Specialisation in mortgage risk under Basel II

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$^3$4-most

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The views presented here 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 PRA.
Motivation

- Residential **mortgage market**
  - Epicentre of financial crisis (Mian and Sufi, 2015)
  - Large share of total bank lending (Jordà et al, 2016)
Motivation

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  - Epicentre of financial crisis (Mian and Sufi, 2015)
  - Large share of total bank lending (Jordà et al, 2016)

- Methodology-driven heterogeneity in **capital requirements**
  - BCBS (2016)
Motivation

- Residential **mortgage market**
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  - Large share of total bank lending (Jordà et al, 2016)

- Methodology-driven heterogeneity in **capital requirements**
  - BCBS (2016)

- **Specialization →** distribution of **risk**
  - Current debate on reforms of Basel II-III
Heterogeneity in risk weights - UK mortgages

\[ K_{\text{min}} = RWA \cdot K_{\text{Req}} \]

- Two approaches: models (IRB) and standardised (SA)
Do regulatory risk models affect market outcomes?

- **Mechanism:** Similar risk, different methodologies $\rightarrow$ capital requirements $\rightarrow$ specialisation

- **Theory:** Repullo & Suarez (2004)

- **Empirics:** Behn et al (2016a & 2016b) for corporate lending in Germany
This paper

- **Identification challenge**: isolating effect of methodology
  - one borrower, many lenders (Khwaja Mian, 2008)
  - mortgages: one borrower, one lender → ?

Micro-data on 7 million UK mortgages (2005-2015) ⇒ Two identification strategies based on:
1. Quasi-experimental variation from switch to Basel II
2. New LTV-level risk weight data for post-Basel II
This paper

- **Identification challenge**: isolating effect of methodology
  - one borrower, many lenders (Khwaja Mian, 2008)
  - mortgages: one borrower, one lender → ?

- **Micro-data** on 7 million UK mortgages (2005-2015)

  ⇒ Two **identification strategies** based on:
  1. Quasi-experimental variation from switch to Basel II
  2. New LTV-level risk weight data for post-Basel II
Outline

Identification

Results

Policy
Outline

Identification

Results

Policy
Switch to Basel II as a quasi-experiment

- Switch to Basel II as an exogenous supply-side shock
- Selection into IRB group approx. exogenous w.r.t. risk
  - High costs of IRB adoption (CMA, 2015)
  - Mainly driven by firm size (economies of scale)
Risk weights variation

<table>
<thead>
<tr>
<th>Basel I</th>
<th>Basel II-III (2008 onwards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% for ALL loans</td>
<td>Firms choose SA or IRB</td>
</tr>
</tbody>
</table>

IRB-SA gap was larger at lower LTV

Basel I
- 50% for ALL loans

Basel II-III (2008 onwards)
- Firms choose SA or IRB

LTV
- High
- Low

IRB
SA
LTV
High
Low

SA
IRB
LTV>
LTV≤
Mortgage price variation

<table>
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Average interest rate

- **2007**
- **2010**
- **2013**
- **2016**

Mortgage rates fall for both SA and IRB firms

IRB-SA gap is larger at lower LTV

Benchmark rate

- **LTV**
  - High
  - High
  - Low
  - Low

- **SA**
- **IRB**

- **LTV>75**
- **LTV<=75**
Mortgage price variation (IRB-SA price difference)

<table>
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<tr>
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<td>Firms choose SA or IRB</td>
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</tbody>
</table>

\[
\text{price}_{IRB} > \text{price}_{SA}
\]
\[
\text{price}_{IRB} < \text{price}_{SA}
\]

Price gap opens up at low LTV

High LTV

Low LTV

Diff. between IRB & SA avg. rates


LTV>75 LTV≤75

\( p_{IRB} \neq p_{SA} \)
Triple difference model (2005-15)

\[ Rate_{ibst} = \]

Hypotheses:
1. Interest rates: \( \delta_{123} < 0 \)
2. Portfolio shares: \( \delta_{123} > 0 \)
Triple difference model (2005-15)

\[ Rate_{ibst} = \delta_1 BaselII_t + \]

Common impact

Hypotheses:
1. Interest rates: \( \delta_{123} < 0 \)
2. Portfolio shares: \( \delta_{123} > 0 \)
Triple difference model (2005-15)

\[ Rate_{ibst} = \delta_1 \text{BaselII}_t + \]

Common impact:

\[ \delta_1 \text{BaselII}_t \]

Differential impact:

\[ \delta_{12} \text{BaselII}_t \times \text{IRB}_b + \delta_{13} \text{BaselII}_t \times \text{LowLTV}_s + \]

for IRB firms

low LTV

Hypotheses:

1. Interest rates:
   \[ \delta_{123} < 0 \]

2. Portfolio shares:
   \[ \delta_{123} > 0 \]
Triple difference model (2005-15)

\[ Rate_{ibst} = \left\{ \begin{array}{l}
\text{Common impact} \\
\delta_1 \text{BaselII}_t \\
\text{Differential impact} \\
\delta_{12} \text{BaselII}_t \times \text{IRB}_b + \delta_{13} \text{BaselII}_t \times \text{LowLTV}_s \\
\text{for IRB firms} \quad \text{low LTV} \\
\text{Structural differences} \\
\delta_2 \text{IRB}_b + \delta_3 \text{LowLTV}_s + \delta_{23} \text{IRB}_b \times \text{LowLTV}_s \\
\text{for IRB} \quad \text{for low LTV} \quad \text{for IRB firms at low LTV}
\end{array} \right. \]
Triple difference model (2005-15)

\[ Rate_{i\text{bst}} = \left( \delta_1 \text{BaselII}_t \right) + \]

Common impact

\[
\left( \delta_{12} \text{BaselII}_t \times \text{IRB}_b \right) + \left( \delta_{13} \text{BaselII}_t \times \text{LowLTV}_s \right)
\]

Differential impact

\[
\delta_2 \text{IRB}_b + \delta_3 \text{LowLTV}_s + \delta_{23} \text{IRB}_b \times \text{LowLTV}_s
\]

Structural differences

\[
\text{DDD: Differential impact for IRB firms at low LTV}
\]

\[ \delta_{123} \text{BaselII}_t \times \text{IRB}_b \times \text{LowLTV}_s \]
Triple difference model (2005-15)

\[ Rate_{ibst} = \underbrace{\delta_1 \text{BaselII}_t} + \]

- **Common impact**

- **Differential impact**
  \[ \delta_{12} \text{BaselII}_t \times IRB_b + \delta_{13} \text{BaselII}_t \times LowLTV_s + \]
  - for IRB firms
  - low LTV

- **Structural differences**
  \[ \delta_2 IRB_b + \delta_3 LowLTV_s + \delta_{23} IRB_b \times LowLTV_s + \]
  - for IRB
  - for low LTV
  - for IRB firms at low LTV

**DDD**: Differential impact for IRB firms at low LTV

\[
\delta_{123} \text{BaselII}_t \times IRB_b \times LowLTV_s + \alpha Controls_{ibst} + \epsilon_{ibst}
\]
Triple difference model (2005-15)

\[
Rate_{ibst} = \underbrace{\delta_1 \text{BaselII}_t}_\text{Common impact} + \underbrace{\delta_{12} \text{BaselII}_t \times \text{IRB}_b + \delta_{13} \text{BaselII}_t \times \text{LowLTV}_s}_\text{Differential impact} + \underbrace{\delta_2 \text{IRB}_b + \delta_3 \text{LowLTV}_s + \delta_{23} \text{IRB}_b \times \text{LowLTV}_s}_\text{Structural differences} + DDD: \text{Differential impact for IRB firms at low LTV}
\]

\[
\delta_{123} \text{BaselII}_t \times \text{IRB}_b \times \text{LowLTV}_s + \alpha Controls_{ibst} + \epsilon_{ibst}
\]

- Hypotheses:
  1. Interest rates: $\delta_{123} < 0$
  2. Portfolio shares: $\delta_{123} > 0$
Risk weights ‘pass-through’ model (2009-15)

\[
Rate_{ibst} = \]

Risk weights ‘pass-through’ model (2009-15)

\[ Rate_{ibst} = \gamma_{bt} + \gamma_{bs} + \gamma_{st} \]

pairwise-interacted fixed effects

\[ \gamma_{bt} \quad \gamma_{bs} \quad \gamma_{st} \]

bank-time bank-LTV LTV-time

Hypothesis: \( \beta > 0 \)

Also with \( \gamma_{bst} \times \text{CapReq}_{bt} \)
Risk weights ‘pass-through’ model (2009-15)

\[ Rate_{ibt} = \gamma_{bt} + \gamma_{bs} + \gamma_{st} + \beta RW_{bst} \]

pairwise-interacted fixed effects

risk weights by bank, LTV and time
Risk weights ‘pass-through’ model (2009-15)

\[ Rate_{ibst} = \underbrace{\gamma_{bt} + \gamma_{bs} + \gamma_{st}}_{\text{pairwise-interacted fixed effects}} + \beta RW_{bst} + \alpha Controls_{ibst} + \varepsilon_{ibst} \]
Risk weights ‘pass-through’ model (2009-15)

\[ Rate_{ibst} = \underbrace{\gamma_{bt} + \gamma_{bs} + \gamma_{st}}_{\text{pairwise-interacted fixed effects}} + \beta RW_{bst} + \underbrace{\alpha Controls_{ibst} + \varepsilon_{ibst}}_{\text{risk weights by bank, LTV and time}} \]

▶ Hypothesis: \( \beta > 0 \)
Risk weights ‘pass-through’ model (2009-15)

\[ \text{Rate}_{ibst} = \left( \underbrace{\gamma_{bt}}_{\text{bank-time}} + \underbrace{\gamma_{bs}}_{\text{bank-LTV}} + \underbrace{\gamma_{st}}_{\text{LTV-time}} \right) + \beta \text{RW}_{bst} \]

\[ + \alpha \text{Controls}_{ibst} + \varepsilon_{ibst} \]

- Hypothesis: \( \beta > 0 \)
- Also with \( RW_{bst} \times CapReq_{bt} \)
Outline

Identification

Results

Policy
## Triple difference model – Results (2005-15)

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>LTV threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

### Panel A: interest_{bst}

<table>
<thead>
<tr>
<th></th>
<th>Benchmark 75</th>
<th>LTV threshold 70</th>
<th>LTV threshold 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>$DDD_{bst}$</td>
<td>-0.319***</td>
<td>-0.463***</td>
<td>-0.272***</td>
</tr>
<tr>
<td></td>
<td>(0.088)</td>
<td>(0.083)</td>
<td>(0.090)</td>
</tr>
<tr>
<td>Adjust R2</td>
<td>0.401</td>
<td>0.384</td>
<td>0.410</td>
</tr>
<tr>
<td>Observations</td>
<td>6931773</td>
<td>6931773</td>
<td>6931773</td>
</tr>
</tbody>
</table>

### Panel B: portfolio share_{bst}

<table>
<thead>
<tr>
<th></th>
<th>Benchmark 75</th>
<th>LTV threshold 70</th>
<th>LTV threshold 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>$DDD_{bst}$</td>
<td>0.121***</td>
<td>0.110***</td>
<td>0.101***</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Adjust R2</td>
<td>0.077</td>
<td>0.092</td>
<td>0.065</td>
</tr>
<tr>
<td>Observations</td>
<td>19571</td>
<td>19571</td>
<td>19571</td>
</tr>
</tbody>
</table>

- IRB $\rightarrow$ prices fall by an additional 32bp at low LTV (vs. high)
- IRB $\rightarrow$ portfolio share of low LTV increases by 12pp
### Risk weights model – Results (2009-15)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable:</td>
<td>interest_{ibt}</td>
<td></td>
</tr>
<tr>
<td>$RW_{bst}$</td>
<td>0.010***</td>
<td>0.060***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>$RW_{bst} \times \text{Cap req}_{ibt}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed effects:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender-quarter</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lender-segment</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Segment-quarter</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Individual controls</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.636</td>
<td>0.633</td>
</tr>
<tr>
<td>Observations</td>
<td>3748593</td>
<td>3696374</td>
</tr>
</tbody>
</table>

- 1pp $\Delta RW \rightarrow 1bp \Delta Rates$
- $LTV \leq 50$: 30pp $\Delta RW \rightarrow 30bp \Delta Rates$
Outline

Identification

Results

Policy
Main results: impact of Basel II internal models

- Basel II: specialisation of smaller firms (SA) in high LTV
  ⇒ Lower systemic importance
  ⇒ But less sophisticated risk management

- Within Basel II: 1pp $\Delta RW \rightarrow 1bp \Delta Rates$
  ⇒ Below 75% LTV, implies 20-30bp price advantage
  ⇒ Jump from 10th to 1st in best buy tables (at 75% LTV)
Basel: reduction in variability of models and in IRB-SA gap

Options: (1) more risk sensitive SA, (2) floors on IRB
Appendix
## Alternative channels – Triple difference model

<table>
<thead>
<tr>
<th></th>
<th>Dependent variable: $\text{interest}_{i\text{lb}t}$</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basel II$_t \times \text{Low LTV}_b \times$</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{IRB}_l$</td>
<td>-0.319***</td>
<td>0.088</td>
<td>-0.450***</td>
<td>0.086</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{Low buffer}_l$</td>
<td>0.086</td>
<td>0.090</td>
<td>0.079</td>
<td>0.092</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding shock$_l$</td>
<td></td>
<td></td>
<td></td>
<td>-0.027</td>
<td>(0.118)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.401</td>
<td>0.397</td>
<td>0.405</td>
<td>0.401</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>6,931,773</td>
<td>6,931,773</td>
<td>6,931,773</td>
<td>5,032,264</td>
<td></td>
</tr>
</tbody>
</table>

- **Exposure to the crisis (low capital buffer)**
- **Effect of the crisis (high funding cost)**
Heterogeneous effects – Risk weights model

<table>
<thead>
<tr>
<th>Capital buffer</th>
<th>LTV</th>
<th>RW (_{bst})</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (1)</td>
<td>High (3)</td>
<td>0.001 0.019***</td>
</tr>
<tr>
<td>Low (2)</td>
<td>Low (4)</td>
<td>0.017*** 0.014***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.003) (0.005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.004) (0.003)</td>
</tr>
</tbody>
</table>

Fixed effects:
- Lender-quarter: Yes Yes Yes Yes
- Lender-segment: Yes Yes Yes Yes
- Segment-quarter: Yes Yes Yes Yes
- Individual controls: Yes Yes Yes Yes

Adjusted R2: 0.710 0.563 0.671 0.533
Observations: 2244041 1490925 1177934 2570659

- Pass-through driven by lenders with low buffers
- Similar at high and low LTV
Data

- **Product Sales Database: UK residential mortgages**
  - Rates, product characteristics, property and loan values, borrower characteristics
  - **At origination**

- **CMA/PRA survey**
  - Risk weights by loan-to-value band
  - 17 ‘solo’ entities on IRB 2008-2015
## Two complementary identification strategies

<table>
<thead>
<tr>
<th></th>
<th>Triple difference</th>
<th>RW pass-through</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Period</strong></td>
<td>2005-15</td>
<td>2009-15</td>
</tr>
<tr>
<td><strong>Risk weight data</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Variation</strong></td>
<td>only IRB v SA</td>
<td>also IRB v IRB</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>Regime change</td>
<td>IRB models</td>
</tr>
</tbody>
</table>
Portfolio shares

Portfolio share at low LTV (≤75%)

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>Pre-2008</th>
<th>Post-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Portfolio share at low LTV (≤75%)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>IRB</th>
<th>Pre-2008</th>
<th>Post-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portfolio share at low LTV (≤75%)</td>
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<td></td>
<td></td>
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</tbody>
</table>
Market shares in each segment

<table>
<thead>
<tr>
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<th>High LTV (&gt;75%)</th>
<th>Low LTV (&lt;=75%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-2008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SA | IRB

Market shares in each segment

- Market shares in High LTV (>75%) segment:
  - Pre-2008: 60% SA, 40% IRB
  - Post-2008: 65% SA, 35% IRB
- Market shares in Low LTV (<=75%) segment:
  - Pre-2008: 70% SA, 30% IRB
  - Post-2008: 75% SA, 25% IRB