</td>
</tr>
<tr>
<td>2 Year Fixed Premier and Advance Standard</td>
</tr>
<tr>
<td>5 Year Fixed Standard</td>
</tr>
<tr>
<td>5 Year Fixed Fee Saver*</td>
</tr>
<tr>
<td>5 Year Fixed Premier and Advance Standard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum Loan to Valuation (LTV) of 85%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Year Fixed Standard</td>
</tr>
<tr>
<td>2 Year Fixed Fee Saver*</td>
</tr>
<tr>
<td>2 Year Fixed Premier and Advance Standard</td>
</tr>
<tr>
<td>5 Year Fixed Standard</td>
</tr>
<tr>
<td>5 Year Fixed Fee Saver*</td>
</tr>
<tr>
<td>5 Year Fixed Premier and Advance Standard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum Loan to Valuation (LTV) of 80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Year Fixed Standard</td>
</tr>
<tr>
<td>2 Year Fixed Fee Saver*</td>
</tr>
<tr>
<td>2 Year Fixed Premier and Advance Standard</td>
</tr>
<tr>
<td>5 Year Fixed Standard</td>
</tr>
<tr>
<td>5 Year Fixed Fee Saver*</td>
</tr>
<tr>
<td>5 Year Fixed Premier and Advance Standard</td>
</tr>
</tbody>
</table>
## 2 Year Fixed Standard

<table>
<thead>
<tr>
<th>Max loan-to-value</th>
<th>Initial interest rate</th>
<th>Initial interest rate applied until</th>
<th>This reverts to the Variable Rate/BTL Variable Rate, currently</th>
<th>Overall cost for comparison (APR)</th>
<th>Booking fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>3.29%</td>
<td>2 Years Fixed until 31.07.17</td>
<td>3.94%</td>
<td>4% APR</td>
<td>£999</td>
</tr>
<tr>
<td>85%</td>
<td>2.29%</td>
<td>2 Years Fixed until 31.07.17</td>
<td>3.94%</td>
<td>3.8% APR</td>
<td>£999</td>
</tr>
<tr>
<td>80%</td>
<td>1.99%</td>
<td>2 Years Fixed until 31.07.17</td>
<td>3.94%</td>
<td>3.7% APR</td>
<td>£999</td>
</tr>
</tbody>
</table>
Data

- **Product Sales Database** from UK Financial Conduct Authority merged with **MoneyFacts Data** (origination fees)
  - All household mortgage contracts from 2008-14

- Rich mortgage contract and household characteristics

- Our estimation sample is a **panel of remortgagors**
Mortgage Interest Schedule

- Interest rate jumps depend on bank, product and time

- We non-parametrically estimate interest rate jump at notches:

\[ r_i = f(LTV_i) + \beta_1 \text{lender}_i + \beta_2 \text{type}_i \otimes \text{dur}_i \otimes \text{month}_i \]
\[ + \beta_3 \text{repayment}_i + \beta_4 \text{reason}_i + s(\text{term}_i) + \nu_i \]

- Adding borrower demographics have little impact on schedule
Mortgage Interest Schedule

With Individual Controls
Reduced-Form Analysis
LTV Distribution for Full Population

![Graph showing LTV distribution for full population]
Counterfactual Distribution

Standard Approach: Fit Polynomial to Observed Distribution

- Requires that notches only affect the distribution locally
- Here the distribution is affected globally

Our Approach: Empirical Counterfactual using Panel Data

- Previous LTV + amortization + new house price ⇒ **Passive LTV**: LTV immediately before refinancing
- **Counterfactual LTV distribution**: Passive LTV distribution + equity extraction distribution for non-bunchers
Actual and Passive LTV Distributions

Number of Mortgages

Loan to Value Ratio (%)

- Actual LTV
- Passive LTV
Bunching Estimation: Pooling Notches

\[ r(\%) = 3.35 (0.006) \]
\[ r(\%) = 0.25 (0.008) \]
\[ b = 5.65 (0.114) \]
\[ LTV = 1.74 (0.017) \]
# Mortgage Demand Elasticities

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Notch</th>
<th>60</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta r$ (%)</td>
<td></td>
<td>0.12</td>
<td>0.23</td>
<td>0.34</td>
<td>0.37</td>
<td>0.31</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.06)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>$\Delta \lambda$</td>
<td></td>
<td>0.54</td>
<td>1.36</td>
<td>2.64</td>
<td>3.51</td>
<td>5.50</td>
<td>1.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.05)</td>
<td>(0.07)</td>
<td>(0.26)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>$\Delta Equity/V$ (%)</td>
<td>3.34</td>
<td>4.11</td>
<td>5.26</td>
<td>6.12</td>
<td>5.89</td>
<td>4.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.09)</td>
<td>(0.06)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.12)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>$\Delta c_0$</td>
<td></td>
<td>1,611</td>
<td>3,543</td>
<td>5,946</td>
<td>7,050</td>
<td>9,506</td>
<td>4,104</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(87.72)</td>
<td>(83.22)</td>
<td>(113.97)</td>
<td>(145.09)</td>
<td>(455.76)</td>
<td>(39.86)</td>
</tr>
<tr>
<td>$\Delta c_1$</td>
<td></td>
<td>2,418</td>
<td>5,065</td>
<td>8,181</td>
<td>9,807</td>
<td>12,241</td>
<td>5,802</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(105.98)</td>
<td>(105.92)</td>
<td>(150.37)</td>
<td>(237.88)</td>
<td>(677.98)</td>
<td>(66.36)</td>
</tr>
<tr>
<td>$r^*$(%)</td>
<td></td>
<td>13.20</td>
<td>11.78</td>
<td>10.35</td>
<td>9.71</td>
<td>7.18</td>
<td>10.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.11)</td>
<td>(0.62)</td>
<td>(0.46)</td>
<td>(0.47)</td>
<td>(0.81)</td>
<td>(0.27)</td>
</tr>
<tr>
<td>Elasticity $\varepsilon$</td>
<td>0.07</td>
<td>0.19</td>
<td>0.40</td>
<td>0.56</td>
<td>1.37</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.26)</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>
Structural Analysis
There exists a marginal buncher who is indifferent between:

**Interior Choice**
- Interest rate $R + \Delta R$
- Unconstrained choice
- $c_1^i = (\delta (R + \Delta R))^{\sigma} c_0^i$
- Utility $U^I$

**Notch Choice**
- Interest rate $R$
- Borrow to the notch
- LTV $= \lambda^*$
- Utility $U^N$

→ Indifference condition: $U^I = U^N$

$\iff F(\sigma, \Delta \ln \lambda_t, \Delta \ln R_t, X) = 0$
Our Approach vs Standard Approach

Standard Euler Equation Approach

\[
\sigma = \frac{\Delta \ln (c_{t+1}/c_t)}{\Delta \ln R_t}
\]

Our Notch Approach

\[F(\sigma, \Delta \ln \lambda_t, \Delta \ln R_t, X) = 0\]

Two key differences:

- Time variation in \( R_t \) vs notch in \( R_t \)
- LTV change \( \Delta \ln \lambda_t \) vs consumption change \( \Delta \ln (c_{t+1}/c_t) \)
## EIS Estimates

<table>
<thead>
<tr>
<th>Statistic</th>
<th>60</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \lambda$</td>
<td>0.54 (0.03)</td>
<td>1.36 (0.03)</td>
<td>2.64 (0.05)</td>
<td>3.51 (0.07)</td>
<td>5.50 (0.26)</td>
<td>1.74 (0.02)</td>
</tr>
<tr>
<td>$a$</td>
<td>0.67 (0.11)</td>
<td>0.17 (0.05)</td>
<td>0.33 (0.06)</td>
<td>0.14 (0.03)</td>
<td>0.05 (0.02)</td>
<td>0.36 (0.04)</td>
</tr>
<tr>
<td>$\Delta \lambda_{Adj}$</td>
<td>1.68 (0.45)</td>
<td>1.70 (0.15)</td>
<td>4.08 (0.38)</td>
<td>4.22 (0.23)</td>
<td>6.15 (0.34)</td>
<td>2.85 (0.22)</td>
</tr>
<tr>
<td>EIS $\sigma$</td>
<td>0.10 (0.05)</td>
<td>0.05 (0.01)</td>
<td>0.15 (0.03)</td>
<td>0.11 (0.01)</td>
<td>0.23 (0.04)</td>
<td>0.08 (0.01)</td>
</tr>
</tbody>
</table>
Heterogeneity in EIS  
Estimated From Pooled Notch

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Quartile</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Age</td>
<td>0.05</td>
<td>0.06</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.04)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Income</td>
<td>0.09</td>
<td>0.08</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Loan to Income</td>
<td>0.05</td>
<td>0.06</td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>House Price Growth</td>
<td>0.07</td>
<td>0.05</td>
<td>0.04</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Interest Rate Change</td>
<td>0.04</td>
<td>0.05</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.05)</td>
</tr>
</tbody>
</table>
Robustness and Extensions

- **Discount factor** \( \delta \) and **future interest rates** \( \{R_t\}_2^\infty \)
  - Results are very robust to different calibrations

- **Consumption vs home improvements**
  - Dropping home improvers does not affect the results

- **Consumption vs portfolio composition**
  - EIS estimates represent upper bounds

- **Model extensions:**
  - **Hyperbolic Discounting:** Results robust to this
  - **Uncertainty and Epstein-Zin-Weil:** Results robust to this
### Robustness and Extensions

#### Panel A: Future Interest Rates $\{r_t\}_2^\infty$

<table>
<thead>
<tr>
<th></th>
<th>2%</th>
<th>3.35%</th>
<th>7%</th>
<th>15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_1$</td>
<td>0.0743</td>
<td>0.0764</td>
<td>0.0817</td>
<td>0.0909</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.0111</td>
<td>0.0115</td>
<td>0.0123</td>
<td>0.0138</td>
</tr>
</tbody>
</table>

#### Panel B: Discount Factor $\delta$

<table>
<thead>
<tr>
<th></th>
<th>0.7</th>
<th>0.9</th>
<th>0.95</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>0.0811</td>
<td>0.0772</td>
<td>0.0764</td>
<td>0.0759</td>
</tr>
<tr>
<td></td>
<td>(0.0133)</td>
<td>(0.0118)</td>
<td>(0.0115)</td>
<td>(0.0113)</td>
</tr>
</tbody>
</table>

#### Panel C: Hyperbolic Discounting $\beta$

<table>
<thead>
<tr>
<th></th>
<th>0.5</th>
<th>0.7</th>
<th>0.9</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>0.0766</td>
<td>0.0765</td>
<td>0.0765</td>
<td>0.0764</td>
</tr>
<tr>
<td></td>
<td>(0.0115)</td>
<td>(0.0115)</td>
<td>(0.0115)</td>
<td>(0.0115)</td>
</tr>
</tbody>
</table>

#### Panel D: Risk Aversion $\gamma$ (With Uncertainty)

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>0.0764</td>
<td>0.0795</td>
<td>0.0781</td>
<td>0.0749</td>
</tr>
<tr>
<td></td>
<td>(0.0115)</td>
<td>(0.0120)</td>
<td>(0.0117)</td>
<td>(0.0112)</td>
</tr>
</tbody>
</table>
Conclusions

- Novel source of quasi-experimental interest rate variation

- Elasticities of mortgage demand (reduced-form)
  - Relatively large and strongly heterogeneous elasticities
  - Important for monetary and tax policy, but not a deep parameter invariant to environment

- Elasticities of intertemporal substitution (structural)
  - Relatively small and homogeneous elasticities
  - Liquidity constraints cannot (easily) explain low elasticities
  - Important for macro and consumption theory; key statistic for monetary and fiscal policy
Households Refinance when Reset Rate Kicks In

- Remortgage When Should
- Remortgage After Should
- Remortgage Before Should
Mortgage Interest Schedule: With Individual Controls

\[ r_i = f(LTV_i) + \beta_1 lender_i + \beta_2 type_i \otimes dur_i \otimes month_i \]
\[ + \beta_3 repayment_i + \beta_4 reason_i \]
\[ + s_1 (age_i) + s_2 (income_i) I \{single_i\} \]
\[ + s_3 (income_i) I \{couple_i\} + s_4 (term_i) + \nu_i \]
Equity Extracted by Passive LTV for Non-Bunchers

![Graph showing equity extracted as a percentage of loan value over a passive LTV ratio range from 50 to 100. The graph illustrates a downward trend as the LTV ratio increases, indicating a decrease in equity extracted.]
Bunching Estimation: 60% LTV Notch

\[ r(\%) = 3.08 \pm 0.006 \]
\[ Dr(\%) = 0.12 \pm 0.010 \]
\[ b = 2.00 \pm 0.132 \]
\[ DLTV = 0.54 \pm 0.029 \]
Bunching Estimation at the 70% LTV Notch

- \( r (%) = 3.17 \ (0.004) \)
- \( r (%) = 0.23 \ (0.013) \)
- \( b = 4.72 \ (0.190) \)
- \( LTV = 1.36 \ (0.032) \)

![Graph showing loan to value ratio and interest rate distribution](image-url)

- **Actual**
- **Counterfactual**
- **Conditional Interest Rate**
Bunching Estimation: 75% LTV Notch

- $r (%) = 3.37 (0.004)$
- $r (%) = 0.34 (0.017)$
- $b = 7.71 (0.252)$
- $LTV = 2.64 (0.048)$

![Graph showing density distribution of loan to value ratio and conditional interest rates.]
Bunching Estimation at the 80% LTV Notch

- $r(\%) = 3.73 \pm 0.005$
- $r(\%) = 0.37 \pm 0.024$
- $b = 8.97 \pm 0.382$
- $LTV = 3.51 \pm 0.070$

The graph shows the density distribution of loan to value ratios with actual, counterfactual, and conditional interest rates.
Bunching Estimation at the 85% LTV Notch

- $r (%) = 4.35 (0.009)$
- $r (%) = 0.31 (0.056)$
- $b = 9.75 (0.612)$
- $LTV = 5.50 (0.258)$
Intertemporal Choice
Without Mortgage Interest Notch

\[
\begin{align*}
    c_1 & \quad \bar{c}_1 \\
    c_1^{CF} & \quad \bar{c}_0 \\
    c_0^{CF} & \quad c_0
\end{align*}
\]
Intertemporal Choice
With Mortgage Interest Notch

\[ c_1^* - \Delta c_1 \]

\[ c_1^* \]

\[ c_1^I \]

\[ c_1 \]

\[ c_0^* \quad c_0^I \quad c_0^* + \Delta c_0 \]
LTV Distribution with Bunching

Density

\[ \bar{\lambda} \]

\[ \lambda^I \]

\[ \bar{\lambda} + \Delta\lambda \]

- Density with linear interest
- Density with interest notches
Distribution with Bunching and Heterogeneous EIS

\[ \lambda \]

\[ \bar{\lambda} \]

\[ \lambda + \Delta \lambda \]

Density with linear interest

Density with interest notches
Model Details (1)

- Remortgagors with pre-determined housing wealth $H^i$, infinite horizon, and perfect foresight

- Preferences $U(C^i, H^i)$ where

\[
C^i \equiv \left( \sum_{t=0}^{\infty} \delta^t (c^i_t) \frac{\sigma-1}{\sigma} \right)^{\frac{\sigma}{\sigma-1}}
\]

- Budget constraint

\[
c^i_t \leq y^i_t + (\lambda^i_{t+1} - \bar{\lambda}^i_t) P_t H^i
\]

where $\bar{\lambda}^i_t \equiv \frac{R^i_t D^i_t}{P_t H^i}$ is passive LTV; $\lambda^i_{t+1} \equiv \frac{D^i_{t+1}}{P_t H^i}$ is chosen LTV
Model Details (2)

- Remortgage decision in period zero

- **Mortgage interest notch:**
  - Gross interest rate of \( R_1^i = R \) if \( \lambda_1^i \leq \lambda^* \)
  - Or \( R_1^i = R + \Delta R \) if \( \lambda_1^i > \lambda^* \)

- Face a path \( \{ R_t \}_{2}^\infty \) anticipating not to bunch at \( \lambda^* \) in the future
# Parameters for Structural Estimation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>60</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>60–85</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta t$ (yrs)</td>
<td>3.28</td>
<td>3.22</td>
<td>3.25</td>
<td>3.57</td>
<td>3.65</td>
<td>3.35</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>$D_1^*$</td>
<td>178,414.30</td>
<td>181,526.42</td>
<td>168,504.81</td>
<td>160,125.30</td>
<td>146,975.95</td>
<td>169,716.78</td>
</tr>
<tr>
<td></td>
<td>(1,263.62)</td>
<td>(992.48)</td>
<td>(838.41)</td>
<td>(916.45)</td>
<td>(963.22)</td>
<td>(454.95)</td>
</tr>
<tr>
<td>$R_0D_0$</td>
<td>168,986.00</td>
<td>170,941.69</td>
<td>156,551.13</td>
<td>147,659.69</td>
<td>136,005.20</td>
<td>158,523.98</td>
</tr>
<tr>
<td></td>
<td>(1,300.79)</td>
<td>(983.00)</td>
<td>(774.30)</td>
<td>(828.35)</td>
<td>(896.77)</td>
<td>(449.86)</td>
</tr>
<tr>
<td>$y_0$</td>
<td>48,834.93</td>
<td>46,819.63</td>
<td>43,148.35</td>
<td>41,400.18</td>
<td>39,790.09</td>
<td>44,343.52</td>
</tr>
<tr>
<td></td>
<td>(532.61)</td>
<td>(393.18)</td>
<td>(239.40)</td>
<td>(224.48)</td>
<td>(247.38)</td>
<td>(150.03)</td>
</tr>
<tr>
<td>$\Delta E/V$ (%)</td>
<td>3.30</td>
<td>4.15</td>
<td>5.26</td>
<td>5.97</td>
<td>5.97</td>
<td>4.87</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.10)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>$r$ (%)</td>
<td>3.09</td>
<td>3.17</td>
<td>3.38</td>
<td>3.74</td>
<td>4.37</td>
<td>3.36</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>$\Delta r$</td>
<td>0.12</td>
<td>0.23</td>
<td>0.33</td>
<td>0.36</td>
<td>0.34</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.05)</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>