

**Technical Appendix to  
“Now and Then: The Evolution of Loan Quality for U.S. Banks”**

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Aggregate data provide useful indicators of overall performance, but enormous heterogeneity is a fact for most industries.<sup>1</sup> This appendix summarizes the methodology used in Stiroh and Metli (2003) to decompose both the level and the change in the aggregate nonperforming loan (NPL) ratio for U.S. banks.

*Decomposing the Level of Loan Quality*

The aggregate NPL ratio for the banking industry in year  $t$ ,  $NPLRAT_t$ , equals industry nonperforming loans,  $NPL_t$ , divided by industry total loans,  $L_t$ :

$$(1) \quad NPLRAT_t = \frac{NPL_t}{L_t} = \frac{\sum_i NPL_{i,t}}{\sum_i L_{i,t}},$$

where  $NPL_{i,t}$  and  $L_{i,t}$  are nonperforming loans and total loans, respectively, for the  $i$ th type of loans or banks, and the summation covers the entire industry.

Equation 1 can be rewritten as

$$(2) \quad NPLRAT_t = \sum_i \frac{NPL_{i,t}}{L_{i,t}} \frac{L_{i,t}}{\sum_i L_{i,t}} = \sum_i NPLRAT_{i,t} \theta_{i,t},$$

where  $\theta_{i,t}$  represents the share of industry loans  $i$  at time  $t$  and  $\sum_i \theta_{i,t} = 1$ .

Each share-weighted ratio in equation 2 is a *contribution to the level of the NPL ratio* and shows how important that type of loan is to the aggregate ratio. For example, one can quantify the contribution of different types of loans (consumer, real estate, and commercial and industrial loans) as

$$(3) \quad NPLRAT_t = NPLRAT_{CONS,t} \theta_{CONS,t} + NPLRAT_{RE,t} \theta_{RE,t} + NPLRAT_{C\&I,t} \theta_{C\&I,t},$$

where, for example,  $NPLRAT_{CONS,t}$  is the NPL ratio for all consumer loans,  $\theta_{CONS,t}$  is the share of consumer loans in total loans, and  $NPLRAT_{CONS,t} \theta_{CONS,t}$  is the contribution to the level of the NPL ratio for consumer loans.

Chart 2 in Stiroh and Metli (2003) shows this decomposition by loan type, while Chart 3 shows a similar decomposition by bank size (small, medium, and large). Table A1 in this appendix reports the

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<sup>1</sup>See Haltiwanger (1997) for details from manufacturing and Stiroh (2000) for details from banking.

component data. The first two columns show the contribution of each loan type to the level of the NPL ratio, the next two columns report the NPL ratio, and the final two columns report the loan shares, all for second-quarter 1991 and third-quarter 2002. Table A2 in this appendix reports similar results based on data from the Shared National Credit Program for 1991 and 2002.

#### *Decomposing Changes in Loan Quality*

Stiroh and Metli (2003) also discuss the sources of *changes* in the industry NPL ratio. Starting from equation 2, the change in the industry NPL can be expressed as

$$\Delta NPLRAT_t = NPLRAT_t - NPLRAT_{t-1} =$$

$$(4) \sum_i \left[ \Delta NPLRAT_{i,t} * \theta_{i,t-1} \right]_{\text{within effect}} + \left[ \Delta \theta_{i,t} * (NPLRAT_{i,t-1} - NPLRAT_{i-1}) \right]_{\text{share effect}} + \left[ \Delta NPLRAT_{i,t} * \Delta \theta_{i,t} \right]_{\text{covariance effect}}$$

where  $\Delta$  refers to a discrete change from period  $t-1$  to period  $t$ . Each component is referred to as a *contribution to the change in the NPL ratio*.

Each element in equation 4 has a precise economic meaning, and together they show how bank-level loan quality and share changes generate industry trends. The first set of brackets is a “within effect,” which measures the aggregate impact of changes in loan quality for a given category of loans or lenders. The second set of brackets is a “share effect,” which measures the aggregate impact of changes in the relative size of banks. The third set of brackets is a “covariance effect,” which measures the aggregate effect of changes in both share and performance. The share and covariance effects make up the total “reallocation effect.” Estimates of these effects are reported in the table in Stiroh and Metli (2003).

#### *References*

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- Stiroh, Kevin J. 2000. “Compositional Dynamics and the Performance of the U.S. Banking Industry.” Federal Reserve Bank of New York *Staff Reports*, no. 98, February.
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Table A1  
**Loan Quality by Bank Size and Loan Type**  
 Percentage Points

Loan Type	Contribution to NPL Ratio		NPL Ratio		Loan Share	
	1991:2	2002:3	1991:2	2002:3	1991:2	2002:3
All Banks						
Total	4.00	1.50	4.00	1.50	100.00	100.00
Commercial and industrial plus other	1.73	0.81	4.27	2.32	40.48	34.70
Consumer	0.27	0.24	1.45	1.45	18.59	16.91
Commercial real estate	1.61	0.19	8.65	0.93	18.62	20.07
Consumer real estate	0.29	0.22	1.43	0.84	20.24	26.64
Farm real estate	0.10	0.03	4.76	2.07	2.07	1.69
Large Banks						
Total	2.47	1.18	5.23	1.69	100.0	100.0
Commercial and industrial-domestic	0.67	0.44	5.21	3.13	27.3	20.1
Commercial and industrial-foreign	0.20	0.15	5.40	4.78	7.8	4.4
Consumer	0.13	0.21	1.98	1.59	14.3	18.6
Commercial real estate	0.97	0.09	13.49	0.94	15.2	14.2
Consumer real estate	0.12	0.17	1.50	0.88	16.3	26.9
Farm real estate	0.08	0.02	6.13	2.61	2.6	1.3
Other	0.31	0.10	3.94	1.04	16.5	14.4
Medium Banks						
Total	1.09	0.18	3.35	1.05	100.0	100.0
Commercial and industrial-domestic	0.32	0.06	4.10	1.83	23.8	18.9
Commercial and industrial-foreign	0.01	0.00	6.17	1.05	0.3	0.4
Consumer	0.10	0.03	1.25	0.97	24.5	14.9
Commercial real estate	0.51	0.05	7.11	0.90	22.2	33.5
Consumer real estate	0.09	0.03	1.43	0.72	20.4	24.6
Farm real estate	0.01	0.00	5.10	1.75	0.5	1.1
Other	0.05	0.01	1.85	0.88	8.3	6.5
Small Banks						
Total	0.44	0.13	2.16	1.04	100.0	100.0
Commercial and industrial plus other	0.18	0.04	3.19	1.46	27.4	23.6
Consumer	0.04	0.01	0.93	0.97	19.1	10.5
Commercial real estate	0.13	0.04	3.08	0.95	20.9	33.6
Consumer real estate	0.08	0.03	1.34	0.76	29.2	27.7
Farm real estate	0.01	0.01	2.17	1.33	3.3	4.6

Source: Federal Financial Institutions Examination Council, Consolidated Reports of Condition and Income.

Notes: The decomposition framework is presented in equation 2. Second-quarter 1991 and third-quarter 2002 mark the highest level of the aggregate nonperforming loan (NPL) ratio for the 1988:4–1991:2 and 1999:4–2002:4 periods, respectively. The NPL ratio is defined as nonaccrual loans plus loans ninety days past due as a percentage of loans for each type and total. Small banks have assets less than \$500 million; medium banks, assets between \$500 million and \$10 billion; and large banks, assets greater than \$10 billion (all values are in 2002 dollars).

Table A2  
**Loan Quality by Borrower Industry**  
**Percentage Points**

Industry	North American Industry Classification System Code	Contribution to NPLC Ratio		NPLC Ratio		Commitment Share	
		1991	2002	1991	2002	1991	2002
Total		2.58	2.08	2.58	2.08	100.00	100.00
Agriculture	11	0.00	0.01	0.19	1.40	0.57	0.50
Mining	21	0.02	0.05	0.44	1.48	3.92	3.36
Utilities	22	0.12	0.17	1.77	2.72	6.81	6.20
Construction	23	0.59	0.04	8.70	1.29	6.79	2.83
Manufacturing, excl. computers	31-33, excl. 334 & 335	0.49	0.59	1.84	2.61	26.48	22.64
Computers	334-335	0.12	0.08	4.36	2.62	2.80	3.15
Wholesale trade	42	0.07	0.09	2.23	1.53	3.24	5.92
Retail trade	44-45	0.36	0.04	6.60	0.72	5.45	4.95
Transportation	48-49	0.04	0.14	0.95	4.19	4.01	3.26
Information, excl. broadcasting and telecommunications	51, excl. 513	0.06	0.03	1.41	0.65	4.32	4.44
Broadcasting and telecommunications	513	0.13	0.48	1.81	7.74	7.02	6.25
Finance and insurance	52	0.17	0.14	1.01	0.65	16.90	22.17
Real estate	53	0.09	0.04	3.10	1.12	2.76	3.72
Professional services	54	0.06	0.03	5.77	2.30	0.99	1.49
Management	55	0.03	0.01	1.61	1.22	1.71	0.84
Administration and support	56	0.02	0.08	2.29	4.75	0.95	1.79
Educational services	61	0.00	0.00	1.84	0.00	0.24	0.22
Health care	62	0.05	0.03	2.78	1.74	1.64	1.75
Entertainment	71	0.03	0.01	5.31	0.71	0.55	0.93
Accommodation	72	0.12	0.02	6.39	0.78	1.81	2.65
Other services	81	0.01	0.00	3.82	0.10	0.28	0.39
Public administration	92	0.01	0.00	1.83	0.04	0.76	0.57
Median		0.06	0.04	2.03	1.35	2.78	2.99

Source: Shared National Credit Program.

Notes: The decomposition framework is presented in equation 2. The years 1991 and 2002 mark the highest level of the aggregate nonperforming loan commitment (NPLC) ratio for the 1988–91 and 1999–2002 periods, respectively. The NPLC ratio, calculated as an aggregate number and for individual borrower industries, is defined as the sum of all loan commitments rated "doubtful" or "loss" and 10 percent of those rated "substandard" expressed as a percentage of total commitments.