Explaining Aggregate Consumer Delinquency Behaviour Over Time

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The Literature

- Ability to pay hypothesis (Gross and Souleles 2002)
- Strategic default hypothesis (for secured debt) Kau et al (1995, 1994), Lambrecht et al (1997)

Increasing default rates for credit cards in the US explained by (Gross and Souleles 2002):

- Increase in % of borrowers that are high risk
- Increased willingness to default

Evidence

Cross-Section (duration models)

Credit Card holders

Gross & Souleles (2002)

Not related to delinquency: Unemployment rate in area of residence, per capita income, house prices in region

Marginally related: borrower's predicted risk

Residual variance ascribed to reduces stigma of defaulting

Agarwal (2003)

Was related to delinquency: borrower's predicted risk, unemployment rate in area of residence 6 months earlier, account balance 3 months earlier.

Cross Sectional (duration models) contd.

Mortgages

Lambrecht (1997)
Evidence more in favour of ability to pay than strategic default hypothesis.

Deng (1993)
Evidence in favour of both hypotheses

Teo (2004)
Characteristics of mortgage and of state of macroeconomy effected hazard rate, but neither characteristics of property bought nor of borrowers did- support for both hypotheses.

Time Series Evidence

Bank Instalment debt delinquency

Sullivan (1987) Data for 1975-86

Explained by debt burden (ability to pay) , growth rate of debt, share of consumer debt issued by banks (willingness to lend).

Bank Cards and Auto Loans delinquency

Sullivan (1987) Data for *1975-86*
Explained by debt burden (willingness to pay), growth rate, unemployment rate.

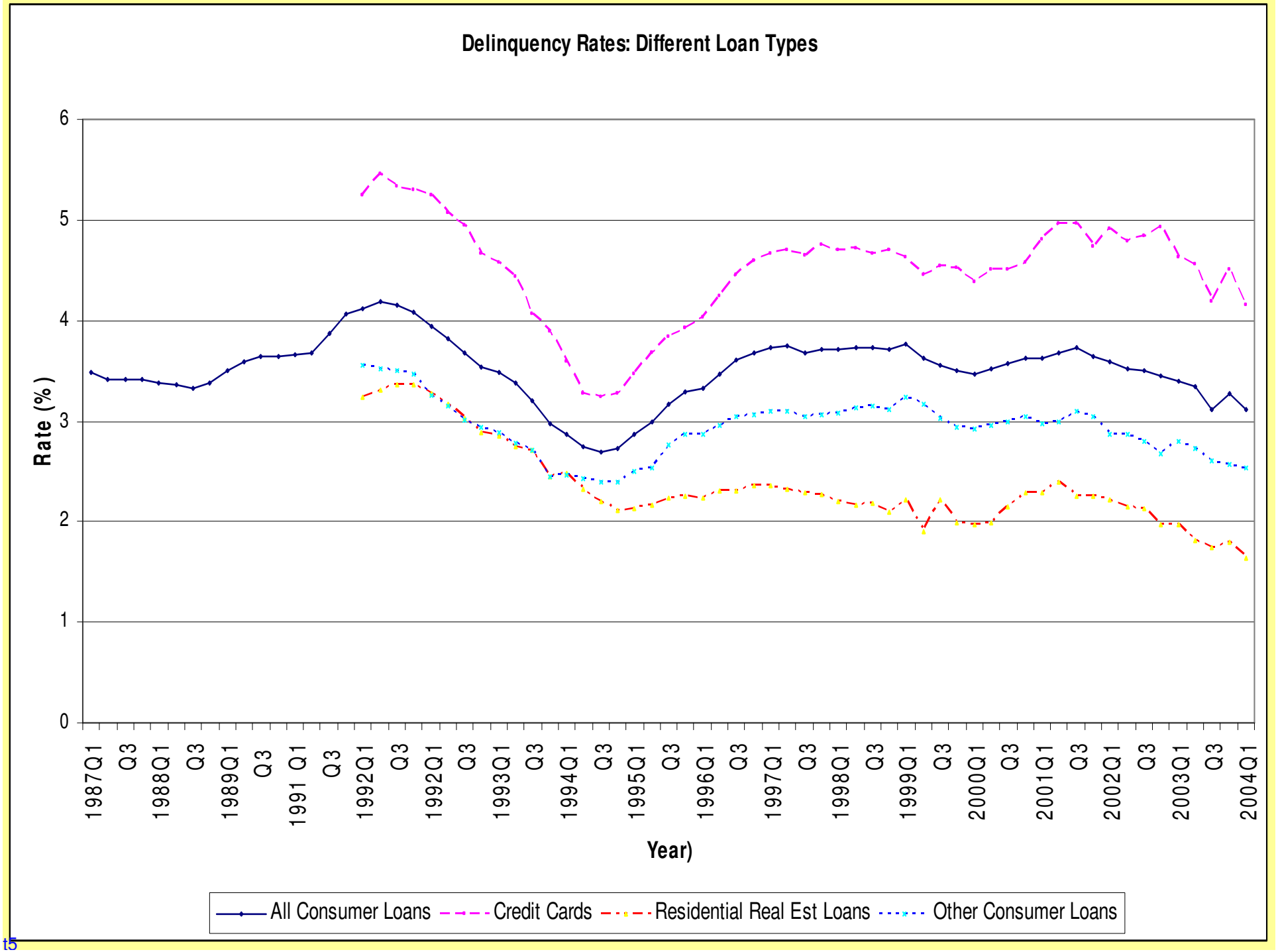
But – no interest rates, misspecification

Grieb et al (2001) Data for 1981-1999
Explained by debt:income ratio (capacity to pay). No effect detected for job market conditions.

Consumers default on credit card debt before other debt.

Mortgages delinquency (UK)

Whitley et al (2004)
Explained by mortgage income gearing, unemployment, loan to value ratio for first time buyers. But data issues, no diagnostics, lack of rationale for structure.


Delinquency Rates: Different Loan Types
Rate (%)
6
5
4
3
2
1
0
1987Q1
Q3
1988Q1
Q3
1989Q1
Q3
1991 Q1
Q3
1992Q1
Q3
1992Q1
Q3
1993Q1
Q3
1994Q1
Q3
1995Q1
Q3
1996Q1
Q3
1997Q1
Q3
1998Q1
Q3
1999Q1
Q3
2000Q1
Q3
2001Q1
Q3
2002Q1
Q3
2003Q1
Q3
2004Q1
Year)
All Consumer Loans
Credit Cards
Residential Real Est Loans
Other Consumer Loans

t5

Table 1 Repayments Transition Matrix

		1	2	3	4
No credit	1	v_{11}	v_{12}	v_{13}	v_{14}
Up to date	2	v_{21}	v_{22}	v_{23}	v_{24}
30+ overdue	3	v_{31}	v_{32}	v_{33}	v_{34}
Charged off	4	v_{41}	v_{42}	v_{43}	v_{44}

V_{im} = volume of credit that moves from state i at end of period t to state m end of period t+1

Change in stock of 30+ overdue debt = $v_{23} - (v_{31} + v_{32}) - v_{34}$

Let $d_t = v_{23}$, = volume that becomes overdue
$p_t = (v_{31} + v_{32})$ = volume that is no longer overdue because is on track
$c_t = v_{34}$ = volume that is no longer overdue because is charged off

Change in stock of 30+ overdue debt = $S_t - S_{t-1} = (d_t - p_t) - c_t$

Assume volume of 30+ overdue is explained in equilibrium by

*	Nominal interest rates	ability to repay
*	Personal disposable income	ability to repay
*	Volume of debt outstanding	
*	Expectations about future income	desire for future debt
*	Real house prices	strategic default

Assume linear long run relationship

$$S_t = \delta + \delta' \mathbf{x_t} + \varepsilon_t$$

Estimation

- Regressing S_t on x_t may be a spurious regression. So we look to see if there is a cointegrating relationship.

- A series is integrated order d if: after differencing it d times it has a stationary invertible non- deterministic ARMA representation.

- Variables in vector x are cointegrated of order d,b, CI(d,b), if all of the variables are I(d) and there exists a linear combination of them, $y_t=\delta' x_t$, which is I(d-b). δ' is the cointegrating vector.

- If d=b=1 and y and x are cointegrated, then there exists a long run relationship between levels of y and x over time.

Engle Granger representation Theorem:

If variables in the x_t vector and y_t are integrated order 1, and if a cointegrating vector exists, there is a vector error correction representation of the model $y_t=\alpha' x_t$ which can be written as

$$\Delta y_t = \beta' \Delta \mathbf{x_{t-1}} + \theta_1 (y_{t-1} - \delta - \delta' \mathbf{x_{t-1}}) + \varepsilon_t$$

We assumed

$$S_t = \delta + \delta' \mathbf{x_t} + \varepsilon_t$$

Vector error correction representation is:

$$\Delta S_t = \beta' \Delta \mathbf{x_{t-1}} + \theta_1 (S_{t-1} - \delta - \delta' \mathbf{x_{t-1}}) + \varepsilon_t$$

Procedures

- Test each variable to see if integrated order 1: Phillips –Perron test
- Test to see if there exists a cointegarting vector: Johansen ML test
- If there is a cointegating vector, estimate it: Johansen ML estimates
- Estimate the shortrun dynamic model: OLS, tested down to a parsimonious form

$$\Delta S_t = \alpha + \sum_{l=1}^{4} \Delta S_{t-l} + \sum_{l=0}^{4} \beta_{1l} . \Delta ri_{t-l} + \sum_{l=0}^{4} \beta_{2l} \Delta pdi_{t-l} + \sum_{l=0}^{4} \beta_{3l} \Delta ccout_{t-l} + \sum_{l=0}^{4} \beta_{4l} \Delta (optimism)_{t-l}$$

$$+ \theta_1 (S_{t-1} - \delta_1 - \delta_2 ri_{t-1} - \delta_3 pdi_{t-1} - \delta_4 ccout_{t-1} - \delta_5 (optmism)_{t-1}) + \varepsilon_t$$

Data

Consumer loans and mortgage loans made by US commercial banks
(from FRB)

All variables seasonally adjusted by authors using X12, unless already sa by data source.

Delinquency = 30+ days overdue.

- Volume of delinquent debt outstanding for total consumer debt (1987Q1-2004Q1)
- Delinquency rates (ie volume delinquent/debt outstanding) for
  - * credit cards (1991Q1-2004Q1)
  - * other consumer loans
  - * loans on residential real estate

Phillips- Perron Unit Root tests
(Adjusted t-statistics)

	Levels (with trend)	First Differences (without trend)
Consumer delinquency types		
Bank consumer credit total	-2.068	-5.441**
Bank credit card	-1.936	-5.368**
Other bank consumer credit	-1.951	-5.366**
Bank mortgagge loans	-1.887	-9.336**
Explanatory variables		
Consumer credit outstanding	-1.810	-4.352**
Personal loan interest rate	-2.266	-7.520**
Consumer sentiment index	-3.210	-11.121**
Personal disposable income	-1.710	-10.992**
Real house price index	-1.216	-4.016**
Real estate credit outstanding	-0.811	-5.095**
Mortgage interest rate	-3.124	-6.725**
Credit card interest rate	-1.815	-5.727**

HO: The exists a unit root.

**= significant at 1%, one sided, MacKinnon.

Johansen Cointegration tests

	Trace Statistic	5% critical	Max-Eigenvalue	5% critical
Consumer Credit				
Total Volume			Lags in ECM=4	
r = 0	82.99**	62.99	42.29**	31.46
r ≤ 1	40.70	42.44	20.98	25.54
r ≤ 2	19.72	25.32	13.9	18.96
r ≤ 3	5.82	12.25	5.82	12.25
Default rate on credit cards			Lags in ECM=4	
r = 0	136.77**	87.31	44.65**	37.52
r ≤ 1	92.11**	62.99	42.34**	31.46
r ≤ 2	49.77**	42.44	23.02	25.54
r ≤ 3	26.75	25.32	16.26	18.96
r ≤ 4	10.50	12.25	10.5	12.25
Default rate on other loans			Lags in ECM=4	
r = 0	146.01**	87.31	69.17**	37.52
r ≤ 1	76.84**	62.99	36.51*	31.46
r ≤ 2	40.33	42.44	17.29	25.54
r ≤ 3	23.04	25.32	16.50	18.96
r ≤ 4	6.55	12.25	6.55	12.25
Residential Real Estate				
Default rate on residential real estate			Lags in ECM=2	
r = 0	82.54**	62.99	45.74**	31.46
r ≤ 1	36.80	42.44	16.86	25.54
r ≤ 2	19.94	25.32	11.98	18.96
r ≤ 3	7.96	12.25	7.96	12.25

Cointegrating Vectors (normalised)

Dependent Variable	Consumer Credit			Residential
	Total Volume	Credit Card Rate	Other rate	Real estate Rate
Independent variable (logs)				
Personal loan interest rate	-1.62**		2.95**	9.53**
Credit card interest rate		0.86**		
Consumer credit outstanding	1.83**			
Personal disposable income		-1.01	-4.42**	-5.98**
Consumer sentiment index	-0.36	-3.94**	-1.51**	-6.81**
Trend	0.002	0.03**	0.05**	0.08**
Constant	-12.93	21.32	17.10	30.50

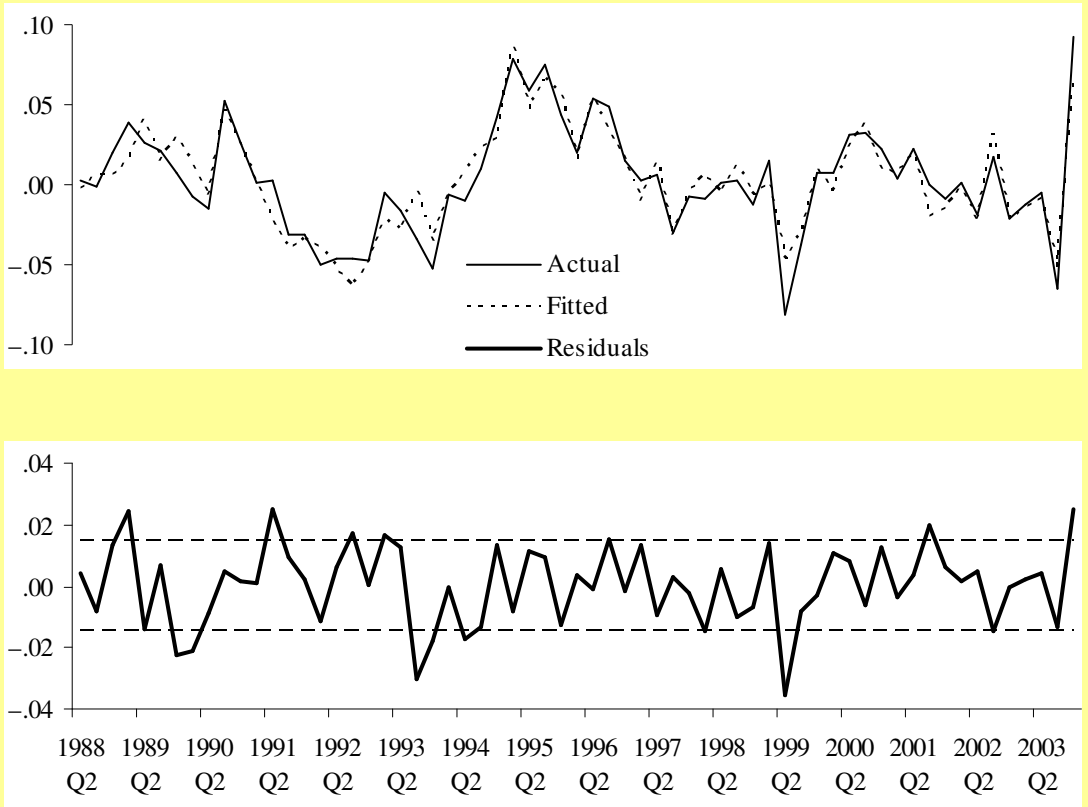
Short Run Dynamic Model (Parsimonious Form)

Δdelinquent volume

	Coefficient	t-stat		Coefficient	t-stat
Δdel volume			Δpersonal disp income		
Lag 0			Lag 0	-0.160	-0.85
Lag 1	0.258	2.70**	Lag 1	-0.182	-0.79
Lag 2			Lag 2		
Lag 3			Lag 3	0.601	2.59*
Lag 4	0.202	2.15*	Lag 4		
Δpers loan int rate			Δ optimism		
Lag 0	0.221	2.19*	Lag 0	-0.270	-4.50**
Lag 1	-0.530	-4.55**	Lag 1		
Lag 2			Lag 2		
Lag 3			Lag 3		
Lag 4	-0.451	-3.44**	Lag 4		
Δcon credit outstanding			ECM		
Lag 0	1.174	7.09**	Lag 1	-0.336	-8.85**
Lag 1	-0.859	-4.28**			
Lag 2					
Lag 3					
Lag 4	-0.901	-4.62**			
Adj R^2	0.823	Durbin's h	-2.69	RESET	0.074
Jarque-Bera	1.22	DW	1.989	LM het	0.616

** = signif at 1%, * = signif at 5%.

Changes in (log) Volume of Delinquent Consumer Credit



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Short Run Dynamic Model (Parsimonious Form)

Δdelinquency rates

	Credit Cards		Other	
	Coeff	t-stat	Coeff	t-stat
Δdel volume				
Lag 0				
Lag 1	0.094	0.70	-0.093	-0.90
Lag 2	0.429	2.89**	-0.294	-2.83**
Lag 3	0.116	0.96		
Lag 4	-0.173	-1.48		
Δpers loan int rate				
Lag 0				
Lag 1			-0.448	-2.87**
Lag 2				
Lag 3				
Lag 4				
Δcredit card int rate				
Lag 0				
Lag 1				
Lag 2				
Lag 3	0.516	2.24*		
Lag 4				
Δcons credit outstanding				
Lag 0			0.557	2.48*
Lag 1	-1.364	-4.23**	-0.312	-1.508
Lag 2	-1.462	-4.71**		
Lag 3	-0.677	-2.19*		
Lag 4	-1.194	-4.21**		
Δpersonal disp income				
Lag 0				
Lag 1	-0.847	-1.71	-1.132	-3.05**
Lag 2	1.522	2.88**	-1.767	-5.14**
Lag 3	1.880	3.17**		
Lag 4				
Δ optimism				
Lag 0	-0.338	-2.23*		
Lag 1	1.250	5.52**		
Lag 2	0.977	5.85**		
Lag 3	0.913	5.21**		
Lag 4	0.741	4.38**		
ECM (dep var)				
Lag 1	-0.518	-6.86**	-0.197	-5.20**
ECM (cons credit outstanding)				
Lag 1	0.565	3.11**	0.571	7.60**

Adj R^2	0.77	0.65	Durbin's h	-0.13	0.66	RESET	0.28	0.071
Jarque-Bera	0.002	0.31	DW	2.04	1.84	LM het	0.13	0.30

Short Run Dynamic Model (Parsimonious Form)

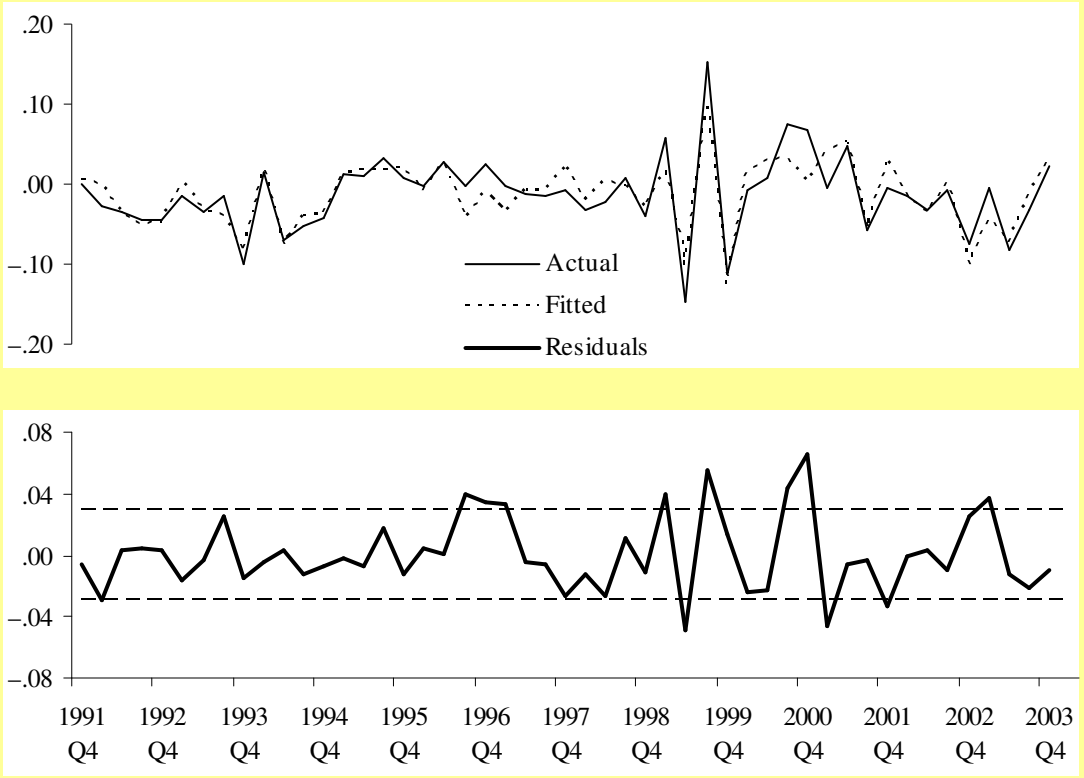
Δmortgage delinquency rate

	Coefficient	t-stat
Δdel rate		
Lag 0		
Lag 1	-0.42	-3.26**
Lag 2	0.12	0.88
Δpers loan int rate		
Lag 0	0.93	3.41**
Lag 1		
Lag 2	-0.73	-2.33*
Δmortgage int rate		
Lag 0	0.25	2.25*
Lag 1	-0.12	-1.04
Lag 2		
Δcon credit outstanding		
Lag 0	0.61	1.67
Lag 1	-0.71	-2.08*
Lag 2		

	Coefficient	t-stat
Δreal estate debt outstanding		
Lag 0	-1.07	-2.54*
Lag 1	1.06	2.27*
Lag 2		
Δ personal disposable income		
Lag 0	-2.32	-4.03**
Lag 1		
Lag 2	1.67	3.10**
Δoptimism		
Lag 0	-0.70	-3.60**
Lag 1		
Lag 2	0.54	2.53*
ECM		
Lag 1	-0.136	-5.32**

Adj R^2	0.62	Durbin's h	-0.54	RESET	0.26
Jarque-Bera	1.04	DW	2.07	LM het	1.46

** = signif at 1%, * = signif at 5%.



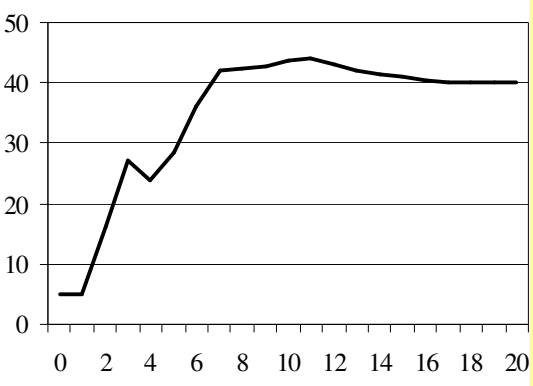
Changes In (Log) Default Rate For Residential Real Estate Loans

Shock Responses to Volume of Delinquent Consumer debt

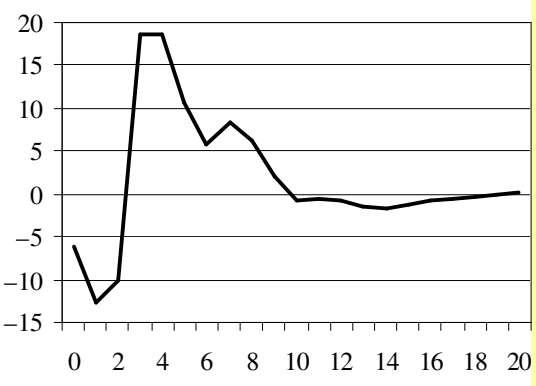
We examine the effects of a permanent shock of approx 2 sd's

	Volume of Delt. Debt $00million	Interest Rate Annual %	Debt Outstanding $00 million	Income $00 million	Sentiment
Minimum	128.6	11.7	4117.6	48.0	110.4
Maximum	202.6	15.6	5865.3	78.5	139.1
Mean	173.8	13.9	4947.9	61.4	128.2
Standard Deviation	20.6	0.95	444.8	9.04	6.16
Shock		2.00	900.00	17.00	13.00
Delinquency Impact					
Initial		5.01	35.55	-6.23	-7.75
Long run		40.38	58.51	0.00	-10.35

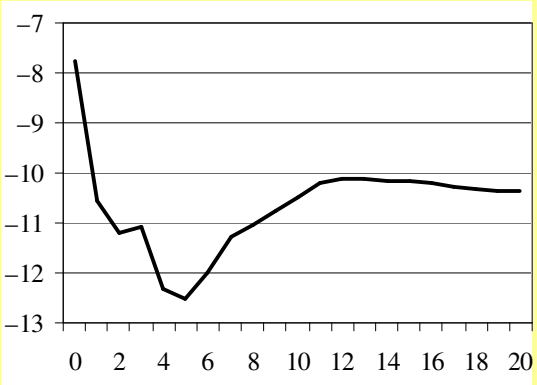
Interest rate raised by 2%



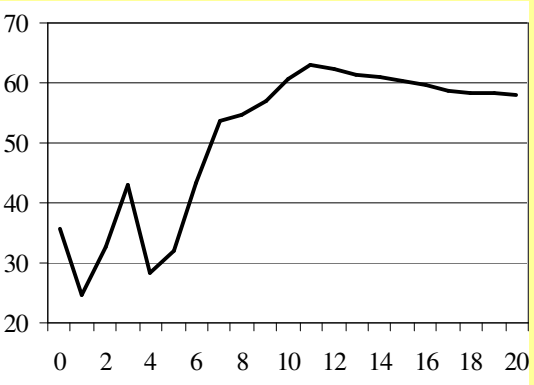
Disposable Income raised by $1700 million



Outstanding credit raised by $90,000 million



Optimism raise by 13 index points



Forecasting Performance

We compared m-step ahead forecasts from

- Short-run dynamic econometric model

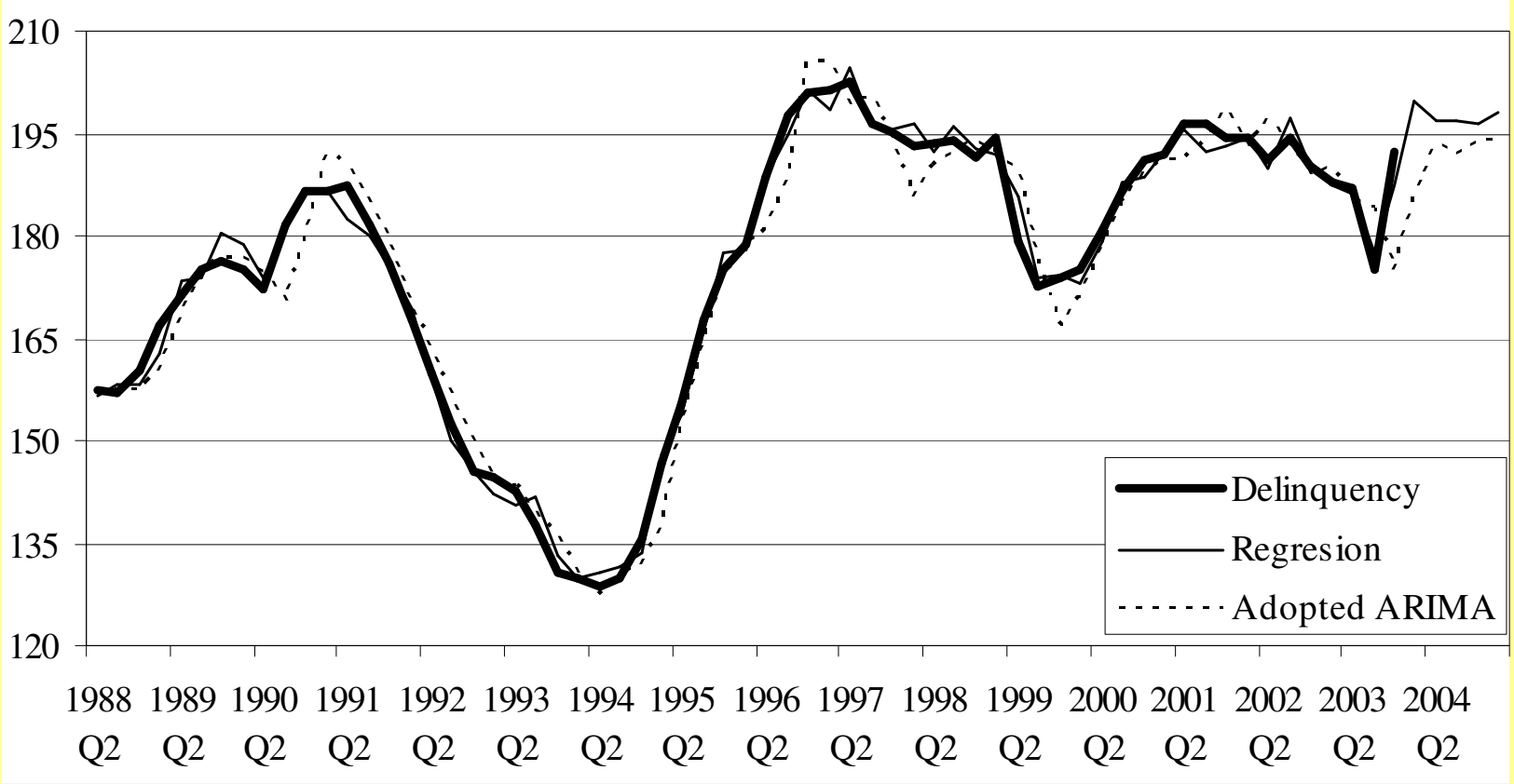
  Each explanatory variable forecast using an ARIMA (p,q) model

- ARIMA (p,q) model

$$y_t = \alpha + \phi_1 y_{t-1} + \phi_2 y_{t-2} + ... + \phi_p y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - ... - \theta_q y_{t-q}$$

Forecasts compared for ex-sample period 2004Q1 – 2005Q1.

Tracking Behaviour of Alternative Models for Delinquency Volume



Comparison of Regression Forecasts with ARIMA Forecasts

	Observed	ARIMA1	SRD	ARMA2
Forecasts				
2004Q1	183.5	185.4	199.7	191.0
2004Q2	196.8	193.5	196.9	197.5
2004Q3	194.0	191.9	196.8	201.3
2004Q4	193.1	193.8	196.5	203.5
2005Q1	184.4	194.2	198.1	203.5
Errors				
2004Q1		-1.92	-16.27	-7.51
2004Q2		3.24	-0.10	-0.75
2004Q3		2.11	-2.75	-7.27
2004Q4		-0.65	-3.36	-8.82
2005Q1		-9.76	-13.64	-19.12
Ex sample RMSE		4.78	9.69	10.52
In sample RMSE		4.84	2.22	4.78

Conclusions

* We found long run relationships between

- Volume of delinquent debt and personal loan interest rate and optimism
- Delinquency rates on credit cards and disposable income, interest rates, optimism
- Delinquency rates on mortgages and personal loan rate, disposable income and optimism.

*These relationships are consistent with

- more debt outstanding increasing loan portfolio risk
- adverse selection
- optimism causing people to expect to borrow in the future so they maintain repayments
- reduced stigma associated with delinquency

*No evidence found to support the strategic default hypothesis

* Also found

- Delinquency rates adjust to long run equilibrium faster in consume credit markets than in residential loan markets

- Forescasting accuracy of regression short run dynamic model is comparable to an ARIMA model

- A shock to each variable showed the expected reaction to delinquency except disposable income which suggested that if income increases borrowers tend to borrow more than they can service.