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

  1. Lucas (1988): role of financial factors in growth "badly over-stressed"

  2. Apparent lack of interests from development economists

 3. Evidence of strong finance-growth relationship: Goldsmith (1969); King and Levine (1993a, 1993b, 1993c)

… 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)
2. Asset price dynamics: Kiyotaki & Moore (1997); Kiyotaki (1998)
3. Lenders' balance sheets: Kashyap & Stein (1995)
4. Balance sheets of financial intermediaries: Adrian & Shin (2008); Gertler and Kiyotaki (2010)
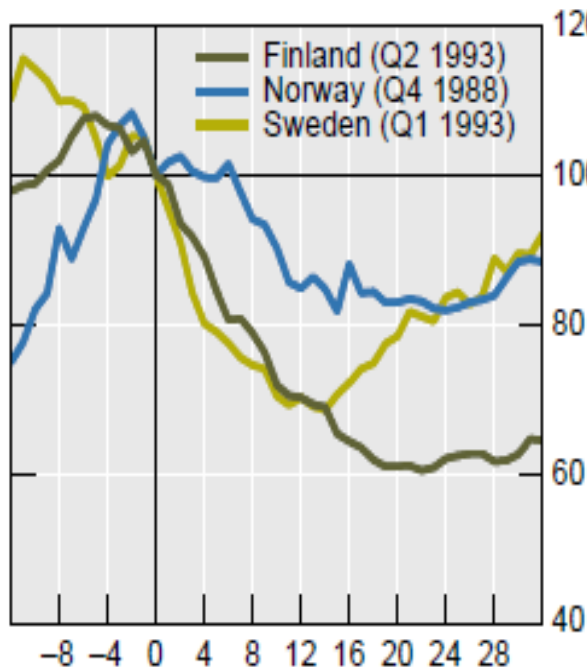
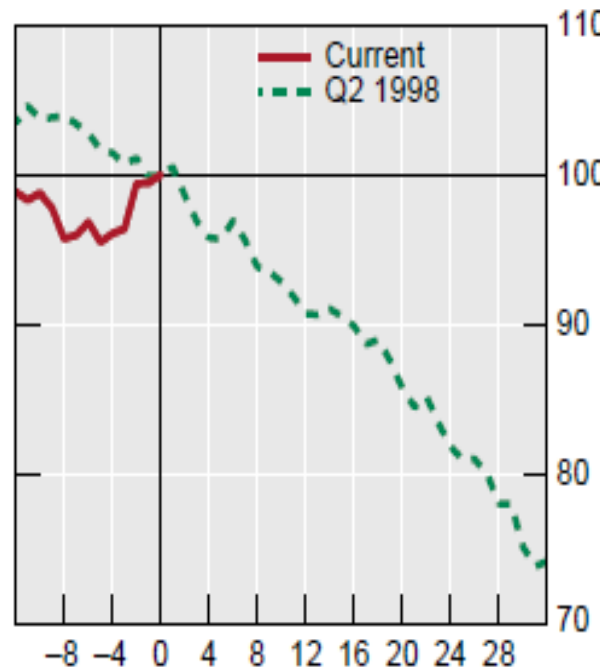➢ Empirical evidence?

Credit & business cycles: synchronised?
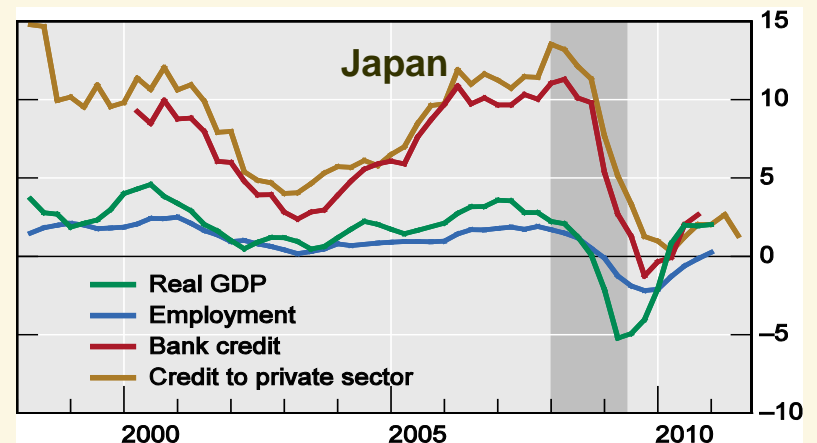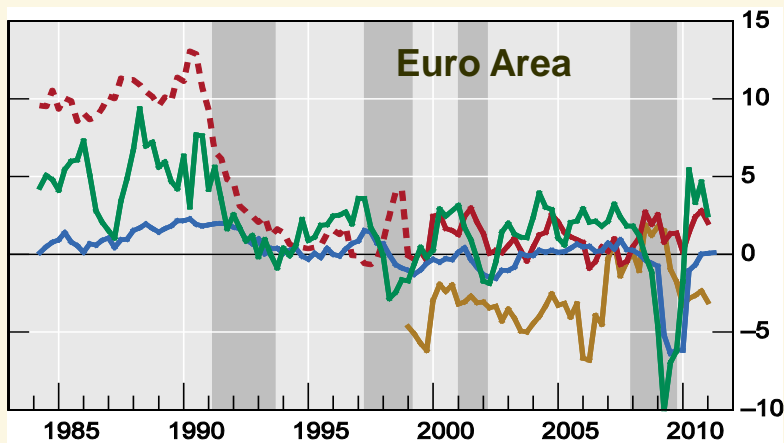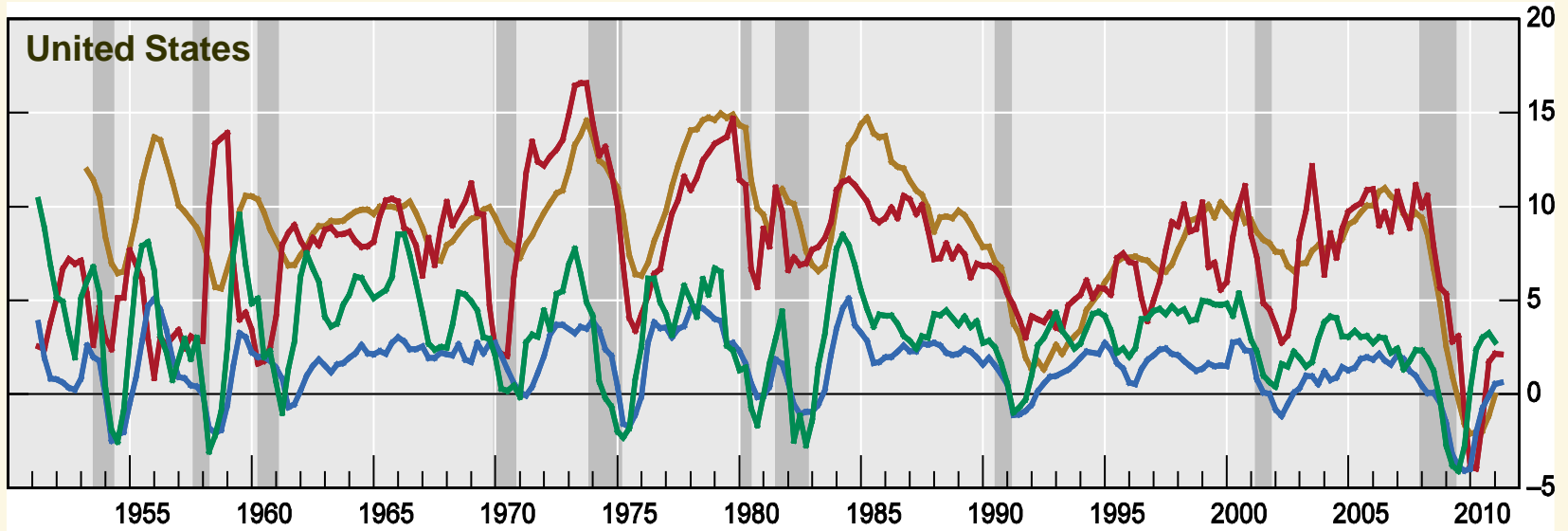
Credit recovery over selected cycles
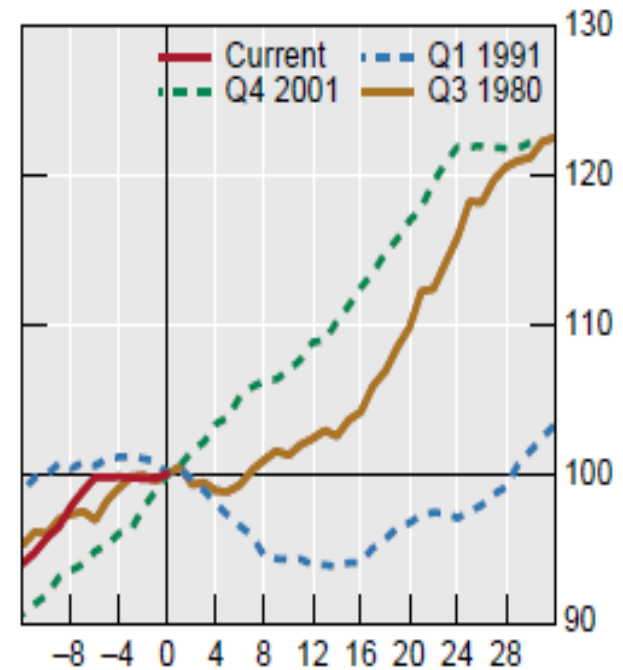
Credit & business cycles: synchronised?

➢ 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 $Corr(X,Y_t)$'s are positive and close to 1 around t; ***countercyclical*** if $Corr(X,Y_t)$'s are negative and close to 1 around t; or ***acyclical*** if $Corr(X,Y_t)$'s are small;

2. Phase shift: X ***leads*** the output cycle by i quarters if $Corr(X,Y_t)$'s peak at X_{t-i} with $i>0$; X ***lags*** the output cycle by j quarters if $Corr(X,Y_t)$'s peaks at X_{t+j} with $j>0$; X ***coincides with*** the output cycle if $Corr(X,Y_t)$'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

Variable X	Cross Correlation of Real GDP With										
	x(t−5)	x(t−4)	x(t−3)	x/t−2)	x(t−1)	x(t)	x(t+1)	x(t+2)	x(t+3)	x(t+4)	x(t+5)
Real GDP	−0.50	−0.31	0.06	0.50	0.86	1.00	0.86	0.51	0.06	−0.32	−0.52
Real consumption	−0.36	−0.13	0.22	0.60	0.85	0.89	0.71	0.36	−0.03	−0.35	−0.51
Nondurables	0.17	0.44	0.66	0.81	0.85	0.79	0.66	0.48	0.28	0.11	−0.03
Durables	0.31	0.45	0.59	0.66	0.60	0.38	0.07	−0.22	−0.36	−0.29	−0.12
Real fixed inv.	0.00	0.18	0.38	0.58	0.75	0.86	0.88	0.80	0.64	0.42	0.17
Non−residential	−0.17	−0.01	0.18	0.41	0.62	0.80	0.90	0.88	0.77	0.56	0.31
Residential	0.60	0.67	0.64	0.56	0.46	0.34	0.19	0.05	−0.07	−0.14	−0.18
Exports	−0.21	−0.15	0.00	0.23	0.50	0.72	0.80	0.70	0.44	0.11	−0.18
Imports	0.03	0.10	0.22	0.41	0.64	0.80	0.83	0.67	0.38	0.06	−0.19
Employment	−0.49	−0.44	−0.22	0.11	0.48	0.76	0.86	0.77	0.51	0.18	−0.12
Ind. production	−0.38	−0.28	−0.03	0.30	0.61	0.80	0.79	0.60	0.28	−0.05	−0.30
Retail sales	−0.38	−0.06	0.28	0.56	0.72	0.73	0.63	0.47	0.31	0.20	0.14
New orders, manuf	−0.22	−0.09	0.12	0.35	0.55	0.67	0.68	0.55	0.33	0.08	−0.12

US: cross-correlations with nominal variables

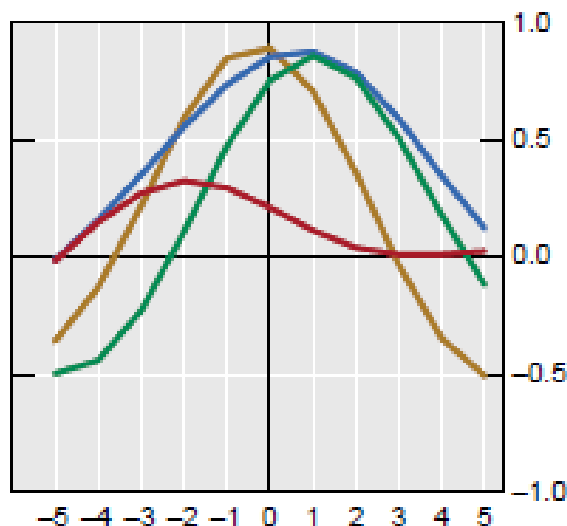| Variable X	Cross Correlation of Real GDP With										
	x(t−5)	x(t−4)	x(t−3)	x/t−2)	x(t−1)	x(t)	x(t+1)	x(t+2)	x(t+3)	x(t+4)	x(t+5)
M2	0.23	0.37	0.48	0.51	0.44	0.28	0.07	−0.14	−0.30	−0.39	−0.39
Bank credit	−0.01	0.15	0.27	0.32	0.29	0.20	0.11	0.04	0.02	0.02	0.03
Business loans	−0.40	−0.46	−0.42	−0.28	−0.05	0.22	0.45	0.60	0.63	0.54	0.35
Real estate loans	−0.31	−0.20	−0.04	0.15	0.33	0.46	0.52	0.48	0.37	0.21	0.04
Mortgage	0.02	−0.01	−0.04	−0.03	0.02	0.12	0.21	0.25	0.21	0.11	−0.02
Consumer loans	−0.39	−0.39	−0.27	−0.04	0.26	0.52	0.68	0.70	0.59	0.38	0.13
Credit to private sector	−0.49	−0.50	−0.40	−0.20	0.09	0.38	0.62	0.74	0.72	0.59	0.41
Residential property prices	−0.23	−0.13	−0.02	0.06	0.12	0.15	0.16	0.15	0.14	0.13	0.12
Commercial property prices	−0.37	−0.40	−0.36	−0.23	−0.02	0.21	0.42	0.55	0.56	0.48	0.33
Share prices	0.00	0.09	0.18	0.23	0.24	0.19	0.12	0.05	−0.01	−0.03	−0.02
Long rate	−0.43	−0.41	−0.28	−0.07	0.14	0.30	0.36	0.30	0.15	−0.01	−0.14
Short rate	−0.64	−0.57	−0.35	−0.02	0.32	0.57	0.66	0.58	0.38	0.14	−0.05
IR spread	0.47	0.39	0.21	−0.04	−0.28	−0.47	−0.55	−0.51	−0.38	−0.22	−0.08

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
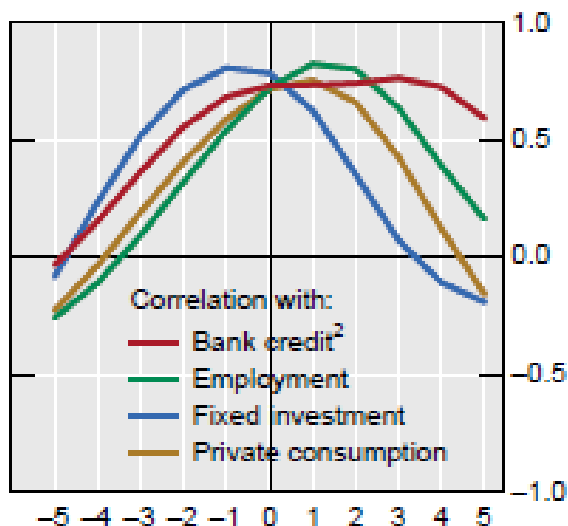➢ Credit and asset price "myths"?

Cross-correlations in G3 economies
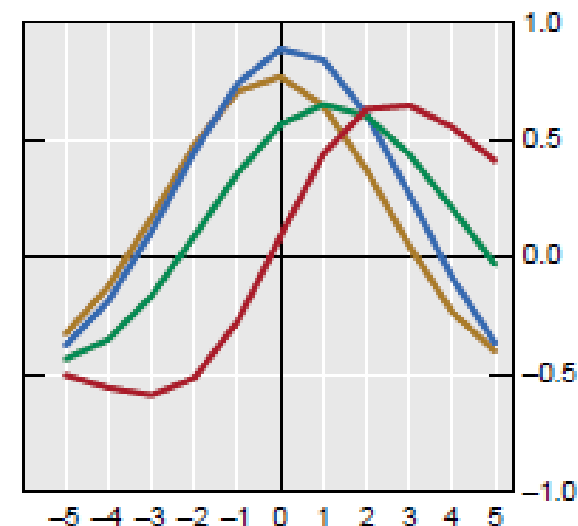

Cross-correlations of GDP with other variables[1]

United States

Euro area

Japan[3]

Correlation with:
- Bank credit[2]
- Employment
- Fixed investment
- Private consumption

[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.
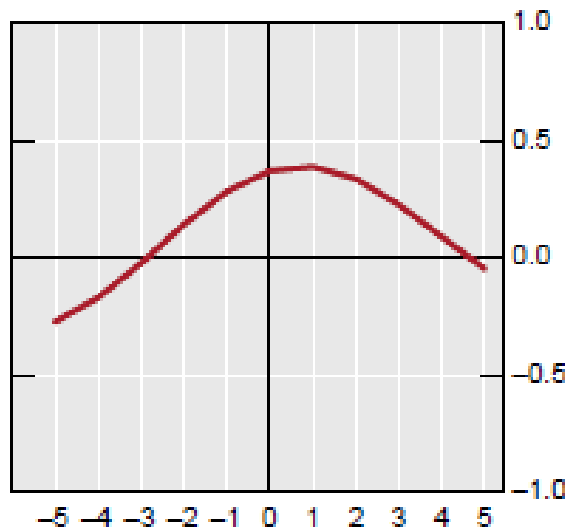
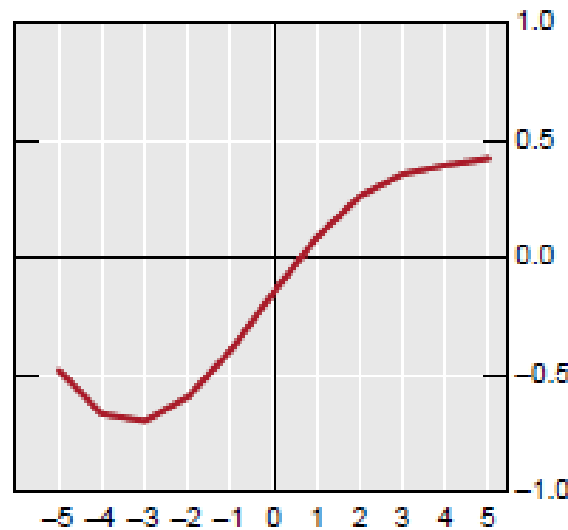Sources: Bank of Japan; national data; BIS calculations.

Cross-correlations in Japan

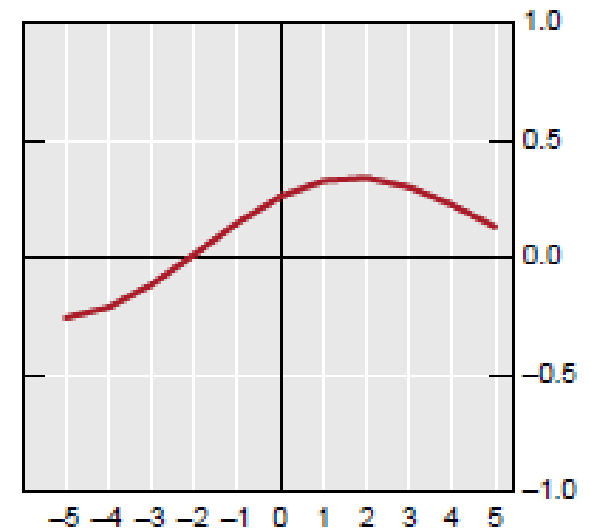Cross-correlations of Japanese GDP with nominal credit[1,2]

[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.

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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
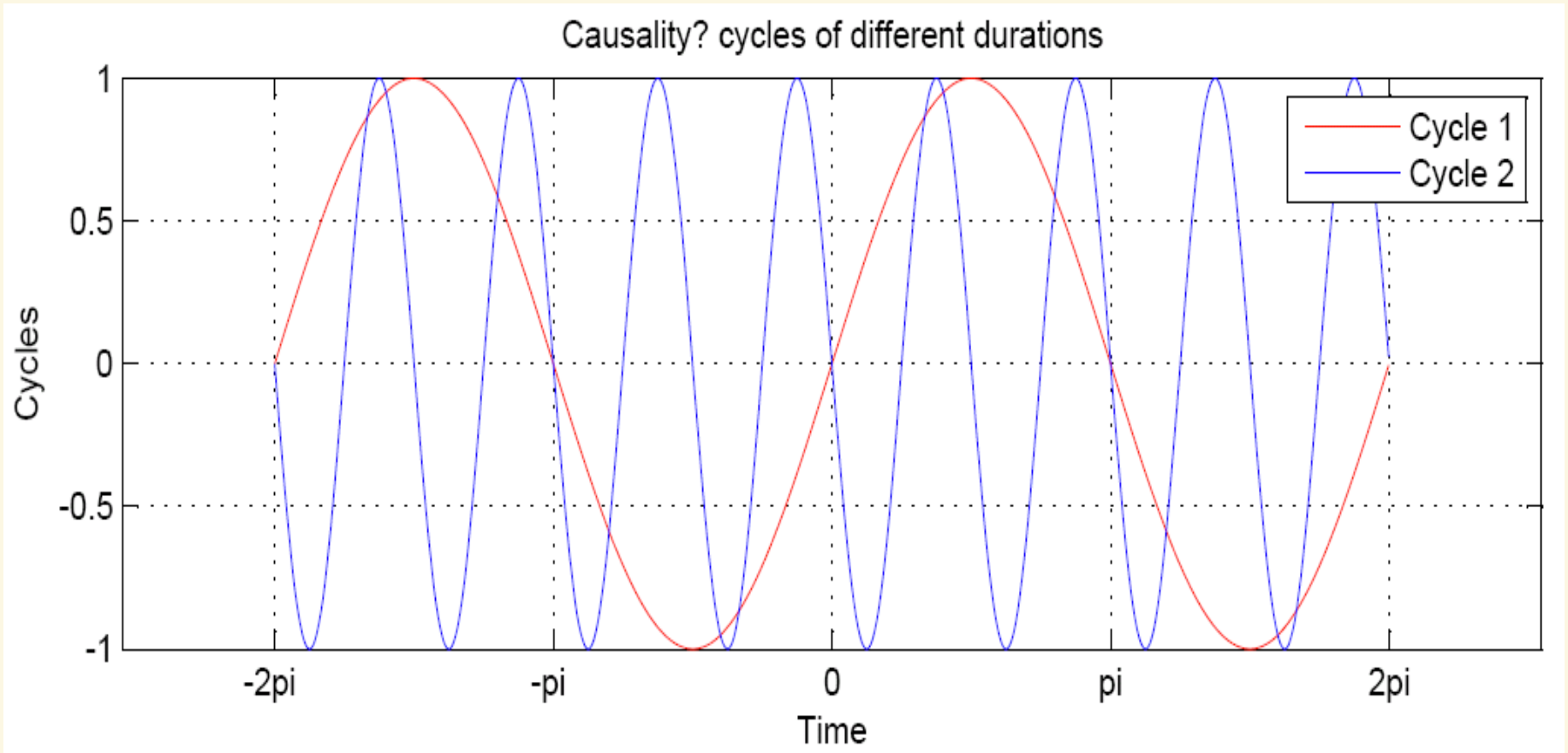3. 1964Q4–2009Q3: dominated by pre-1997Q4 sample results

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Causality for "displaced" cycles

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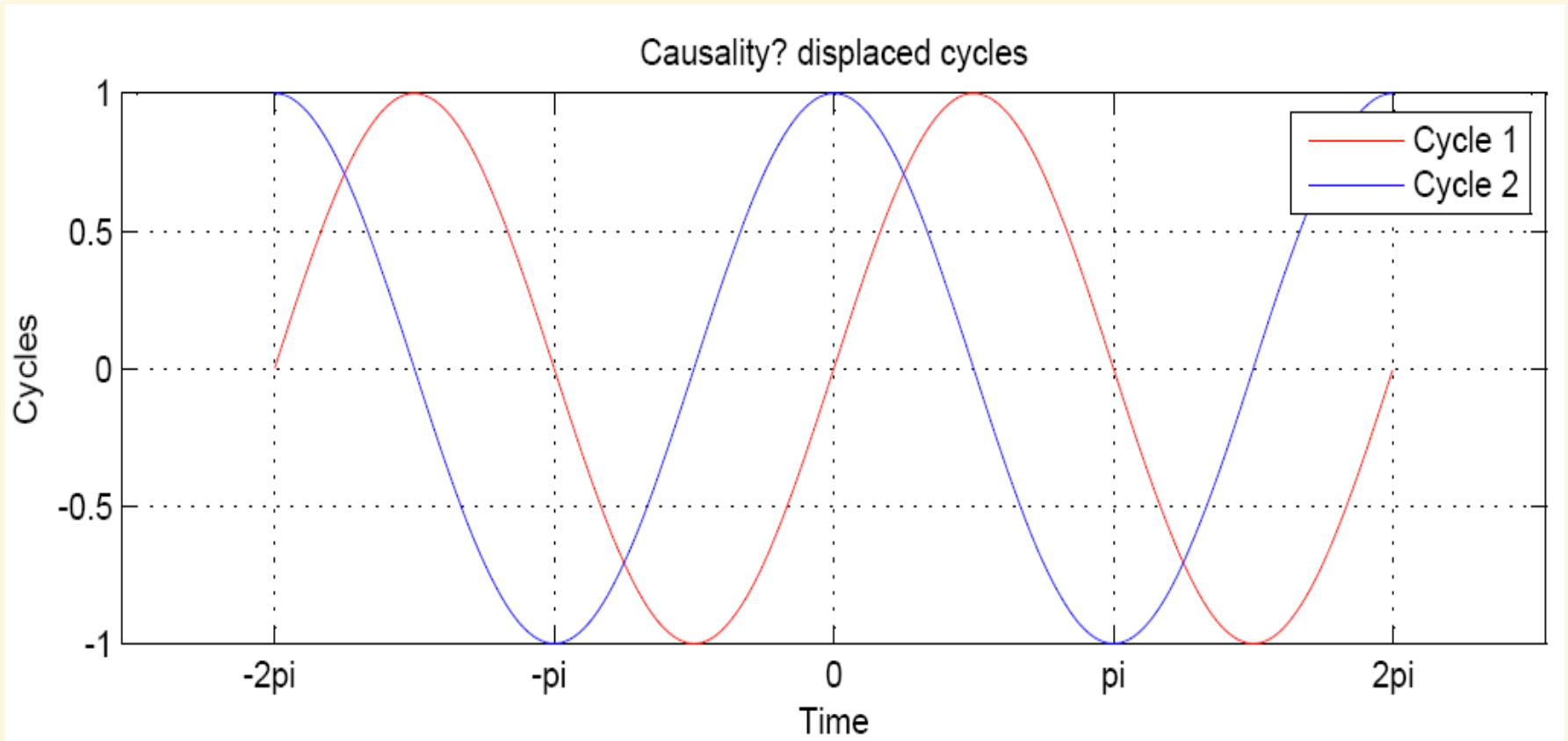
Causality for cycles of different durations

Causality? cycles of different durations

Causality test results

	Table 3: Granger non-causality tests (Granger version)*		
Variable X	Variable Y	$X \rightarrow Y$	$Y \rightarrow X$
Real GDP	Bank credit	No	Yes
	Credit to private sector	Yes	Yes
Employment	Bank credit	Yes**	Yes
	Credit to private sector	Yes	Yes
Industrial production	Business loans	Yes	Yes
	Bank loans (FoF)	Yes	Yes
New orders, manufacturing	Business loans	Yes	Yes
Bankruptcy filings	Business loans	Yes	Yes**
Real private fixed investment	Bank loans (FoF)	No	No**
Structures	Real estate loans	No	No
Non-residential	Commercial real estate loans	No	No
Residential	Mortgage loans	Yes**	Yes**
Real private consumption	Consumer loans	Yes	No
Durable goods	Consumer loans	No	No
Non-durable goods	Consumer loans	No	No
Retail sales	Consumer loans	No	No

* 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

➢ Filters & business cycle analysis: Hodrick-Prescott (1980) filter; Baxter-King (1999) band-pass filter

➢ 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

➢ Robert Engle (1974):

"... 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

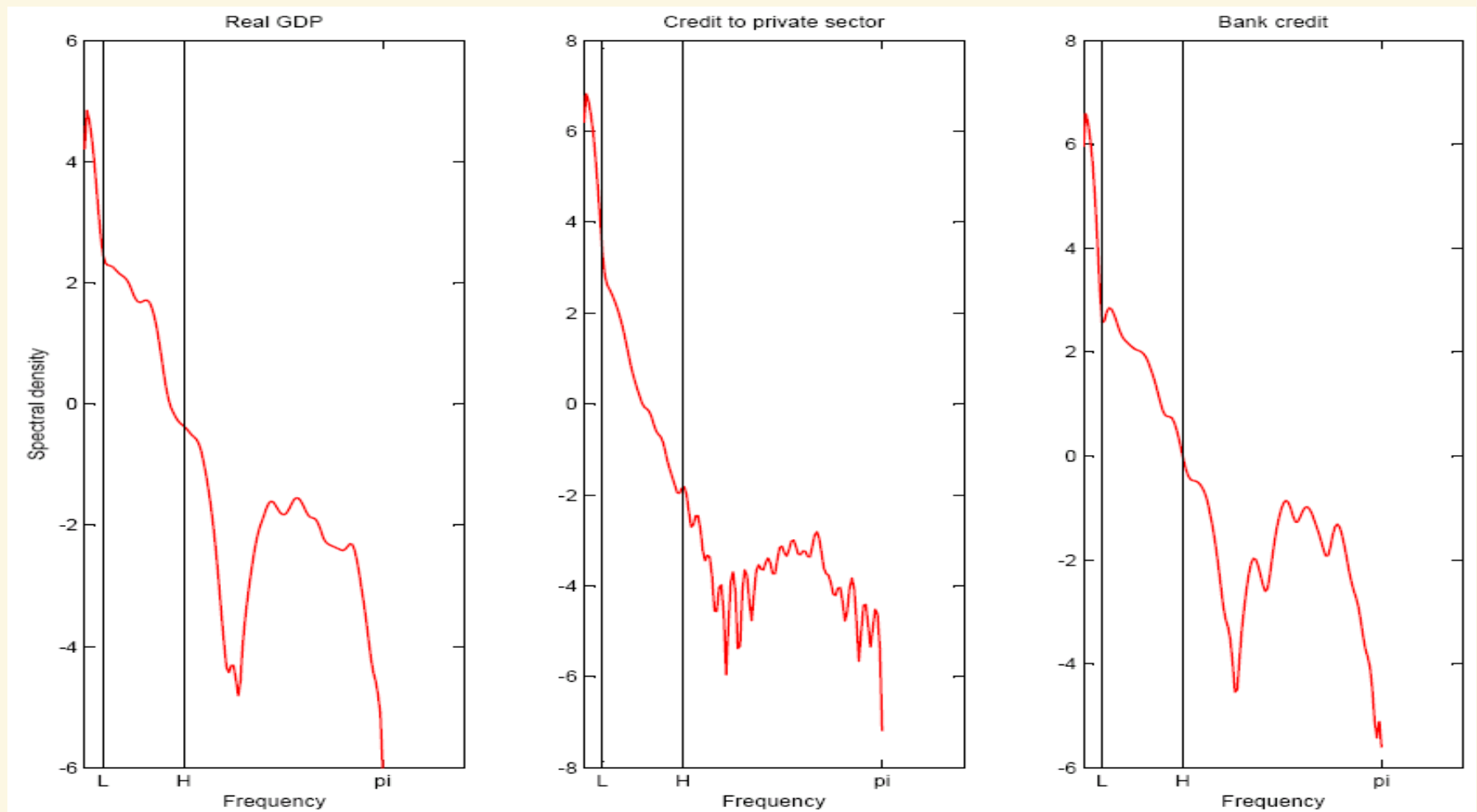 ➢ Low vs. business-cycle frequencies

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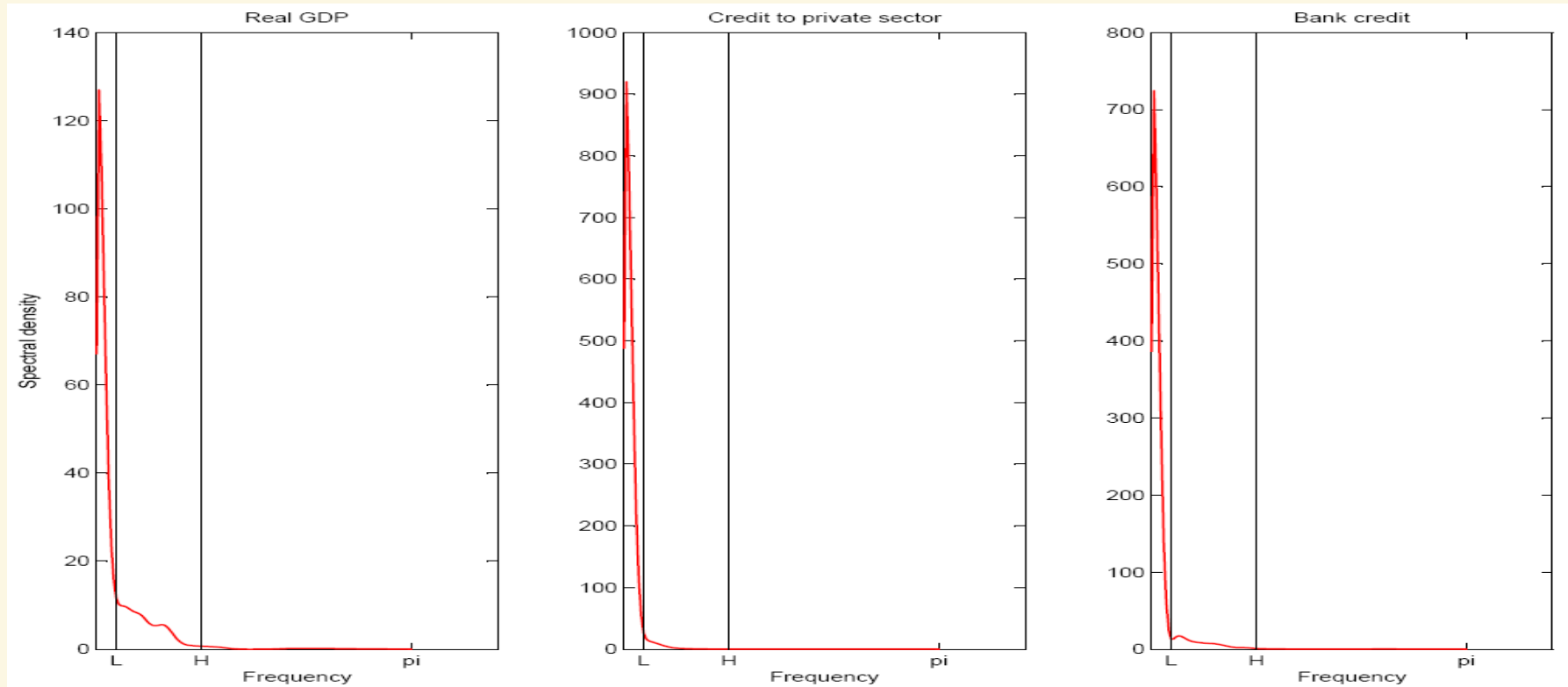
- Power spectrum records contribution of the component(s) belonging to a given frequency (band) to total variance of a stochastic process
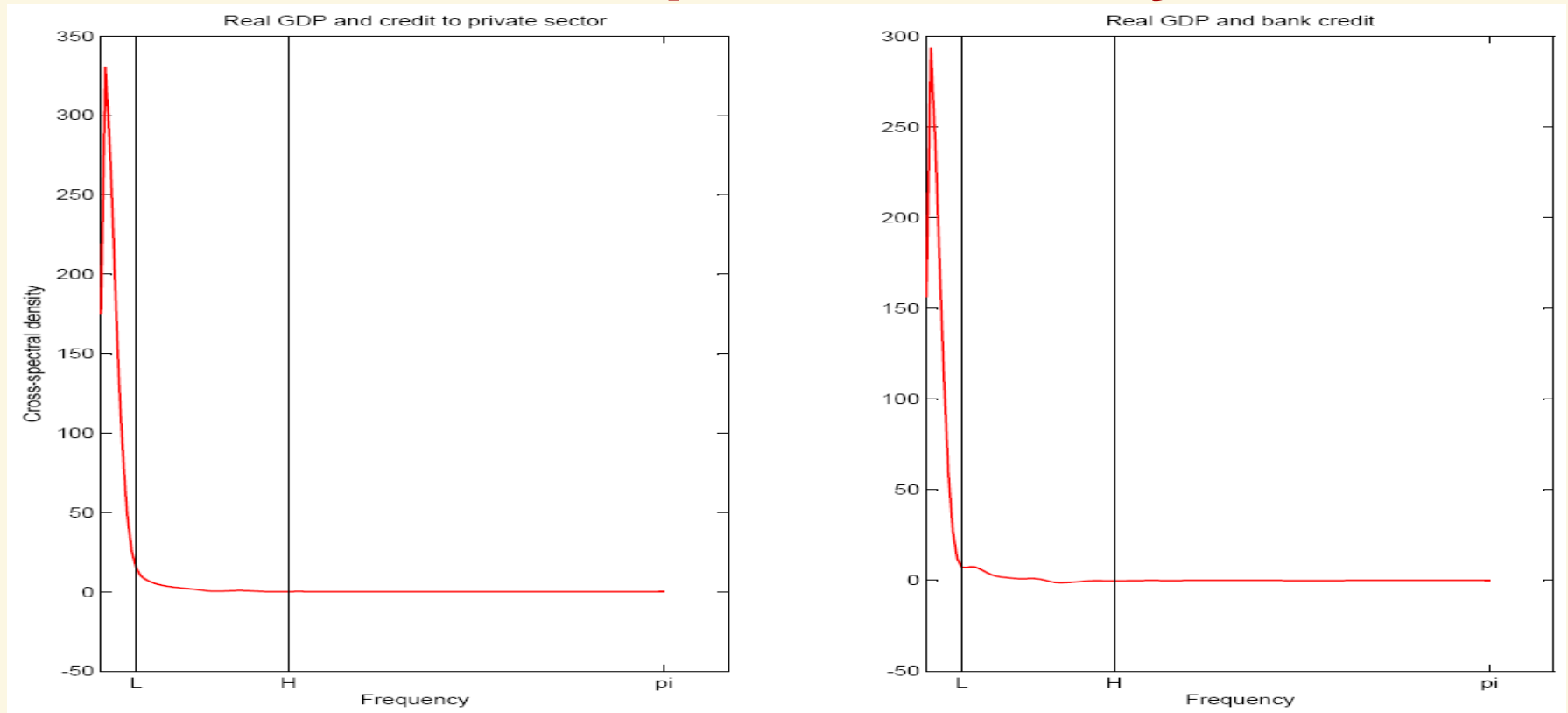- Great importance of low-frequency components: trends!

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Logged power spectral density

Cross-spectral density

Real GDP and credit to private sector

Real GDP and bank credit
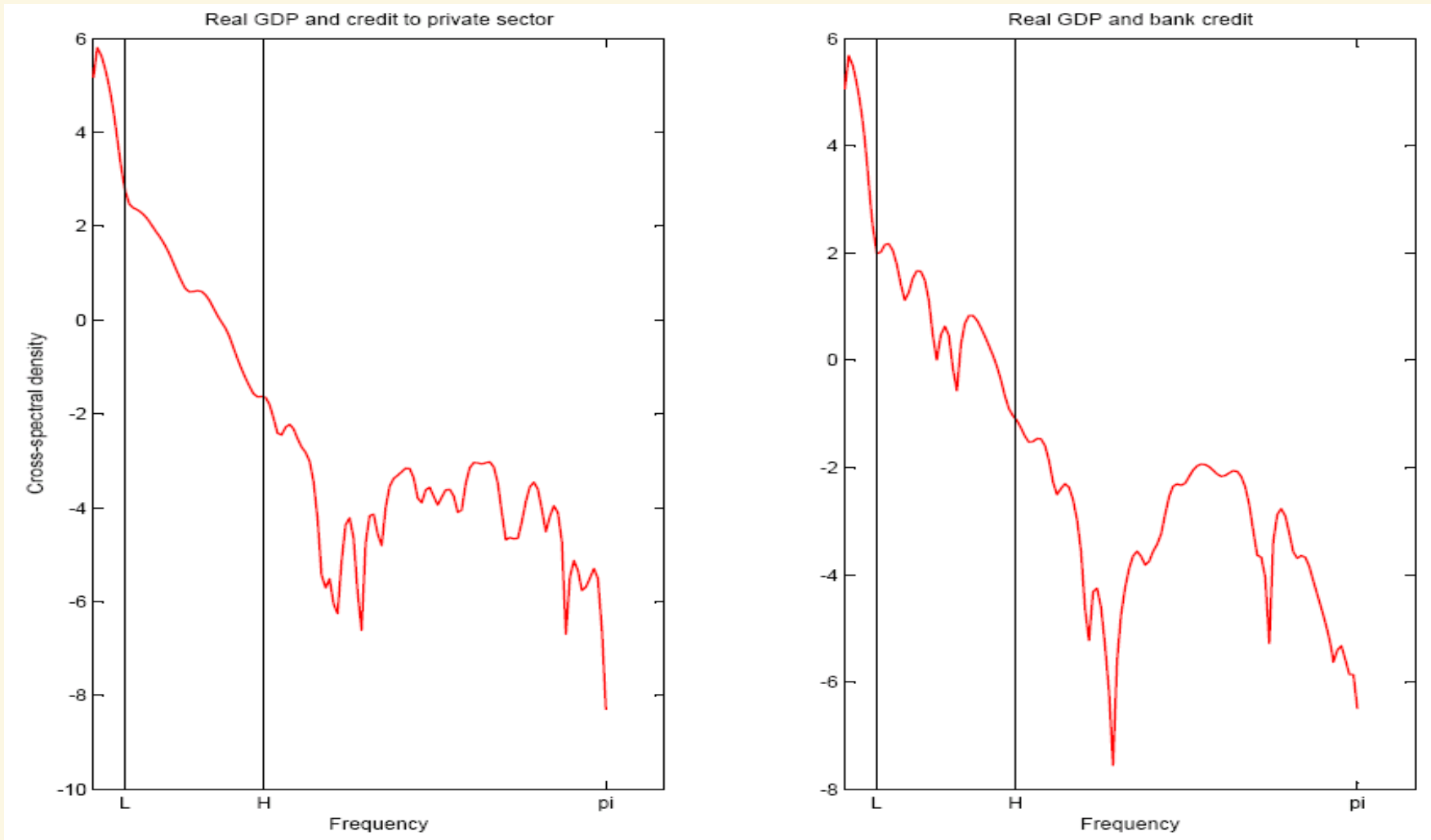
- Cospectrum represents covariance between in-phase components of two time series at a given frequency (band)
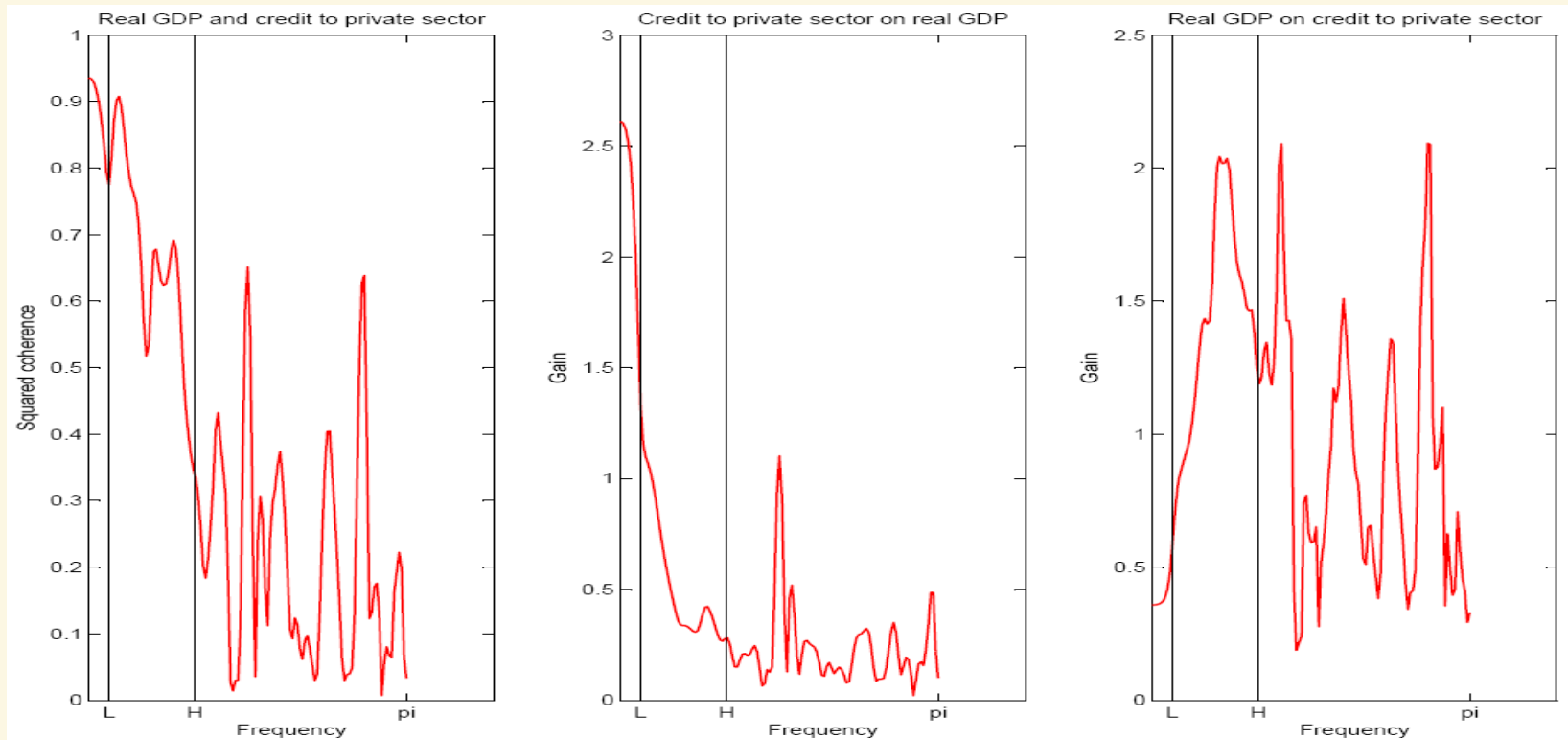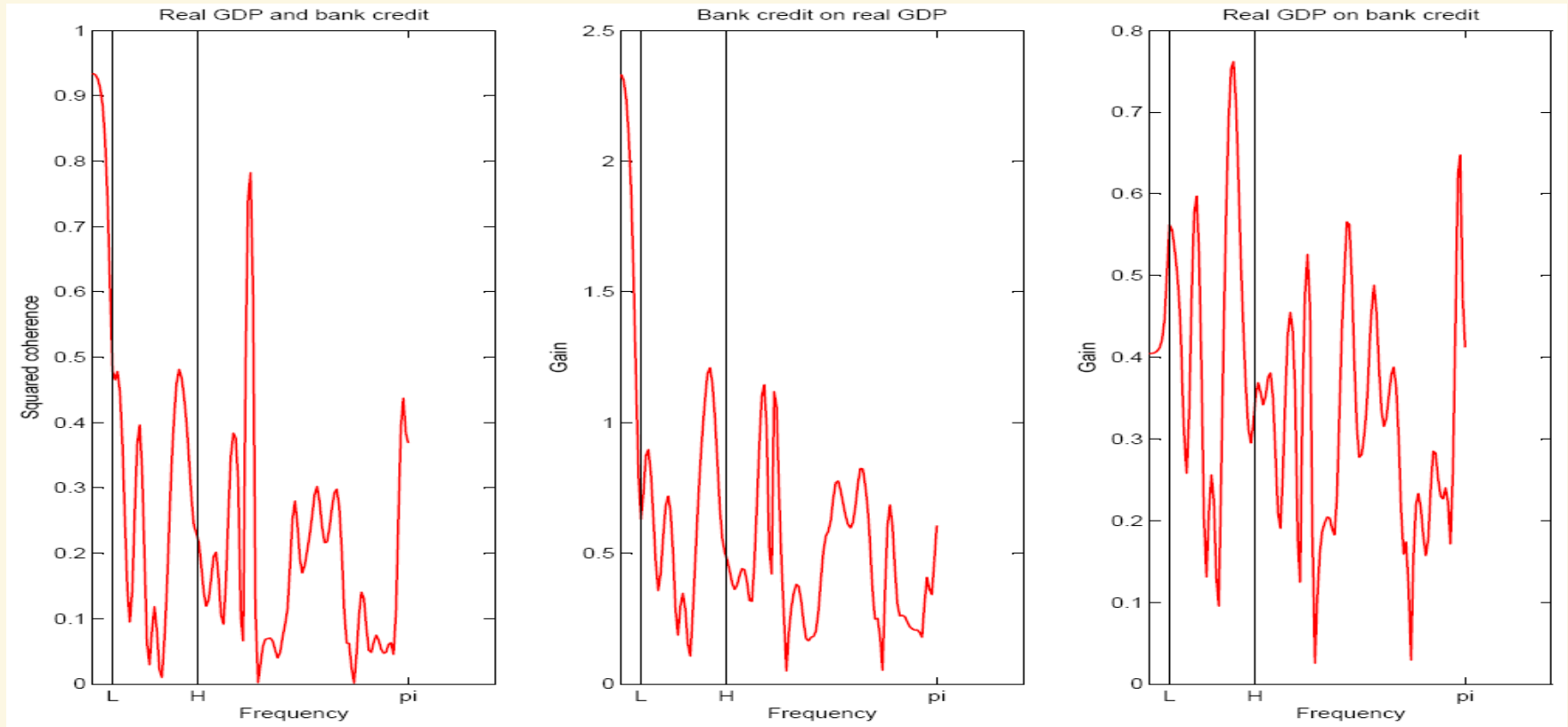
Logged cross-spectral density

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)
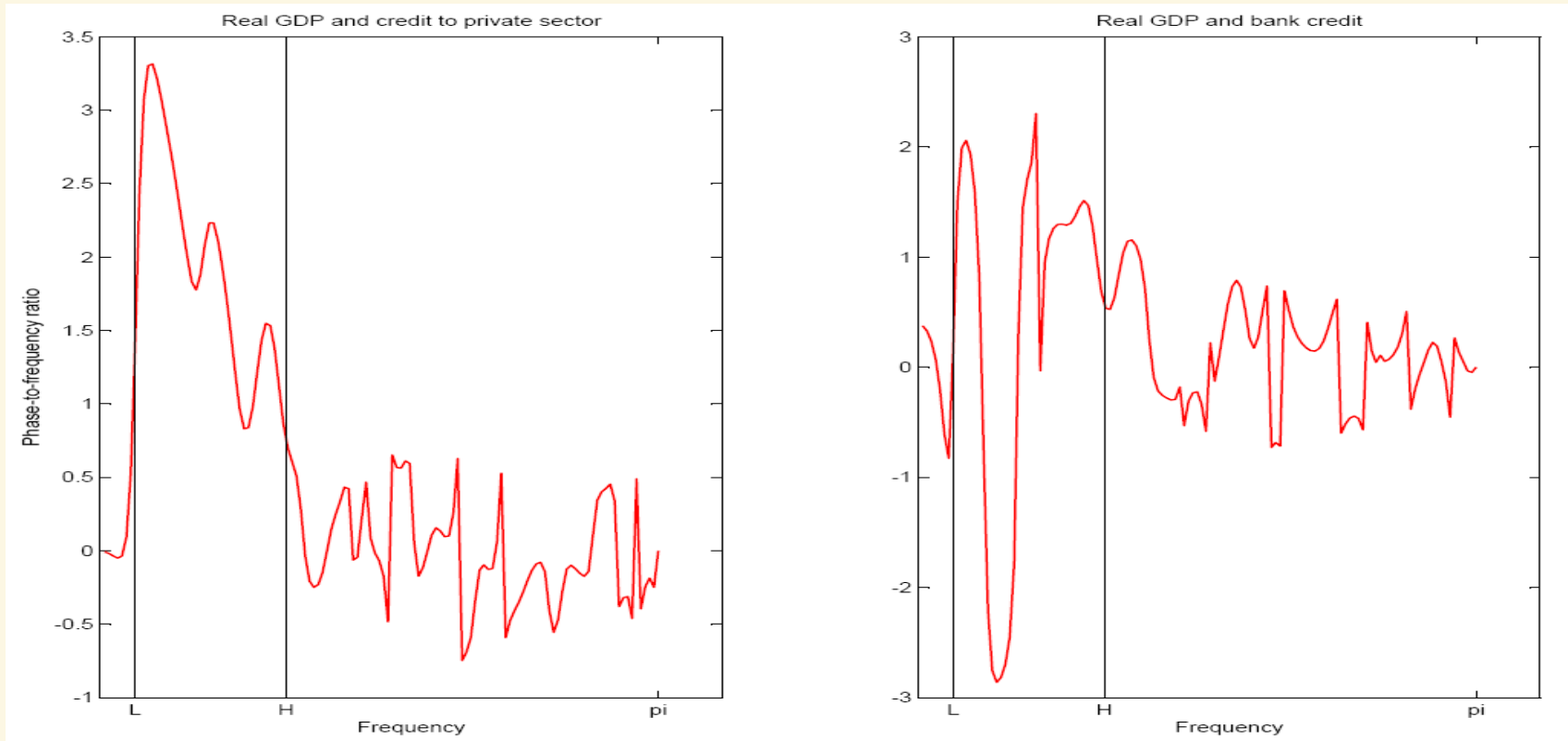
Coherency and gains (bank credit)

- 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_**

$$\omega_s = 2\pi s / T$$

for $s = 1, \ldots, T$

☞ **_Discrete Fourier Transform_** (DFT) of x at frequency ω_s:

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

where $w_s = T^{-1/2} \begin{bmatrix} 1 & e^{i\omega_s} & e^{2i\omega_s} & \cdots & e^{(T-1)i\omega_s} \end{bmatrix}$

Frequency-specific data extraction 2

☞ Define

$$W = \left[w_0^T, w_1^T, \ldots, w_{T-1}^T\right]^T$$

where W is *unitary*: $W^*W = WW^* = I$

☞ DFT of x at all frequencies: $\tilde{x} = Wx$

☞ DFT of x at the s-th frequency:

$$A_s\tilde{x} = A_sWx$$

where A_s is a $T \times T$ ***selection matrix*** with 1 as the s, s-th element and zeros elsewhere.

Frequency-specific correlation coefficient

☞ Frequency-ω_s *Inverse Fourier Transform* (IFT) of x:

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

where $L_s \doteq W^* A_s W$ 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 ω_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 ω_s:

$$L_s y = \beta_s L_s x + L_s \varepsilon$$

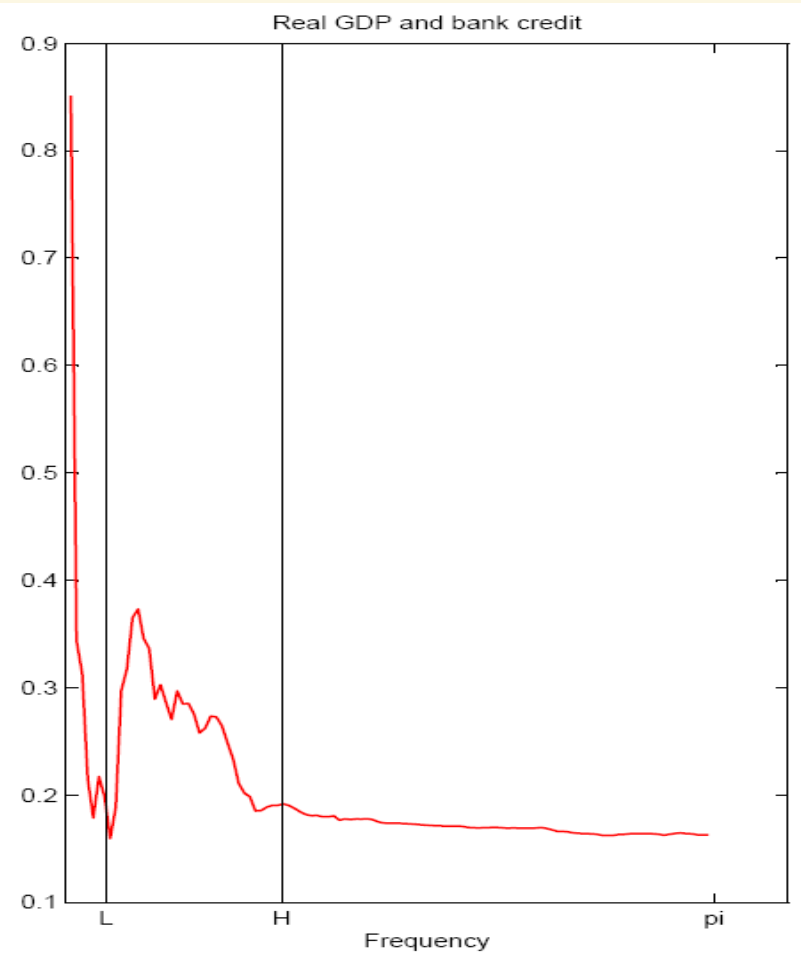$$\tilde{\beta}_s = \left(\hat{x}_s^T \hat{x}_s\right)^{-1} \hat{x}_s \hat{y}_s$$
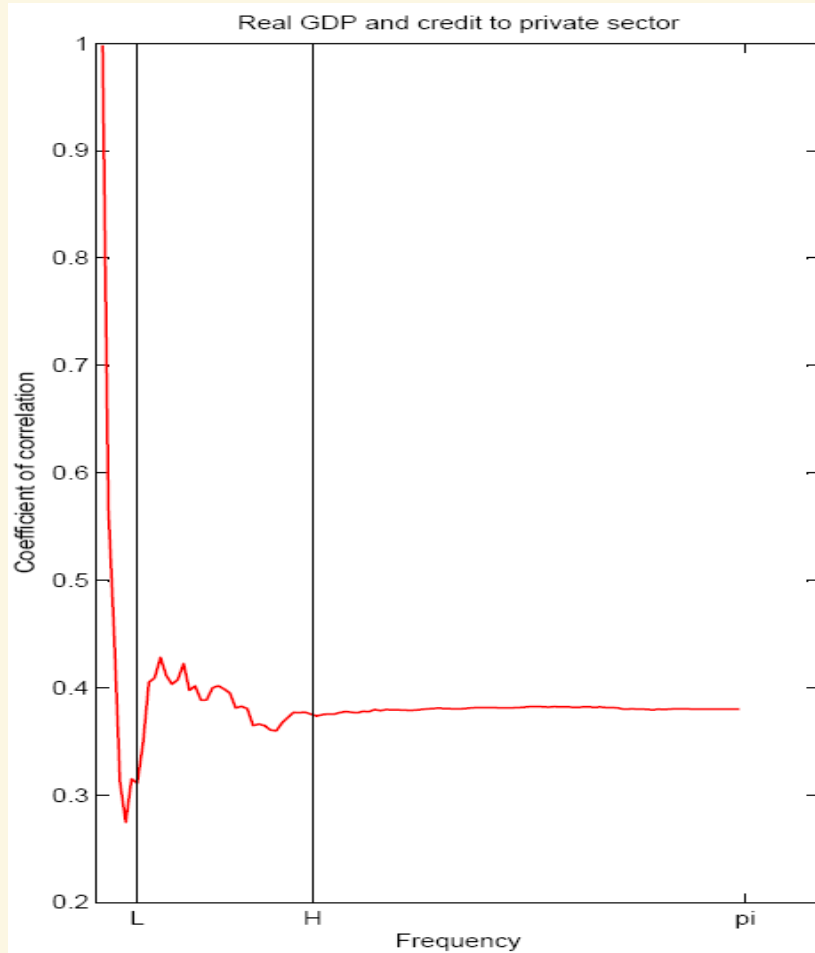
where $L_s \doteq W^* A_s W$.

☞ *Cross-Frequency Spectral Regression* at frequencies ω_s & ω_t:

$$L_s y = \beta_{s,t} L_t x + \varepsilon_{s,t}$$

$$\tilde{\beta}_{s,t} = \left(\hat{x}_t^T \hat{x}_t\right)^{-1} \hat{x}_t \hat{y}_s$$

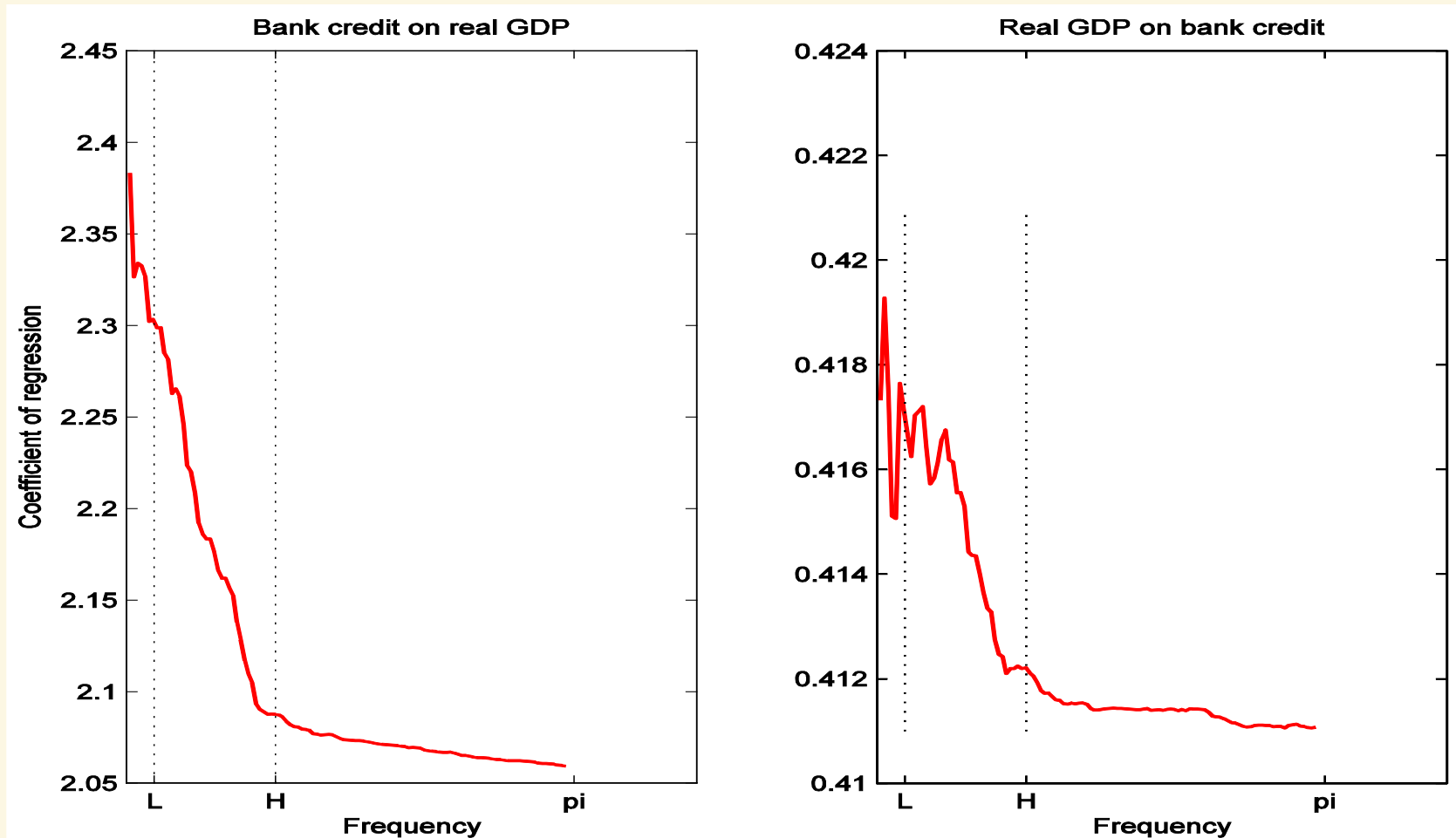# Frequency-specific correlation coefficient

Frequency-specific regression coefficient

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

  - ➢ Lown, Morgan & Rohatgi (2000), Lown & Morgan (2006)

  - ➢ Indicator value & optimal credit response to lending standards?

- Role of private sector balance sheets

  - ➢ Household balance sheets: Mishkin (1977, 1995)

  - ➢ Corporate balance sheets: Bernanke & Gertler (1989), Kiyotaki & Moore (1997)

  - ➢ Commercial banks: Kashyap & Stein (1995)

  - ➢ Brokers & dealers: Adrian-Shin (2008)

Channels: beyond Bernanke-Gertler (1989)
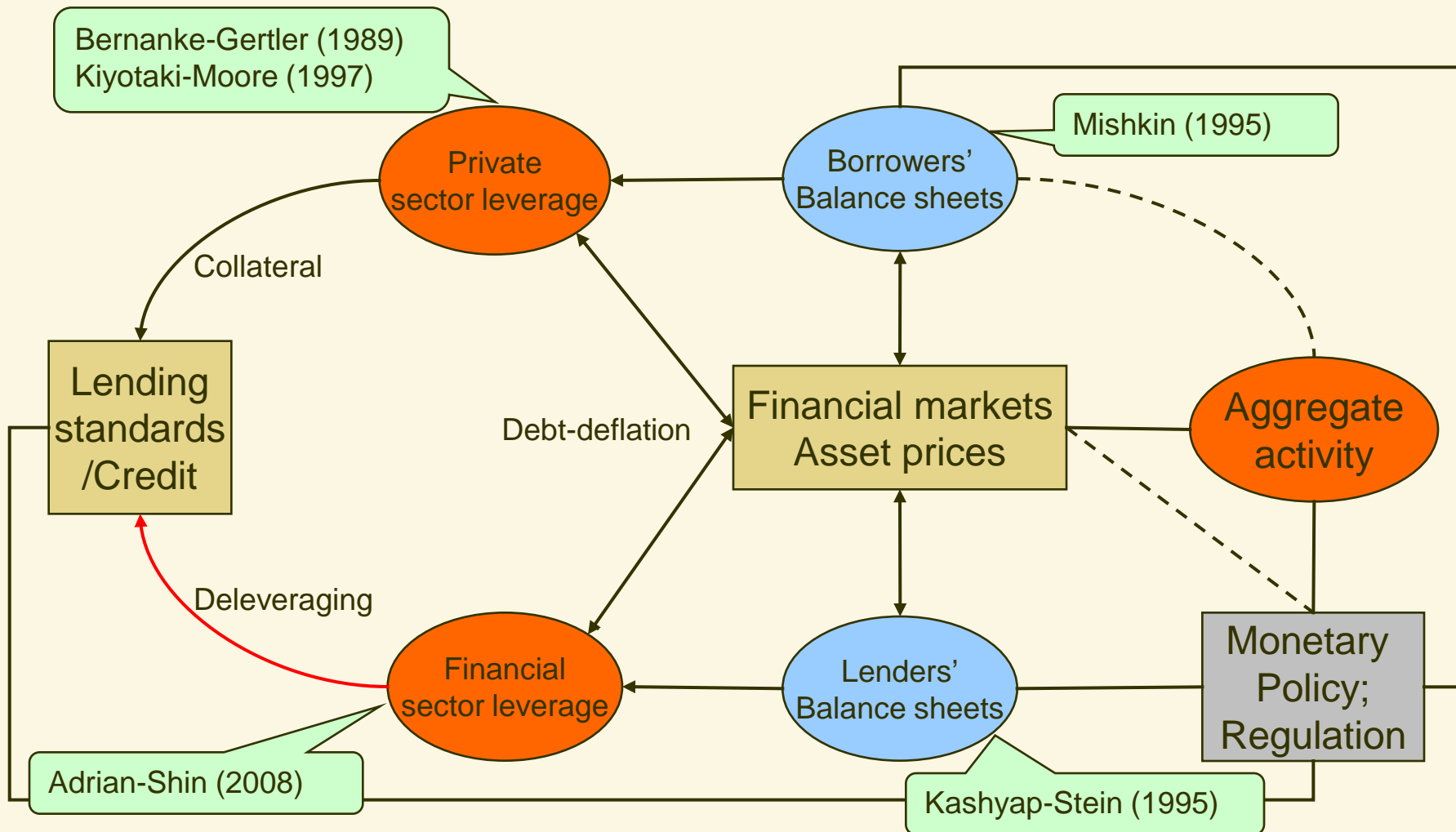
Data

- FRB senior loan officer survey
  - ➢ Non-price terms of lending
  - ➢ 1964-1977; 1977-1986; 1986-1990; 1990-now
  - ➢ 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*				
Variable X	Independent variable ΔY_t (credit growth)			
	Credit to private sector	Bank credit	Bank loans	Business loans
Constant	0.76	1.16	−0.46	0.88
$\sum \Delta Y_{t-1}$	0.94 (0.00)	0.77 (0.00)	0.82 (0.00)	0.93 (0.00)
Standards$_{t-1}$	−0.12 (0.06)	−0.09 (0.01)	−0.15 (0.00)	−0.66 (0.00)
Δ Real GDP$_{t-1}$	−0.14 (0.89)	0.43 (0.39)	1.35 (0.06)	2.18 (0.34)
Loan spread$_{t-1}$	−1.82 (0.37)	0.54 (0.64)	2.55 (0.14)	−3.16 (0.55)
Adjusted R^2	0.97	0.72	0.86	0.96
DW statistic	1.70	1.93	1.73	1.92

* 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

Variable X	Independent variable ΔY_t (credit growth)			
	Credit to private sector	Bank credit	Bank loans	Business loans
Constant	1.11	3.68	1.29	3.38
$\sum \Delta Y_{t-1}$	0.91 (0.00)	0.71 (0.00)	0.79 (0.00)	0.90 (0.00)
$CBLEV_{t-1}$	−0.005 (0.33)	−0.01 (0.04)	−0.01 (0.18)	−0.024 (0.06)
Δ Real Activity$_{t-1}$	0.42 (0.53)	0.84 (0.01)	1.81 (0.00)	2.11 (0.01)
Loan spread$_{t-1}$	−0.64 (0.64)	−0.08 (0.93)	1.25 (0.37)	−2.05 (0.58)
Adjusted R^2	0.96	0.70	0.85	0.96
DW statistic	1.69	1.77	2.06	1.97

Table 5: Credit growth and commercial bank leverage 1988Q1 – 2008Q4*

* 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