Credit and economic cycles: some stylised facts

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Views expressed belong to the author alone and do not reflect those of the BIS.
Outline

- Financial crises and real activity: past experience
  - Synchronised? Degree of synchronisation?
- Credit and business cycles: time domain
  - Cross-correlations and causality tests
- Frequency domain
  1. Simple spectral indicators
  2. Frequency-specific coefficients of correlation & regression
- How to better predict credit?
  1. Information content of lending standards
  2. The role of private sector balance sheets
- Conclusion
Credit and output: long run ...

- Financial development leads to faster growth
  1. Facilitates K mobilisation: Bagehot (1873), Hicks (1969)
  2. Spurs technological innovation: Schumpeter (1912)

- Growth creates demand for specific financing
  - Joan Robinson (1952)

- Scepticism about causal linkages
  2. Apparent lack of interests from development economists
… but credit and economic cycles

- These are trends, what about cycles?
- Money and business cycles
  1. Monetarist view: money plays an essential role
  2. RBC: monetary “myth”
- Credit and business cycles
  1. Financial accelerator; importance of borrowers’ balance sheets: Bernanke & Gertler (1989); Bernanke, Gertler & Gilchrist (1999)
- Empirical evidence?
Credit & business cycles: synchronised?

United States

Euro Area

Japan

- Real GDP
- Employment
- Bank credit
- Credit to private sector
Credit recovery over selected cycles
Credit & business cycles: synchronised?

- Financial crises and real activity
  1. Recessions associated with asset market booms and busts
  2. Recessions associated with credit crises
  3. “Creditless” recoveries after major financial crises

- US credit-output relationship time-varying
  1. Lack of synchronisation in the 1950s, early 1960s & 1990s
  2. Greater synchronisation following recessions
Cross-correlations in the time domain

- Some definitions (Kydland & Prescott 1990)
  1. Let $Y$ be real GDP. $X$ is **procyclical** if $\text{Corr}(X, Y_t)$’s are positive and close to 1 around $t$; **countercyclical** if $\text{Corr}(X, Y_t)$’s are negative and close to 1 around $t$; or **acyclical** if $\text{Corr}(X, Y_t)$’s are small;
  2. Phase shift: $X$ **leads** the output cycle by $i$ quarters if $\text{Corr}(X, Y_t)$’s peak at $X_{t-i}$ with $i>0$; $X$ **lags** the output cycle by $j$ quarters if $\text{Corr}(X, Y_t)$’s peaks at $X_{t+j}$ with $j>0$; $X$ **coincides with** the output cycle if $\text{Corr}(X, Y_t)$’s peak at $X_t$. 
Financial variables and business-cycles

- Abel, Bernanke and Croushore (Macroeconomics, 2007) on financial variables
  1. “sensitive to the cycle”
  2. “stock prices are generally procyclical and leading”
  3. “nominal interest rates are procyclical and lagging”
  4. “real interest rate doesn’t have an obvious cyclical pattern”
## US: cross-correlations with real variables

<table>
<thead>
<tr>
<th>Variable X</th>
<th>$x(t-5)$</th>
<th>$x(t-4)$</th>
<th>$x(t-3)$</th>
<th>$x(t-2)$</th>
<th>$x(t-1)$</th>
<th>$x(t)$</th>
<th>$x(t+1)$</th>
<th>$x(t+2)$</th>
<th>$x(t+3)$</th>
<th>$x(t+4)$</th>
<th>$x(t+5)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP</td>
<td>-0.50</td>
<td>-0.31</td>
<td>0.06</td>
<td>0.50</td>
<td>0.86</td>
<td>1.00</td>
<td>0.86</td>
<td>0.51</td>
<td>0.06</td>
<td>-0.32</td>
<td>-0.52</td>
</tr>
<tr>
<td>Real consumption</td>
<td>-0.36</td>
<td>-0.13</td>
<td>0.22</td>
<td>0.60</td>
<td>0.85</td>
<td>0.89</td>
<td>0.71</td>
<td>0.36</td>
<td>-0.03</td>
<td>-0.35</td>
<td>-0.51</td>
</tr>
<tr>
<td>Nondurables</td>
<td>0.17</td>
<td>0.44</td>
<td>0.66</td>
<td>0.81</td>
<td>0.85</td>
<td>0.79</td>
<td>0.66</td>
<td>0.48</td>
<td>0.28</td>
<td>0.11</td>
<td>-0.03</td>
</tr>
<tr>
<td>Durables</td>
<td>0.31</td>
<td>0.45</td>
<td>0.59</td>
<td>0.66</td>
<td>0.60</td>
<td>0.38</td>
<td>0.07</td>
<td>-0.22</td>
<td>-0.36</td>
<td>-0.29</td>
<td>-0.12</td>
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<td>Real fixed inv.</td>
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<td>0.18</td>
<td>0.38</td>
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<td>0.86</td>
<td>0.88</td>
<td>0.80</td>
<td>0.64</td>
<td>0.42</td>
<td>0.17</td>
</tr>
<tr>
<td>Non-residential</td>
<td>-0.17</td>
<td>-0.01</td>
<td>0.18</td>
<td>0.41</td>
<td>0.62</td>
<td>0.80</td>
<td>0.90</td>
<td>0.88</td>
<td>0.77</td>
<td>0.56</td>
<td>0.31</td>
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<tr>
<td>Residential</td>
<td>0.60</td>
<td>0.67</td>
<td>0.64</td>
<td>0.56</td>
<td>0.46</td>
<td>0.34</td>
<td>0.19</td>
<td>0.05</td>
<td>-0.07</td>
<td>-0.14</td>
<td>-0.18</td>
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<tr>
<td>Exports</td>
<td>-0.21</td>
<td>-0.15</td>
<td>0.00</td>
<td>0.23</td>
<td>0.50</td>
<td>0.72</td>
<td>0.80</td>
<td>0.70</td>
<td>0.44</td>
<td>0.11</td>
<td>-0.18</td>
</tr>
<tr>
<td>Imports</td>
<td>0.03</td>
<td>0.10</td>
<td>0.22</td>
<td>0.41</td>
<td>0.64</td>
<td>0.80</td>
<td>0.83</td>
<td>0.67</td>
<td>0.38</td>
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</tr>
<tr>
<td>Employment</td>
<td>-0.49</td>
<td>-0.44</td>
<td>-0.22</td>
<td>0.11</td>
<td>0.48</td>
<td>0.76</td>
<td>0.86</td>
<td>0.77</td>
<td>0.51</td>
<td>0.18</td>
<td>-0.12</td>
</tr>
<tr>
<td>Ind. production</td>
<td>-0.38</td>
<td>-0.28</td>
<td>-0.03</td>
<td>0.30</td>
<td>0.61</td>
<td>0.80</td>
<td>0.79</td>
<td>0.60</td>
<td>0.28</td>
<td>-0.05</td>
<td>-0.30</td>
</tr>
<tr>
<td>Retail sales</td>
<td>-0.38</td>
<td>-0.06</td>
<td>0.28</td>
<td>0.56</td>
<td>0.72</td>
<td>0.73</td>
<td>0.63</td>
<td>0.47</td>
<td>0.31</td>
<td>0.20</td>
<td>0.14</td>
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<tr>
<td>New orders, manuf</td>
<td>-0.22</td>
<td>-0.09</td>
<td>0.12</td>
<td>0.35</td>
<td>0.55</td>
<td>0.67</td>
<td>0.68</td>
<td>0.55</td>
<td>0.33</td>
<td>0.08</td>
<td>-0.12</td>
</tr>
</tbody>
</table>
## US: cross-correlations with nominal variables

<table>
<thead>
<tr>
<th>Variable X</th>
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<th>x(t+3)</th>
<th>x(t+4)</th>
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<tbody>
<tr>
<td>M2</td>
<td>0.23</td>
<td>0.37</td>
<td>0.48</td>
<td>0.51</td>
<td>0.44</td>
<td>0.28</td>
<td>0.07</td>
<td>-0.14</td>
<td>-0.30</td>
<td>-0.39</td>
<td>-0.39</td>
</tr>
<tr>
<td>Bank credit</td>
<td>-0.01</td>
<td>0.15</td>
<td>0.27</td>
<td>0.32</td>
<td>0.29</td>
<td>0.20</td>
<td>0.11</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Business loans</td>
<td>-0.40</td>
<td>-0.46</td>
<td>-0.42</td>
<td>-0.28</td>
<td>-0.05</td>
<td>0.22</td>
<td>0.45</td>
<td>0.60</td>
<td>0.63</td>
<td>0.54</td>
<td>0.35</td>
</tr>
<tr>
<td>Real estate loans</td>
<td>-0.31</td>
<td>-0.20</td>
<td>-0.04</td>
<td>0.15</td>
<td>0.33</td>
<td>0.46</td>
<td>0.52</td>
<td>0.48</td>
<td>0.37</td>
<td>0.21</td>
<td>0.04</td>
</tr>
<tr>
<td>Mortgage</td>
<td>0.02</td>
<td>-0.01</td>
<td>-0.04</td>
<td>-0.03</td>
<td>0.02</td>
<td>0.12</td>
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<td>0.25</td>
<td>0.21</td>
<td>0.11</td>
<td>-0.02</td>
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<tr>
<td>Consumer loans</td>
<td>-0.39</td>
<td>-0.39</td>
<td>-0.27</td>
<td>-0.04</td>
<td>0.26</td>
<td>0.52</td>
<td>0.68</td>
<td>0.70</td>
<td>0.59</td>
<td>0.38</td>
<td>0.13</td>
</tr>
<tr>
<td>Credit to private sector</td>
<td>-0.49</td>
<td>-0.50</td>
<td>-0.40</td>
<td>-0.20</td>
<td>0.09</td>
<td>0.38</td>
<td>0.62</td>
<td>0.74</td>
<td>0.72</td>
<td>0.59</td>
<td>0.41</td>
</tr>
<tr>
<td>Residential property prices</td>
<td>-0.23</td>
<td>-0.13</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.12</td>
<td>0.15</td>
<td>0.16</td>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>Commercial property prices</td>
<td>-0.37</td>
<td>-0.40</td>
<td>-0.36</td>
<td>-0.23</td>
<td>-0.02</td>
<td>0.21</td>
<td>0.42</td>
<td>0.55</td>
<td>0.56</td>
<td>0.48</td>
<td>0.33</td>
</tr>
<tr>
<td>Share prices</td>
<td>0.00</td>
<td>0.09</td>
<td>0.18</td>
<td>0.23</td>
<td>0.24</td>
<td>0.19</td>
<td>0.12</td>
<td>0.05</td>
<td>-0.01</td>
<td>-0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td>Long rate</td>
<td>-0.43</td>
<td>-0.41</td>
<td>-0.28</td>
<td>-0.07</td>
<td>0.14</td>
<td>0.30</td>
<td>0.36</td>
<td>0.30</td>
<td>0.15</td>
<td>-0.01</td>
<td>-0.14</td>
</tr>
<tr>
<td>Short rate</td>
<td>-0.64</td>
<td>-0.57</td>
<td>-0.35</td>
<td>-0.02</td>
<td>0.32</td>
<td>0.57</td>
<td>0.66</td>
<td>0.58</td>
<td>0.38</td>
<td>0.14</td>
<td>-0.05</td>
</tr>
<tr>
<td>IR spread</td>
<td>0.47</td>
<td>0.39</td>
<td>0.21</td>
<td>-0.04</td>
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<td>-0.47</td>
<td>-0.55</td>
<td>-0.51</td>
<td>-0.38</td>
<td>-0.22</td>
<td>-0.08</td>
</tr>
</tbody>
</table>
Cross-correlations

- Real GDP and output components
  - Results largely in line with previous RBC literature
  - Business cycles are “real”:
    1. Real variables strongly pro-cyclical
    2. Real government consumption counter-cyclical & lagging

- Real GDP and financial variables
  1. Financial variables acyclical
  2. M2 leads but correlation weak: monetary “myth”
  3. Credit-output correlation weak
  4. Housing and share prices basically uncorrelated with output
  5. Interest rates: cross-correlations not consistent

- Credit and asset price “myths”?
Cross-correlations in G3 economies

Cross-correlations of GDP with other variables

United States

Euro area

Japan

1. Refer to data up to Q4 2009; for the euro area, bank credit, employment, fixed investment and private consumption refer to data up to Q3 2009; for Japan, bank credit refers to data up to Q3 2009; all variables have been logged and de-trended using a band-pass filter; x-axis: number of leads (lags) of quarters of the variables with which contemporaneous GDP has been correlated; y-axis: correlation coefficient.

2. In nominal terms.

3. Bank credit defined as non-financial corporations’ liabilities plus housing loans plus consumer credit plus liabilities of government from the Japanese Flow of Funds for the period Q4 1997–Q3 2009.

Sources: Bank of Japan; national data; BIS calculations.
Cross-correlations in Japan

Cross-correlations of Japanese GDP with nominal credit

Q4 1964–Q3 1997

Q4 1997–Q3 2009

Q4 1964–Q3 2009

1. All variables have been logged and de-trended using a band-pass filter; x-axis: number of leads (lags) of quarters of the variables with which contemporaneous GDP has been correlated; y-axis: correlation coefficient. 2. Credit defined as loans by private financial Institutions/banks/stock (assets). 3. Discontinued series. 4. Credit data backdated using the discontinued series.

Sources: Bank of Japan; BIS calculations.
Credit & business cycle synchronisation

- Credit-output relation behaves differently in G3
  1. Weak correlations in the US
  2. Credit led & was strongly correlated with output in euro area
  3. Counter-intuitive credit-output correlations in Japan
  4. Credit leading or lagging unclear

- Credit-output relationship time-varying: Japan
  1. 1964Q4–1997Q3: credit pro-cyclical, lags the output cycle
  2. 1997Q4–2009Q3: disrupted credit-output relationship
  3. 1964Q4–2009Q3: dominated by pre-1997Q4 sample results
Causality for “displaced” cycles

Causality? displaced cycles

Cycle 1
Cycle 2

Time

Cycles
Causality for cycles of different durations

![Graph showing cycles of different durations](image)
# Causality test results

## Table 3: Granger non-causality tests (Granger version)*

<table>
<thead>
<tr>
<th>Variable X</th>
<th>Variable Y</th>
<th>$X \rightarrow Y$</th>
<th>$Y \rightarrow X$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP</td>
<td>Bank credit</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Credit to private sector</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Employment</td>
<td>Bank credit</td>
<td>Yes**</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Credit to private sector</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industrial production</td>
<td>Business loans</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Bank loans (FoF)</td>
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<td>Yes</td>
</tr>
<tr>
<td>New orders, manufacturing</td>
<td>Business loans</td>
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<td>Yes</td>
</tr>
<tr>
<td>Bankruptcy filings</td>
<td>Business loans</td>
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<td>Yes**</td>
</tr>
<tr>
<td>Real private fixed investment</td>
<td>Bank loans (FoF)</td>
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<td>No**</td>
</tr>
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<tr>
<td>Non-residential</td>
<td>Commercial real estate loans</td>
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<td>No</td>
</tr>
<tr>
<td>Residential</td>
<td>Mortgage loans</td>
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<td>Yes**</td>
</tr>
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<td>Real private consumption</td>
<td>Consumer loans</td>
<td>Yes</td>
<td>No</td>
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<td>Durable goods</td>
<td>Consumer loans</td>
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<td>Non-durable goods</td>
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</tr>
<tr>
<td>Retail sales</td>
<td>Consumer loans</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*All variables are in terms of year-on-year growth rates. **Weak evidence.
Causality test results

- Granger (1969) non-causality tests
  - Temporally exogenous: cause precedes effect
  - Linearly informative, but: nonlinear structural changes

- Mixed evidence
  - Some evidence of causality between credit and real activity
  - No evidence of causality between
    - Credit and investment
    - Credit and consumption
  - Causality tests inconclusive
Spectral analysis

- Spectral analysis of time series
  1. Granger’s (1966) “typical spectral shape”
  2. Engle’s (1974, 1980) band-spectrum regression

- Credit-output relationship
  - Spectral & cross-spectral densities, coherency, gain and phase-to-frequency ratio
  - Frequency-specific correlation & regression: Zhu (2005)
  - Instead of one frequency band, examine ENTIRE spectrum
Credit-output in frequency domain

- Model consistency across frequencies
  "... there is little discussion of whether the same model applies to all frequencies. It may be too much to ask of a model that it explain both slow and rapid shifts in the variables, or both seasonal and non-seasonal behavior. It is at least reasonable to test the hypothesis that the same model applies at various frequencies."

- Credit-output relationship can vary across frequencies
  - Low vs. business-cycle frequencies
Spectral density: “typical spectral shape”

- Power spectrum records contribution of the component(s) belonging to a given frequency (band) to total variance of a stochastic process
- Great importance of low-frequency components: trends!
Logged power spectral density
Cross-spectral density

- Cospectrum represents covariance between in-phase components of two time series at a given frequency (band)
Logged cross-spectral density
Coherency & gains (credit to private sector)

- Coherency (squared coherence) varies in [0,1], is similar to a correlation of determination ($R^2$) at a given frequency (band)
Coherency and gains (bank credit)

- Gain (transfer) is similar to a standardised regression coefficient at a given frequency (band)
Phase-to-frequency ratio: time lag

- Phase measures timing or average phase lead of one series over another, it incorporates all information about leads and lags
Frequency-specific correlation and regression

- Zhu (2005)
- A simple procedure to retrieve frequency-specific data
- Frequency-specific coefficient of correlation (FSCC)
  - Unlike coherence, FSCC is signed
  - Unlike cospectrum, FSCC takes into account both real and imaginary components
  - Standardised, takes values in the $[-1, 1]$ range.
- Frequency-specific coefficient of regression (FSCR)
  - Any frequency
  - Conventional asymptotic theory remains valid
Frequency-specific data extraction 1

Time series vector: \( x = [x_1, x_2, \ldots, x_T]^T \)

Fundamental Frequencies

\[ \omega_s = \frac{2\pi s}{T} \]

for \( s = 1, \ldots, T \)

Discrete Fourier Transform (DFT) of \( x \) at frequency \( \omega_s \):

\[ \omega_s x = T^{-1/2} \sum_{t=1}^{T} x_t e^{(t-1)i\omega_s} \]

where \( \omega_s = T^{-1/2} \begin{bmatrix} 1 & e^{i\omega_s} & e^{2i\omega_s} & \cdots & e^{(T-1)i\omega_s} \end{bmatrix} \)
Frequency-specific data extraction 2

Define

\[ W = \begin{bmatrix} w_0^T, w_1^T, \ldots, w_{T-1}^T \end{bmatrix}^T \]

where \( W \) is unitary: \( W^* W = W W^* = I \)

DFT of \( x \) at all frequencies: \( \tilde{x} = W x \)

DFT of \( x \) at the \( s \)-th frequency:

\[ A_s \tilde{x} = A_s W x \]

where \( A_s \) is a \( T \times T \) selection matrix with 1 as the \( s \)-th element and zeros elsewhere.
Frequency-specific correlation coefficient

- **Frequency-**$\omega_s$ **Inverse Fourier Transform (IFT)** of $x$:

$$
\hat{x}(\omega_s) = L_s x = W^* A_s W x
$$

where $L_s = W^* A_s W$ is a linear operator.

- Since $L_s$ is linear, **NO** new inferential theory is needed for statistical analysis of the new series;

- **Frequency-Specific Coefficient of Correlation (FSCC)** at frequency $\omega_s$:

$$
\rho(\omega_s) = \frac{Cov(\hat{x}(\omega_s), \hat{y}(\omega_s))}{\sqrt{Var(\hat{x}(\omega_s)) \sqrt{Var(\hat{y}(\omega_s))}}}
$$
Frequency-specific spectral regression

**Frequency-Specific Coefficient of Regression (FSCR) at frequency** $\omega_s$:

\[
L_s y = \beta_s L_s x + L_s \varepsilon \\
\tilde{\beta}_s = (\hat{x}_s^T \hat{x}_s)^{-1} \hat{x}_s \hat{y}_s
\]

where $L_s \doteq W^* A_s W$.

**Cross-Frequency Spectral Regression** at frequencies $\omega_s$ & $\omega_t$:

\[
L_s y = \beta_{s,t} L_t x + \varepsilon_{s,t} \\
\tilde{\beta}_{s,t} = (\hat{x}_t^T \hat{x}_t)^{-1} \hat{x}_t \hat{y}_s
\]
Frequency-specific correlation coefficient

Real GDP and credit to private sector

Real GDP and bank credit
Frequency-specific regression coefficient

Bank credit on real GDP

Real GDP on bank credit
Credit and output in frequency domain

1. Relation strong in low frequencies (long run)
2. Weak or lack of clear pattern in business-cycle frequencies
3. Lead-lag relationship varies wildly in business cycle frequencies (bank credit)
4. Credit to private sector more significant correlation with real GDP than bank credit
How to better predict credit?

- Lending standards regression
  - Indicator value & optimal credit response to lending standards?

- Role of private sector balance sheets
  - Household balance sheets: Mishkin (1977, 1995)
  - Brokers & dealers: Adrian-Shin (2008)
Channels: beyond Bernanke-Gertler (1989)

- Lending standards/Credit
- Financial sector leverage
- Private sector leverage
- Borrowers' Balance sheets
- Lenders' Balance sheets
- Financial markets
  - Asset prices
  - Aggregate activity
- Monetary Policy; Regulation
- Debt-deflation
- Collateral
- Deleveraging

References:
- Bernanke-Gertler (1989)
- Kiyotaki-Moore (1997)
- Mishkin (1995)
- Kashyap-Stein (1995)
- Adrian-Shin (2008)
Data

- FRB senior loan officer survey
  - Non-price terms of lending
  - From over 120 to over 60 banks, representative

- Balance sheet data: flow of funds
  - Supply-side: banks (commercial and broker-dealers),
  - Demand-side: firms & households
Results I: lending standards

Table 4: Credit growth and lending standards 1990Q2 – 2009Q1*

<table>
<thead>
<tr>
<th>Variable $X$</th>
<th>Credit to private sector</th>
<th>Bank credit</th>
<th>Bank loans</th>
<th>Business loans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.76</td>
<td>1.16</td>
<td>-0.46</td>
<td>0.88</td>
</tr>
<tr>
<td>$\sum \Delta Y_{t-1}$</td>
<td>0.94 (0.00)</td>
<td>0.77 (0.00)</td>
<td>0.82 (0.00)</td>
<td>0.93 (0.00)</td>
</tr>
<tr>
<td>Standards$_{t-1}$</td>
<td>-0.12 (0.06)</td>
<td>-0.09 (0.01)</td>
<td>-0.15 (0.00)</td>
<td>-0.66 (0.00)</td>
</tr>
<tr>
<td>$\Delta$ Real GDP$_{t-1}$</td>
<td>-0.14 (0.89)</td>
<td>0.43 (0.39)</td>
<td>1.35 (0.06)</td>
<td>2.18 (0.34)</td>
</tr>
<tr>
<td>Loan spread$_{t-1}$</td>
<td>-1.82 (0.37)</td>
<td>0.54 (0.64)</td>
<td>2.55 (0.14)</td>
<td>-3.16 (0.55)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.97</td>
<td>0.72</td>
<td>0.86</td>
<td>0.96</td>
</tr>
<tr>
<td>DW statistic</td>
<td>1.70</td>
<td>1.93</td>
<td>1.73</td>
<td>1.92</td>
</tr>
</tbody>
</table>

* All credit variables are in terms of year-on-year growth rates. Reported values are long-run regression coefficient estimates (with $p$-values included in parentheses). We use the Akaike Information Criterion (AIC), Bayesian information criterion (BIC) and Final Prediction Error (FPE) to choose the optimal lag combination. For variables “Credit to private sector” and “Business loans”, the optimal number of own lags were four and two, respectively.
# Results II: commercial bank leverage

<table>
<thead>
<tr>
<th>Variable X</th>
<th>Credit growth and commercial bank leverage 1988Q1 – 2008Q4*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Independent variable $\Delta Y_t$ (credit growth)</td>
</tr>
<tr>
<td></td>
<td>Credit to private sector</td>
</tr>
<tr>
<td>Constant</td>
<td>1.11</td>
</tr>
<tr>
<td>$\sum \Delta Y_{t-1}$</td>
<td>0.91 (0.00)</td>
</tr>
<tr>
<td>$\text{CBLEV}_{t-1}$</td>
<td>-0.005 (0.33)</td>
</tr>
<tr>
<td>$\Delta \text{Real Activity}_{t-1}$</td>
<td>0.42 (0.53)</td>
</tr>
<tr>
<td>Loan spread$_{t-1}$</td>
<td>-0.64 (0.64)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.96</td>
</tr>
<tr>
<td>DW statistic</td>
<td>1.69</td>
</tr>
</tbody>
</table>

* All credit variables are in terms of year-on-year growth rates. Reported values are long-run regression coefficient estimates (with p-values included in parentheses). We use the Akaike Information Criterion (AIC), Bayesian information criterion (BIC) and Final Prediction Error (FPE) to determine the optimal lag combination. The commercial bank leverage is defined as the assets-to-equity ratio.
Results

- Lending standards
  - Statistically and economically significant
  - Other key variables lose significance; credit persistent
  - Optimal lag dynamics: ONE for standards!

- Indicator value of CB leverage
  - Small, only significant for bank credit and business loans
  - More analysis needed
    1. HH debt-disposable income ratio: strong impact on consumer loans
    2. Corporate leverage: negatively affect business loan growth
Conclusions

- Credit-output relationship in time and frequency domain
  - Real facts and nominal (credit & asset prices) myths
  - Causality tests: mixed evidence
  - Credit-output correlations strong in low frequencies: long run
  - Weak business-cycle frequency correlations

- Predicting credit growth
  - Lending standards has value
  - ONE quarter credit response to changes in lending standards
  - No definite evidence of usefulness of commercial bank leverage