Structural Breaks in the Current U.S. Banking Crisis

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In this study we examine key changes in the U.S. banking industry from early 2000 to late 2010. For this purpose we identify an array of time-series structural breaks within the current U.S. banking crisis. We analyze 28 aggregate variables within the banking sector and find that the economic disarray stretches far beyond the failure of a large number of financial institutions. We portray a more complete view of the current disorder, associate the structural breaks with major economic turning events, explain the long-term effects of the observed transitions, and classify critical economic predictors for such a calamity.

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1. Introduction

The recent financial crisis has generated numerous studies that largely focus on its apparent causes and probable solutions. This research adds to the financial literature by exploring the fundamental economic developments within the U.S. banking industry and depository institutions throughout the banking crisis post 2007. For this purpose we identify 28 aggregate market variables and investigate their gradual progress from the fourth quarter of 2000 to the fourth quarter of 2010. We pinpoint the primary structural breaks contained in these time-series analyses, and through that classify the pertinent economic shocks as having temporary or permanent effects. The inferences could provide a basis for the future image of the U.S. banking sector. We further examine the chronological sequence of these structural changes and highlight several important economic implications for policy makers.

The current U.S. banking crisis originated after a long era of securitization of mortgages and an acute growth in the worldwide use of Credit Default Swaps (CDS).[1] The present calamity is deeply rooted in the subprime lending market, and a consensus among regulators suggests that this crisis was intensified by credit ratings that underestimated the risks involved in the market of structured mortgage-backed securities. Yet many agree that the crisis itself erupted only on August 9, 2007, when BNP Paribas, a major French bank, provisionally halted redemptions from three of its U.S. subprime mortgage debt related funds.[2] A week later, on August 16, 2007, Countrywide Financial, at the time a leading U.S. mortgage lender, announced it had borrowed $11.5 billion from a consortium of 40 large banks. Countrywide Financial further declared that it would make significant changes in its operations by largely limiting itself to only the safest mortgages that could be bought by Fannie Mae and Freddie Mac, the U.S. government-chartered agencies. Consequently, more banks raised mortgage interest payments to existing borrowers and further restricted new mortgage loans to better secured home buyers. A subsequent decline in the U.S. home prices led to an inevitable foreclosure epidemic. The situation quickly deteriorated with a massive wave of bank failures, including the most prominent failure of Washington Mutual on September 25, 2008. As of 2011, the U.S. banking crisis has no end in sight, with more banking institutions forced to fail by the U.S. Federal Deposit Insurance Corporation (FDIC).

[1] Barth (2009) reports that the notional amount of CDS increased from less than $1 trillion in 2001 to slightly more than $62 trillion in 2007, before declining to $47 trillion on October 31, 2008. The author further explains that both the wide securitization of mortgages and the broad utilization of CDS allowed investors to transfer risk to other counterparties, which evidently propelled a global financial epidemic.

[2] Taylor and Williams (2009) provide more details on this turning point.

Numerous scholars have attempted to study the recent financial crisis, it's likely origins, economic implications, and feasible resolutions. We briefly review a small but representative sample of these articles hereafter. Adrian and Shin (2008) and Mizen (2008) revise the early regulatory policies and immediate responses to the first signs of the current banking crisis. McAndrews, Sarkar, and Wang (2008), Wu (2008), and Anderson and Gascon (2009) investigate the collapse of liquidity within this crisis. Heilpern, Haslam, and Andersson (2009) explore how permissive regulatory conditions helped to change the size and scope of the U.S. mortgage market, and how this transformation triggered the current banking crisis. Brunnermeier (2009), Calomiris (2009), Kane (2009), and Capiro, Demirgüç-Kunt, and Kane (2010) thoroughly analyze the incentive problems of banks and credit rating agencies that led to the recent financial crisis.

Büyükkarabacak and Valev (2010) illustrate that household credit expansions have been a statistically and economically significant predictor of banking crises in developed and emerging markets. Tarr (2010) discusses the key political failures of the current crisis and explains that Congress failed to provide the regulator of Fannie Mae and Freddie Mac sufficient bank supervisory strength. Moshirian (2011) analyzes the dual processes that evolved from the recent crisis, market development and regulation, and further explains the emergence of new national and international institutions.

While prior studies emphasize the evident causes, the urgent responses, and the potential answers for the current financial crisis, we choose to focus on the various time-series structural breaks in the U.S. banking industry throughout this crisis. Our investigation illuminates the real developments this vital economic sector is now going through. This inquiry further assists in identifying whether these economic changes are permanent or transitory. Therefore, our findings intend to lay the foundation for bank supervisors to design better policies, regulatory mechanisms, and government safety nets, as well as to turn on early warning signs before the next banking crisis.[3]

We discover that the current U.S. banking crisis extends far beyond the failure of a large number of financial institutions. The market aggregate measures (both absolute value and percentage) for failed bank total assets and total deposits demonstrated two structural breaks, with secondary "after shocks" thereafter. Nonetheless, we can expect a gradual return to somewhat normal levels within these inclusive variables in the coming years. On the other hand, the number of employees in the U.S. banking industry experienced two major hits, which are likely to decay this measure for a long time. Moreover, the U.S. banking sector was rapidly contracting after a structural break in the number of institutions reporting to the FDIC, and it will take a while before this trend could change. In addition, real estate owned by financial institutions and net charge-offs exhibited major upward turns, thus it is unlikely that these economic variables will revert to their previous heights any time soon. We detect other significant deteriorations in cash dividends, letters of credit, net income, pre-tax net operating income, and return of assets. We also report key adjustments in the inclusive market total assets, total deposits, total liabilities, total risk weighted assets, and salaries and employee benefits. All of the above transformations are robust and permanent, or at least long lasting.

By analyzing the chronological sequence of the major turning events and the corresponding structural breaks we further learn about the evolution of the current crisis. We recognize how the U.S. banking system reacted to various regulatory and economic steps, but more importantly, we identify two vital warning signs for such a crash. These are the market cumulative number of employees and the inclusive market value of other real estate owned by banks. These two aggregate variables went through significant time-series structural breaks long before the U.S. banking crisis became apparent.

The remainder of the study is organized as follows. In Section 2 we present the data, describe the examined variables, and stage the relevant methodologies. In Section 3 we reveal the empirical

[3] Barth (2009) discusses other warning signs of the current crisis outside of the banking industry including an increase in median home prices that quickly outstripped historical norms and median household income.

results. In Section 4 we discuss the economic implications of our findings and recommend policy adjustments. In Section 5 we conclude.

2. Sample and Methodologies

2.1 Data and Variables

The goal of this study is to discover major structural developments in various aspects of the U.S. banking industry throughout the past decade. We therefore compose from the FDIC publications a database that includes 28 different economic variables. This comprehensive set of records helps us to portray a broad view of the current U.S. banking crisis.

The FDIC issues a detailed list of all U.S. failed banks since October 2000. For each failed bank the FDIC attaches the original press release immediately following the closure of that institution. Within these public announcements we are able to identify the exact closing date, as well as the specific total assets and total deposits for that failed bank. We accumulate these discrete figures and assess the complete U.S. market quarterly rates of Failed Bank Total Assets (FBTA) and Failed Bank Total Deposits (FBTD) from the fourth quarter of 2000 to the fourth quarter of 2010. These absolute quantities are measured in dollar amounts.

The FDIC also reveals inclusive market information about all U.S. commercial banks and savings institutions throughout this time frame.[4] These variables, however, lack observations within the first, second, and third quarters of 2001 and 2002. We therefore collect 35 quarterly sets of data of Market Total Assets (MTA) and Market Total Deposits (MTD), which are also measured in dollar amount. We then divide FBTA by MTA and FBTD by MTD and obtain the Percentage of Failed banks Total Assets (PFTA) and the Percentage of Failed banks Total Deposits (PFTD), respectively. We gather more data concerning the total number of reporting institutions (INST) and the total number of full time employees (EMP) within this economic sector.

The FDIC quarterly reports on assets and liabilities provide the following market figures: Total Liabilities (TL), Total Risk Weighted Assets (TRWA), Total Equity Capital (TEC), Tier 1 and Tier 2 Risk Based Capital (T1RBC and T2RBC), Other Real Estate Owned (OREO), derivatives (DER), and securities (SEC). The FDIC quarterly reports on income and expense assemble the following market measures: Salaries and Employee Benefits (SAEB), Net Income (NI), Net Interest Income (NII), Pre-Tax Net Operating Income (PTNOI), Net Charge-Offs (NCO), and Cash Dividends (CD).

We further accumulate relevant data concerning the total market Financial Standby Letters of Credit (FSLC), Performance Standby Letters of Credit (PSLC), and Commercial and Similar Letters of Credit (CSLC). Finally, from the FDIC aggregate market quarterly reports on performance and condition ratios we acquire data on the percentage of Unprofitable Institutions (UNPI), Return on Assets (ROA), and Return on Equity (ROE). We provide the average annual figures for these 28 aggregate variables from 2005 to 2010 in Table 1.

2.2 Methodologies

To investigate the unit root hypothesis for the 28 examined economic variables we begin by utilizing three sequential trend-break models as proposed by Zivot and Andrews (1992). These models test the null hypothesis that the time-series is an integrated process with no structural break, against the alternative hypothesis that the process is trend-stationary with a structural break, which occurs at an unknown time. Model A in equation (1) permits a single structural break in the mean. Model B in equation (2) allows a one-time structural break in the slope. Model C in equation (3) authorizes a sole structural break in both the mean and the slope. More formally:

$$\Delta V_t = \mu^{(A)} + \alpha^{(A)} V_{t-1} + \beta^{(A)} t + \gamma^{(A)} DU_t + \sum_{j=1}^{N} \lambda_j^{(A)} \Delta V_{t-j} + \varepsilon_t \quad (1)$$

[4] Contrary to individual bank failures, the aggregate market data is typically reported within a month or two after a quarter ends. This, however, does not create any major problem for the current methodologies.

$$\Delta V_t = \mu^{(B)} + \alpha^{(B)} V_{t-1} + \beta^{(B)} t + \theta^{(B)} DT_t + \sum_{j=1}^{N} \lambda_j^{(B)} \Delta V_{t-j} + \varepsilon_t \quad (2)$$

$$\Delta V_t = \mu^{(C)} + \alpha^{(C)} V_{t-1} + \beta^{(C)} t + \gamma^{(C)} DU_t + \theta^{(C)} DT_t + \sum_{j=1}^{N} \lambda_j^{(C)} \Delta V_{t-j} + \varepsilon_t \quad (3)$$

where V designates the particular economic variable tested within the U.S. banking industry, Δ is the first difference operator, $t = 1,...,T$ indicates the respective point in time, and ε denotes a white noise disturbance term with a fixed variance σ^2. The time-series coefficients are μ, α, β, γ, θ, and λ, and the ΔV_{t-j} terms allow for serial correlation and guarantee that the disturbance term is a white noise.

Table 1
Summary Statistics

	2005	2006	2007	2008	2009	2010
FBTA ($M)	0	0	651	93,397	42,718	23,755
FBTD ($M)	0	0	597	58,540	34,344	19,860
MTA ($M)	10,585,187	11,587,972	12,495,944	13,520,856	13,298,070	13,320,506
MTD ($M)	6,910,066	7,556,681	8,131,639	8,725,475	9,075,734	9,855,274
PFTA (%)	0.000%	0.000%	0.005%	0.687%	0.323%	0.179%
PFTD (%)	0.000%	0.000%	0.007%	0.669%	0.376%	0.211%
INST	8,873	8,748	8,589	8,409	8,138	7,795
EMP	2,130,839	2,193,551	2,219,960	2,184,762	2,085,098	2,047,324
TL ($M)	9,495,659	10,383,328	11,190,683	12,193,537	11,863,362	11,814,385
TRWA ($M)	7,794,771	8,605,101	9,433,561	10,000,858	9,715,572	9,169,362
TEC ($M)	1,089,528	1,204,644	1,305,261	1,327,320	1,434,709	1,506,121
T1RBC ($M)	837,909	917,494	970,656	998,040	1,088,941	1,144,246
T2RBC ($M)	184,699	205,399	240,650	277,181	262,396	241,792
OREO ($M)	5,087	6,598	10,301	21,857	35,833	50,524
DER ($M)	97,554,258	122,645,710	160,143,808	188,542,143	209,742,802	228,024,945
SEC ($M)	1,889,905	1,975,096	1,973,261	2,007,635	2,360,071	2,592,174
SAEB ($M)	35,450	38,225	40,661	40,746	41,079	42,431
NI ($M)	33,624	37,052	25,416	-3,230	372	18,893
NII ($M)	79,773	84,235	89,548	95,875	99,373	107,821
PTNOI ($M)	48,562	53,193	38,000	-756	3,778	26,345
NCO ($M)	8,033	6,796	11,085	28,203	47,922	46,562
CD ($M)	18,369	23,651	28,929	12,810	10,844	13,481
FSLC ($M)	375,661	444,574	479,418	500,092	506,765	474,436
PSLC ($M)	62,028	69,621	74,756	77,794	61,056	56,339
CSLC ($M)	29,577	29,132	31,042	30,393	22,634	26,134
UNPI (%)	6.678%	8.380%	12.208%	22.910%	28.423%	20.880%
ROA(%)	1.285%	1.298%	0.838%	-0.088%	0.010%	0.570%
ROE(%)	12.473%	12.503%	7.968%	-1.063%	0.123%	5.113%

Note: We provide average annual figures for the 28 aggregate variables throughout the years 2005 to 2010. These variables include Failed Bank Total Assets (FBTA), Failed Bank Total Deposits (FBTD), Market Total Assets (MTA), Market Total Deposits (MTD), Percentage of Failed banks Total Assets (PFTA), Percentage of Failed banks Total Deposits (PFTD), number of reporting institutions (INST), total number of full time employees (EMP), Total Liabilities (TL), Total Risk Weighted Assets (TRWA), Total Equity Capital (TEC), Tier 1 and Tier 2 Risk Based Capital (T1RBC and T2RBC), Other Real Estate Owned (OREO), derivatives (DER), and securities (SEC), Salaries and Employee Benefits (SAEB), Net Income (NI), Net Interest Income (NII), Pre-Tax Net Operating Income (PTNOI), Net Charge-Offs (NCO), and Cash Dividends (CD), Financial Standby Letters of Credit (FSLC), Performance Standby Letters of Credit (PSLC), and Commercial and Similar Letters of Credit (CSLC), percentage of Unprofitable Institutions (UNPI), Return on Assets (ROA), and Return on Equity (ROE).

In addition, DU_t represents a dummy variable for a mean shift occurring at a specific time τ, and DT_t is a dummy variable that signifies the corresponding shift in slope, where

$$DU_t = \begin{cases} 1 & \text{if} \quad t > \tau \\ 0 & \text{elsewhere} \end{cases},$$

and

$$DT_t = \begin{cases} t - \tau & \text{if} \quad t > \tau \\ 0 & \text{elsewhere} \end{cases}.$$

To properly apply the Zivot and Andrews (1992) models we must select a sealed time frame where the endogenous structural breaks can be found. We impose this interval to exclude the end points of the sample, since at these edges the asymptotic distributions of the statistics converge to infinity. Since our sample stretches over 41 quarters, from the fourth quarter of 2000 to the fourth quarter of 2010, while the first, second, and third quarters of 2001 and 2002 are missing, we direct our search for structural breaks to the region from the second quarter of 2006 to the fourth quarter of 2009. This period starts well before and ends more than two years after the beginning of the U.S. banking crisis.

Following Campbell and Perron (1991), for each value of τ, we uncover the necessary number of additional ΔV_{t-j} terms, N, as follows. We first estimate the model with $N_{\max} = 15$ lags. If the last lag is statistically significant at a 10% level or better, we preserve all included lags. If not, we continue to reduce the lag order by one until the coefficient of the earliest lag is statistically significant at a 10% level or better.[5]

We further authenticate the need for these ΔV_{t-j} lag terms through two preliminary separate trials: the Ljung-Box-Pierce (1970, 1978) and the Stoffer-Toloi (1992) test statistics with $N_{\max} = 15$ lags.[6] These autocorrelation tests contrast the null hypothesis, which asserts that all the correlation coefficients up to $N_{\max}$ lags are zero, with the alternative hypothesis, which suggests that not all the correlation coefficients up to $N_{\max}$ lags are zero. In our context, it would be good not to be able to reject the null hypothesis. However, whenever the null hypothesis is rejected, we regress additional ΔV_{t-j} terms, which assure that the disturbance term is indeed a white noise.

The three models endogenously identify the time-series structural breaks by choosing the values of τ for which the absolute values of the t-statistic for $\alpha^{(A)}$, $\alpha^{(B)}$, and $\alpha^{(C)}$ are maximized, respectively.[7] If these coefficients are not significantly different from zero, the null hypothesis of an integrated process with no structural break cannot be rejected. However, whenever these coefficients significantly deviate from zero, the alternative hypothesis for a time-series structural break holds.

To consider more complex economic time-series patterns we further deploy the three analogous models of Lumsdaine and Papell (1997). These schemes endogenously test for two feasible structural breaks in the mean, the slope, or both the mean and the slope. The regressions are tagged as model AA in equation (4), model BB in equation (5), and model CC in equation (6) as follows:

$$\Delta V_t = \mu^{(AA)} + \alpha^{(AA)} V_{t-1} + \beta^{(AA)} t + \gamma^{(AA)} DU_{1,t} + \eta^{(AA)} DU_{2,t} + \sum_{j=1}^{N} \lambda_j^{(AA)} \Delta V_{t-j} + \varepsilon_t \tag{4}$$

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[5] Among others, Malliaropulos (2000) and Chaudhuri and Wu (2003) apply this technique.

[6] Box and Pierce (1970) and Ljung and Box (1978) propose a white noise test on the residuals. Stoffer and Toloi (1992) offer a modified test statistic when the series contains missing values, as in our sample.

[7] Zivot and Andrews (1992) and Chaudhuri and Wu (2003) argue for the superiority of this approach over a pre-examination of the data and an exogenous selection of the break points, as proposed by Perron (1989). These models are highly applicable in our context since prior major events (like large bank failures) can be identified today (ex-post), but this does not necessarily mean that they represent key structural breaks or significant turning economic points.

$$\Delta V_t = \mu^{(BB)} + \alpha^{(BB)} V_{t-1} + \beta^{(BB)} t + \theta^{(BB)} DT_{1,t} + \rho^{(BB)} DT_{2,t} + \sum_{j=1}^{N} \lambda_j^{(BB)} \Delta V_{t-j} + \varepsilon_t \quad (5)$$

$$\Delta V_t = \mu^{(CC)} + \alpha^{(CC)} V_{t-1} + \beta^{(CC)} t + \gamma^{(CC)} DU_{1,t} + \eta^{(CC)} DU_{2,t} + \theta^{(CC)} DT_{1,t} + \rho^{(CC)} DT_{2,t} + \sum_{j=1}^{N} \lambda_j^{(CC)} \Delta V_{t-j} + \varepsilon_t \quad (6)$$

where η and ρ are accompanying time-series coefficients, $DU_{1,t}$ and $DU_{2,t}$ are dummy variables that depict two possible mean shifts occurring at times τ_1 and τ_2, respectively, with a general restriction that $\tau_2 > \tau_1 + 2$. Here $DT_{1,t}$ and $DT_{2,t}$ are the corresponding dummy variables that capture the two likely shifts in slope. More formally:

$$DU_{1,t} = \begin{cases} 1 & \text{if} \quad t > \tau_1 \\ 0 & \text{elsewhere} \end{cases}, \quad DU_{2,t} = \begin{cases} 1 & \text{if} \quad t > \tau_2 \\ 0 & \text{elsewhere} \end{cases},$$

and

$$DT_{1,t} = \begin{cases} t - \tau_1 & \text{if} \quad t > \tau_1 \\ 0 & \text{elsewhere} \end{cases}, \quad DT_{2,t} = \begin{cases} t - \tau_2 & \text{if} \quad t > \tau_2 \\ 0 & \text{elsewhere} \end{cases}.$$

2.3 Robustness Tests

For purpose of robustness we choose to execute different econometric approaches to endogenously search for structural breaks. The test suggested by Chow (1960) requires the sum of squared errors from three independent regressions: one for each disjoint subsample period and one for the pooled data. An F-test then evaluates the combined statistic as follows:

$$Chow = \frac{\left(RSS - RSS_1 - RSS_2\right)/k}{\left(RSS_1 + RSS_2\right)/\left(n_1 + n_2 - 2k\right)} \sim F_{k, n_1 + n_2 - 2k} \quad (7)$$

where RSS denotes the sum of squared residuals, n_1 and n_2 are the number of observations in each subsample, and k represents the total number of regression variables, both the dependent and the independent. For each economic variable examined we deploy this test over 15 suspicious points in time, from the second quarter of 2006 to the fourth quarter of 2009, and record the corresponding statistic significance.

To further authenticate our findings, we also conduct a time-series regime switching analysis as proposed by Hamilton (1989). In this second robustness test we split the entire sample into two separate regimes, where each system can be described with a first-order autoregressive model in the form of

$$\Delta V_t = C_{st} + \varphi_{st} \Delta V_{t-1} + \varepsilon_t \quad (8)$$

while the error terms $\varepsilon_t \sim N\left(0, \sigma^2\right)$ and $st \in \left\{1,\ 2\right\}$ for the first and the second regimes, respectively. To have a sufficient number of observations in each regime, we allow a potential regime switch to take place in 11 different points in time, from the second quarter of 2006 to the fourth quarter of 2008. For each examined variable, we identify the most probable period for a regime switch by contrasting the means φ_{st} and their corresponding standard errors.[8] Throughout this inclusive time frame, we deploy both the Levenberg-Marquardt algorithm and the Welch's t-tests to spot the exact points where the most significant regime switches occur.

We do not expect findings from the Chow (1960) and the Hamilton (1989) tests to perfectly align with those of Zivot and Andrews (1992) models. Instead, they should serve as further indications of

[8] The Chow (1960) test requires that the variance of coefficients is the same within the two groups. The Hamilton (1989) test, however, permits some discrepancy between the standard errors of the two regimes.

the chronological sequence of the time-series structural breaks during this financial crisis.

To further authenticate our findings we replicate these analyses, but we fill in the missing observations within the final sample with pseudo-data as described hereafter. Since the first, second, and third quarters of 2001 and 2002 lack records, but data is available for the fourth quarters of 2000, 2001, and 2002, we generate pseudo-data for these six missing observations by adding (subtracting) equal increments (decrements) between any pair of consecutive fourth quarters. Essentially, we create two linear strings of records during these early years to best reflect the likely values within. This procedure does not interfere with data-points throughout the period of the current U.S. banking crisis, yet it increases the overall number of observations to 41 from 35 in the primary setting, thus allowing us to achieve a more comprehensive view of the structural breaks within the later years.

3. Empirical Findings

In this section we summarize the key findings of this study. In Table 2 we present the results of the preliminary Ljung-Box-Pierce (1970, 1978) and the Stoffer-Toloi (1992) white noise tests. Both of these tests help us to identify the particular aggregate variables that require additional ΔV_{t-j} terms in the main regressions. The statistical package allows us to execute each test twice, over two time intervals: to lag 6 and to lag 12. The findings are rather consistent in these tests, and in fact, 11 out of the 28 aggregate variables tested obligate us to regress longer lag periods of their changes to ensure that the disturbance term is indeed a white noise.

Table 2
Preliminary Ljung-Box-Pierce and Stoffer-Toloi White Noise Tests

Variable	Ljung-Box-Pierce Test		Stoffer-Toloi Test	
	To Lag 6	To Lag 12	To Lag 6	To Lag 12
FBTA	10.26	10.78	10.26	10.78
FBTD	10.58	11.34	10.58	11.34
MTA	10.90 *	15.69	8.56	12.61
MTD	10.92 *	19.72 *	8.81	16.91
PFTA	10.34	10.90	8.41	8.88
PFTD	10.54	11.25	8.57	9.18
INST	35.32 ***	39.32 ***	25.39 ***	29.95 ***
EMP	15.48 **	17.21	10.31	11.91
TL	8.93	13.76	7.10	11.31
TRWA	70.29 ***	80.48 ***	56.36 ***	64.57 ***
TEC	8.64	10.42	7.89	9.51
T1RBC	6.75	11.01	6.62	10.15
T2RBC	36.52 ***	62.54 ***	29.84 ***	53.14 ***
OREO	130.20 ***	148.61 ***	98.79 ***	109.49 ***
DER	14.04 **	15.47	13.54 **	14.95
SEC	10.01	11.84	8.51	10.01
SAEB	28.76 ***	43.47 ***	24.09 ***	37.16 ***
NI	35.09 ***	37.17 ***	29.03 ***	30.87 ***
NII	7.53	11.60	6.85	10.80
PTNOI	35.71 ***	39.06 ***	29.48 ***	32.43 ***
NCO	12.92 **	13.29	10.63	10.97
CD	12.08 **	19.78 *	9.81	16.67
FSLC	4.40	7.04	3.58	5.88
PSLC	13.95 **	16.62	11.27 *	13.71
CSLC	29.53 ***	56.89 ***	24.57 ***	49.28 ***
UNPI	41.65 ***	62.90 ***	34.81 ***	53.58 ***
ROA	34.47 ***	37.17 ***	28.60 ***	31.02 ***
ROE	33.82 ***	36.02 ***	27.99 ***	29.96 ***

Note: To better identify the specific variables that require additional ΔV_{t-j} terms in the main time-series regressions, we pre-run the Ljung-Box-Pierce (1970, 1978) and the Stoffer-Toloi (1992) white noise tests. These autocorrelation tests contrast the null hypothesis, which asserts that all the correlation coefficients up to $N_{\max}$ lags are zero, with the alternative hypothesis, which suggests that not all the correlation coefficients up to $N_{\max}$ lags are zero. The first column describes the 28 aggregate economic variables tested, and each test is deployed over two lengths: up to lag 6, and up to lag 12, where ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 level or better, respectively.

In Table 3 we report the results of the Zivot and Andrews (1992) models for single time-series structural breaks. For each of the 28 aggregate variables we detect the precise quarter of a year where a structural break occurred with the highest statistical significance, within its mean (Model A), its slope (Model B), or both its mean and slope (Model C). In Table 4 we describe the findings from the extended analysis of Lumsdaine and Papell (1997) for two potential structural breaks, either within the mean (Model AA), the slope (Model BB), or both the mean and slope (Model CC).

Table 3
Zivot and Andrews (1992) Tests for Single Endogenous Structural Breaks

Aggregate Variable	τ	Model A $\alpha^{(A)}$	Model B $\alpha^{(B)}$	Model C $\alpha^{(C)}$
FBTA	Q2/08	-4.409 ***	-1.301 *	-3.968 ***
FBTD	Q2/08	-4.553 ***	-1.234	-3.914 ***
MTA	Q1/09	-0.407 ***	-0.495 **	-0.522 **
MTD	Q1/09	-0.163	-0.415 **	-0.379 **
PFTA	Q2/08	-4.447 ***	-1.292	-3.977 ***
PFTD	Q2/08	-4.536 ***	-1.227	-3.912 ***
INST	Q3/09	-0.281 **	-1.235 **	-0.254 **
EMP	Q2/06	-0.217 **	-0.401 ***	-0.433 ***
TL	Q1/09	-0.420 ***	-0.552 **	-0.431 **
TRWA	Q2/09	-0.194 ***	-0.138	-0.150 *
TEC	Q2/08	-0.600 ***	-0.469 *	-0.623 ***
T1RBC	Q2/08	-0.786 ***	-0.445 *	-0.745 ***
T2RBC	Q2/07	-0.495 ***	-0.229	-0.352 **
OREO	Q1/07	-0.022	-0.325 ***	-0.322 ***
DER	Q4/06	-0.579 ***	0.0114	-0.282
SEC	Q1/09	-0.404 ***	-0.433 **	-0.401 **
SAEB	Q2/08	-0.710 ***	-2.644 ***	-1.551 **
NI	Q2/07	-0.758 ***	-0.229	-1.290 ***
NII	Q1/07	-0.506 *	-2.101 ***	-2.079 ***
PTNOI	Q1/07	-0.587 ***	-1.527 ***	-1.423 ***
NCO	Q2/07	0.588 **	-1.977 ***	-2.125 **
CD	Q3/06	-0.788 ***	-0.907 ***	-1.763 ***
FSLC	Q1/09	-0.375 **	-0.613 **	-0.568 **
PSLC	Q3/08	-0.310 ***	-0.691 ***	-0.346 *
CSLC	Q3/08	-0.790 ***	-0.910 **	-0.833 ***
UNPI	Q4/06	-0.375 ***	-1.166 ***	-1.116 ***
ROA	Q2/07	-0.789 ***	-1.314 ***	-1.091 ***
ROE	Q2/07	-0.835 ***	-1.255 ***	-1.095 ***

Note: We test for a single unit root in each time-series of the 28 aggregate variables (first column) at a particular point in time τ (second column) through Zivot and Andrews (1992) three models (last three columns): Model A permits a single breakpoint in the mean, Model B allows a one-time breakpoint in the slope, and Model C is a hybrid of the other two models. We report only the most important coefficients: $\alpha^{(A)}$, $\alpha^{(B)}$, and $\alpha^{(C)}$, where ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 level or better, respectively.

Table 4
Lumsdaine and Papell (1997) Tests for Two Endogenous Structural Breaks

Aggregate Variable	τ_1	τ_2	Model AA $\alpha^{(AA)}$	Model BB $\alpha^{(BB)}$	Model CC $\alpha^{(CC)}$
FBTA	Q2/08	Q1/09	-2.858 ***	-11.527 ***	-1.144 **
FBTD	Q2/08	Q1/09	-2.935 ***	-11.594 ***	-1.403 **
MTA	Q1/09	Q4/09	-0.542 ***	-0.531 **	-0.540 **
MTD	Q1/09	Q4/09	-0.283 *	-0.372 **	-0.372 **
PFTA	Q2/08	Q1/09	-2.883 ***	-11.580 ***	-1.107 **
PFTD	Q2/08	Q1/09	-2.881 ***	-11.575 ***	-1.394 **
INST	Q3/09	N/A	N/A	N/A	N/A
EMP	Q2/06	Q2/08	-0.255 ***	-1.325 ***	-1.220 **
TL	Q1/09	Q4/09	-0.487 ***	-0.541 **	-0.421 **
TRWA	Q2/09	N/A	N/A	N/A	N/A
TEC	Q2/08	Q2/09	-0.639 ***	-0.500 *	-0.543 **
T1RBC	Q2/08	Q1/09	-0.773 ***	-0.434	-0.374 **
T2RBC	Q2/07	Q1/09	-0.539 ***	0.085	0.040
OREO	Q1/07	Q1/08	-0.018	-0.263	-0.320
DER	Q4/06	Q4/08	-0.426 **	-1.029	-0.984
SEC	Q1/09	Q4/09	-0.368 **	-0.431 **	-0.393 **
SAEB	Q2/08	Q1/09	-1.322 ***	-2.059 ***	-2.034 **
NI	Q2/07	Q3/08	-1.351 ***	-1.324 ***	-2.008 ***
NII	Q1/07	Q3/08	-1.092 **	-2.104 ***	-2.001 ***
PTNOI	Q1/07	Q3/08	-0.979 ***	-1.224 ***	-2.056 ***
NCO	Q2/07	Q1/09	-1.859 **	-3.771 ***	-4.2333 ***
CD	Q3/06	Q2/07	-0.785 ***	-2.313 ***	-1.811 ***
FSLC	Q1/09	Q4/09	-0.499 **	-0.574 **	-0.563 **
PSLC	Q3/08	Q2/09	-0.335 ***	-0.505 **	-0.371 *
CSLC	Q3/08	Q2/09	-0.681 ***	-1.011 ***	-0.829 ***
UNPI	Q4/06	Q1/08	-0.725 ***	-0.903 **	-0.661 *
ROA	Q2/07	Q3/08	-1.224 ***	-1.224 ***	-1.677 ***
ROE	Q2/07	Q3/08	-1.331 ***	-1.260 ***	-1.705 ***

Note: To obtain a complete structure of the current U.S. banking crisis we examine two possible unit roots for the 28 aggregate variables (first column) at two separate points in time τ_1 and τ_2 (second and third columns) through Lumsdaine and Papell (1997) models (last three columns) as follows: Model AA permits two breakpoints in the mean, Model BB allows two breakpoints in the slope, and Model CC is a hybrid of the other two models. We report only the most important coefficients: $\alpha^{(AA)}$, $\alpha^{(BB)}$, and $\alpha^{(CC)}$, where ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 level or better, respectively. Our sample permits us to test for two structural breaks until the fourth quarter of 2009, but we require that $\tau_2 > \tau_1 + 2$, thus two aggregate variables (INST, TRWA) can only have a single break point. We report these results as N/A.

Our results essentially indicate three things. First, the current U.S. banking crisis extends far beyond the failure of a large number of financial institutions. Considerable structural changes in a number of key market variables signify major transformations in both consumer behavior and conduct of operations within the U.S. banking industry. The present financial crisis evidently escalates bank failures, both in absolute values and in percentage of the whole market, simultaneously in total assets and total deposits. However, these initial structural changes in the second quarter of 2008 are followed by additional structural breaks in the first quarter of 2009. Although more bank failures trail this second structural break in the form of "after shocks," and despite the fact that more bank failures are likely to occur henceforth, we anticipate that the massive wave of bank failures will eventually recede in the future. Conversely, the U.S. banking industry is going through permanent transformations in other important aspects.

We detect a robust deterioration in the U.S. banking market Total Assets (TA) and a synchronized stabilization in the aggregate market Total Deposits (TD) following the first quarter of 2009. These changes suggest that consumers either had less money available to deposit in U.S. banks or alternatively prefer to steer their funds elsewhere, despite a rise in the FDIC insurance coverage from $100,000 to $250,000 per depositor in October 2008. We further observe a faster decline in the number of financial institutions (INST) reporting to the FDIC after the third quarter of 2003.[9] In addition, we spot two structural breaks in the number of employees (EMP) within this economic sector. The first break caused the employment measure to stop rising past the second quarter of 2006, while the second break caused this figure to sharply fall after the second quarter of 2008. These modifications suggest a fundamental shrinkage in the U.S. banking industry.

Furthermore, we observe a significant rise in the proportion of Unprofitable financial Institutions (UNPI) together with a substantial decline in the industry average Return on Assets (ROA) and average Return on Equity (ROE) post 2007. These declining performance ratios corroborate the overall corrosion in profitability measures, Net Income (NI) and Pre-Tax Net Operating Income (PTNOI), and the parallel rise in Net Charge-Offs (NCO) and Other Real Estate Owned (OREO) after 2007. The enduring adjustments in the latter aggregate variables are associated with the collapse of the subprime mortgage market and the subsequent foreclosure epidemic in the U.S. In addition we notice significant structural breaks and vigorous decline in the means of Total Liabilities (TL) and Total Risk Weighted Assets (TRWA) during 2009. These variations further indicate a large industry contraction.

We also detect consequential transformations in the conduct of operations among U.S. banks. While Total Equity Capital (TEC) and Tier 1 Risk Based Capital (T1RBC) experienced a major shock in the second quarter of 2008, both encountered a second structural break and generally returned to their ordinary tracks in the first half of 2009. Inversely, the market collective Tier 2 Risk Based Capital (T2RBC) had its first structural break in the second quarter of 2007 with a relatively rapid increase in percentage, and a second structural break at the beginning of 2009 with a gradual decline.[10] However, the use of Derivatives (DER) was intensified towards the end of 2006 but somewhat stabilized at the end of 2008 (at higher levels than before). Likewise, the use of Securities (SEC) was intensified at the beginning of 2009 but later stabilized at the end of 2009.

During this crisis the U.S. banking industry has become more conservative. We detect two structural breaks in Salaries and Employee Benefits (SAEB). The first occurred at the beginning of 2008 with a significant drop, and the second happened in early 2009 with more steady compensations afterward. Despite a noteworthy rise in Cash Dividends (CD) following the third quarter of 2006, just before the burst of the crisis, we identify a second structural break with a considerable fall since the second half of 2007.[11] The disposition in bank lending policies further affected the Financial, Performance, and Commercial Letters of Credit (FSLC, PSLC, and CSLC, respectively), with a robust decrease in all three types of these irrevocable contracts during 2008 and 2009.

Second, we recognize that the structural breaks occurred at different points in time, and in a particular sequence. We therefore draw several inferences regarding the evolution of the current U.S. banking crisis by witnessing significant changes in the way banks operated before and continue to operate during this crisis. For this purpose we further examine the results of the Chow (1960) tests for endogenous structural breaks as well as the results of the Hamilton (1989) regime switch tests as reported in Table 5 and Table 6, respectively.

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[9] The continuous reduction in this figure during prosperous times, i.e. throughout the first years of the examined decade, evidently results from numerous mergers and acquisitions that are not necessarily related to bank failures.

[10] The differences arise from the nature of these risk based capital measures. Tier 1 capital consists largely of common shareholders' equity and is considered a permanent capital. However, Tier 2 capital is composed of undisclosed reserves, revaluation reserves, general provisions, and subordinated-term debt. Tier 2 bank capital is therefore considered a temporary or a supplementary bank capital.

[11] At least some of this fall is due to an increase in regulatory scrutiny that prevented banks from paying high dividends.

Two aggregate variables stand out as healthy predictors of the current banking crisis. All structural break tests imply that the number of Employees (EMP) within the U.S. banking industry took the first down-turn as early as the second quarter of 2006, i.e., well before the full scale eruption of the U.S. banking crisis. The market inclusive value of Other Real Estate Owned (OREO) by banks has sharply bent upward from the second half of 2006 as well. These two market variables indicate a mounting problem of foreclosed homes by banks along with an attempt to cut operational costs, thus could have served as obvious warning signs for the later collapse.[12]

Third, the prevalent and highly significant structural breaks suggest that the variations in the U.S. banking industry are not at all transitory. We deem these transformations to be permanent or at least long-lasting adjustments. After such pervasive economic shocks we can only presume that it will take a long time for the U.S. banking system to reach firmness again. This inference conveys important insight on the expected recovery rate as well as on the future image of the U.S. banking industry and the necessary regulatory actions to be taken henceforward.

Table 5
Chow (1960) Tests for Endogenous Structural Breaks

Aggregate Variable	Q2/ 06	Q3/ 06	Q4/ 06	Q1/ 07	Q2/ 07	Q3/ 07	Q4/ 07	Q1/ 08	Q2/ 08	Q3/ 08	Q4/ 08	Q1/ 09	Q2/ 09	Q3/ 09	Q4/ 09
FBTA									**	***					
FBTD									*	***					
MTA						**	***	**	***	**	*	*	**	**	*
MTD							*			***	*			**	*
PFTA										***					
PFTD										***					
INST						*	*	**	**	*	**	***	*		
EMP	***	***	***	***	***	***	***	***	**	**					
TL						*	**	*	***	***			*	**	*
TRWA				*	**	**	***	**	**	**	**	**	*		
TEC										**					
T1RBC															
T2RBC						**	**	***	***	***					
OREO	***	***	***	***	***	***	***	***	***	**	**	**	**	**	**
DER	**	**	*	**	***										
SEC						*	**	*	**	**					
SAEB										*					
NI						*				**					
NII															
PTNOI										**	*				
NCO											*	***			
CD				**	***										
FSLC	*	*	**	*	**	**		**	**	***	***	***	**	*	
PSLC	*	**	**	**	**	**	***	***	**						
CSLC															
UNPI										**				**	
ROA						*				**					
ROE						*				**	*				

Note: For the purpose of robustness we execute the Chow (1960) tests for endogenous time-series structural breaks over the 28 aggregate variables (first column) from the second quarter of 2006 to the fourth quarter of 2009 (the remaining 15 columns). We mark the detected breakpoints based on their statistical significance, where ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 level or better, respectively.

[12] To classify a time-series structural break we must include in the regression analysis several more data points beyond the actual break time. Nevertheless, it is sufficient to examine a truncated sample that ends at the second quarter of 2007 to comprehend the robust structural changes in these two aggregate variables. This awareness could have benefited the regulatory groundwork prior to the bursting of the crisis.

Table 6
Hamilton (1989) Tests for Endogenous Time-Series Regime Switches

Aggregate Variable	Q2/ 06	Q3/ 06	Q4/ 06	Q1/ 07	Q2/ 07	Q3/ 07	Q4/ 07	Q1/ 08	Q2/ 08	Q3/ 08	Q4/ 08
FBTA										***	
FBTD										***	
MTA							***				
MTD											**
PFTA										***	
PFTD										***	
INST									**		
EMP	***										
TL							***				
TRWA			***								
TEC										***	
T1RBC										*	
T2RBC										***	
OREO	***										
DER						***					
SEC	***										
SAEB											***
NI							***				
NII			***								
PTNOI							***				
NCO									***		
CD					***						
FSLC										***	
PSLC			***								
CSLC										***	
UNPI											***
ROA							***				
ROE							***				

Note: For the purpose of robustness we conduct the Hamilton (1989) tests for endogenous time-series regime switches over the 28 aggregate variables (first column) from the second quarter of 2006 to the fourth quarter of 2008 (the remaining 11 columns). We mark only the most considerable switches based on their statistical significance, where ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 level or better, respectively.

4. Economic Reasoning and Future Implications

In this section we attempt to provide economic justifications for the observed progress of the current U.S. banking crisis and the associated structural breaks. In Table 7 we draw a chronological line of the major economic events and the realized time-series structural breaks in the U.S. banking industry from the second quarter of 2006 to the fourth quarter of 2010. We focus on the key economic events throughout this period and intentionally exclude political incidents such as the replacement of the U.S. government, the reelection of the chairman of the Federal Reserve, or the mid-term election for the U.S. Senate and the House of Representatives.

By looking at the gradual progress of events within this period it is apparent that the first structural break in the total number of full time employees (EMP) in the second quarter of 2006 is associated with the layoff at a major subprime lender, Ameriquest. At this point, financial institutions were still unaware of the approaching calamity (except perhaps Goldman Sachs), and most of them increased their CD payments after the third quarter of that year. Meanwhile, most banks encouraged the use of credit derivatives, but simultaneously the number of Unprofitable Institutions (UNPI) began to soar in the fourth quarter of 2006.

With a higher volume of foreclosures in the U.S. housing market, a number of key mortgage lenders filed for bankruptcy at the beginning of 2007. As a result Other Real Estate Owned (OREO) reached a structural break, and from this point on, OREO keeps on rising. Due to fewer mortgage paying borrowers, Pre-Tax Net Operating Income (PTNOI) took its first dive. In the next quarter the largest U.S. subprime lender, New Century Financial, filed for bankruptcy, and the economic mess filtered into the investment banking industry, with a major strike to Bear Stearns. Consequently, the market collective Net Income (NI), Return on Assets (ROA), and Return on Equity (ROE) decreased, while Net Charge-Offs (NCO) increased. In the second quarter of 2007 the industry aggregate Cash Dividends (CD) was at an all-time high, but later on this measure shows a dramatic plunge. By the third quarter of 2007 the crisis had gathered momentum with more bankruptcies in the financial industry and the first meaningful government interference. Accordingly, banks became more vigilant and hindered normal operations with regard to issuing new letters of credit. Substantial regulatory and policy acts appeared at the fourth quarter of 2007.

Table 7
Timeline of the U.S. Banking Crisis – Turning Events and Structural Breaks

Year / Quarter	Q1	Q2	Q3	Q4
2006		- Key subprime lender Ameriquest cuts 3,800 jobs and closes its 229 retail branches *- Structural breaks in: EMP*	- The U.S. Home Construction Index is down over 40% from the previous year *- Structural breaks in: CD*	- Goldman Sachs reduces exposure to MBS and increases short positions *- Structural breaks in: DER, UNPI*
2007	- Major mortgage lenders including Network USA Inc., Accredited Home Lenders Holding, and DR Horton file for bankruptcy *- Structural breaks in: OREO, NII, PTNOI*	- The largest U.S. subprime lender, New Century Financial, files for Chapter 11 - Two chief debt funds of Bear Stearns & Co. halt redemptions *- Structural breaks in: T2RBC, NI, NCO, ROA, ROE* *- Second structural breaks in: CD*	- BNP Paribas halts redemptions from three U.S. subprime mortgage debt funds - Countrywide Financial borrows $11.5B and reorganizes - American Home Mortgage Investment Corporation files for bankruptcy - The Fed injects $43B to assist troubled banks and starts to cut the interest rate *- Structural breaks in: PSLC, CSLC*	- The U.S. government with representatives from the private industry establishes the "Hope Now Alliance" to assist selected subprime borrowers - The Fed injects additional $41B to allow banks to borrow at a lower interest rate - The Financial Accounting Standards Board revises standards for "Fair Value Measurements" to allow greater transparency
2008	- The National Association of Realtors declares the largest drop in existing home sales in 25 years - JPMorgan Chase acquires Bear Stearns with the Fed's support - U.S. unemployment rate surrounds 5.0% *- Second structural breaks in: UNPI*	- UBS AG Swiss bank announces it will cut 5,500 jobs - U.S. unemployment rate rises from 5.0% to 5.5% *- Structural breaks in: FBTA, FBTD, PFTA, PFTD, TEC, T1RBC, SAEB* *- Second structural breaks in: EMP*	- Washington Mutual and IndyMac Bank fail - The U.S. government approves the Housing and Economic Recovery Act of 2008 - The Fed takes over Fannie Mae and Freddie Mac and lends $85B to American International Group - Bank of America buys Merrill Lynch - Lehman Brothers files for bankruptcy - U.S. unemployment rate surrounds 6.0% *- Second structural breaks in: NI, NII, PTNOI, ROA, ROE*	- The U.S. government approves the Emergency Economic Stabilization Act with $700B allocated to buy troubled assets, and the FDIC increases basic insurance to $250,000 per depositor - The Fed agrees to provide $900B in short-term cash loans to banks - The U.S. government rescues Citigroup and pledges additional $800B - U.S. unemployment rate rises from 6.6% to 7.4% *- Second structural breaks in: DER*

Table 7 - continued

Year / Quarter	Q1	Q2	Q3	Q4
2009	- In the first two months the S&P 500 drops almost 19 percent - Moody's Investor Services issues a report suggesting that only four of 12 banks' capital ratios remain above the regulatory thresholds - U.S. unemployment rate rises from 7.7% to 8.6% *- Structural breaks in: MTA, MTD, TL, SEC, FSLC* *- Second structural breaks in: FBTA, FBTD, PFTA, PFTD, T1RBC, T2RBC, SAEB, NCO*	- The Financial Accounting Standards Board approves new guidelines to ease the accounting of troubled assets held by banks - The Fed releases the final results of the Supervisory Capital Assessment Program (stress tests) of the 19 largest U.S. banks stating that only nine of them have adequate Tier 1 capital - The Fed Reserve Board allows banks to include senior perpetual preferred stocks in their Tier 1 capital - Fannie Mae records a net loss of $14.8B - U.S. unemployment rate rises from 8.9% to 9.5% *- Structural breaks in: TRWA* *- Second structural breaks in: TEC, PSLC, CSLC*	- The U.S. Treasury Department, the Fed, and the FDIC jointly specify the details of the Legacy Securities Public-Private Investment Program (PPIP) that invests $30B in the market for commercial and non-agency residential MBS - Congress announces the appointment of members of the Financial Crisis Inquiry Commission - The U.S. Treasury Department announces the expiration of the Guarantee Program for Money Market Funds (initiated after the Lehman Brothers failure in Q3/08) - Fannie Mae records a loss of $18.9B - U.S. unemployment rate rises from 9.4% to 9.8% *- Structural breaks in: INST*	- CIT Group Inc. files for prepackaged bankruptcy protection - AIG announces that it has closed two transactions with the Federal Reserve Bank of New York, which reduces its outstanding debt by $25B - Citigroup reaches an agreement with the U.S. government to service the remaining $20B debt - U.S. unemployment rate reaches 10.1% - Freddie Mac records a net loss of $6.5B - Fannie Mae records a net loss of $15.2B *- Second structural breaks in: MTA, MTD, TL, SEC, FSLC*
2010*	- The FDIC states that the number of troubled banks increased from 552 insured institutions with $345.9B in assets for Q3/09 to 702 institutions with $402.8B in assets for Q4/09 - Fannie Mae records a net loss of $11.5B - U.S. unemployment rate surrounds 9.7%	- The Securities and Exchange Commission sues Goldman Sachs for allegedly having failed to disclose material information in one of its MBS funds - U.S. unemployment rate surrounds 9.7%	- U.S. unemployment rate surrounds 9.6%	- A temporary calamity in the foreclosure epidemic, where homes are confiscated by banks without the necessary legal paper-work being in place - U.S. unemployment rate rises to 9.8%

Note: * 2010 events are excluded from the econometric analyses and reported here for completeness.

A second structural break in Unprofitable Institutions (UNPI) occurs with a severe fall in existing home sales and an initial rise in the U.S. unemployment rate in the first quarter of 2008. Only three quarters later the UNPI measure doubled itself. In the second quarter of that year more financial institutions sensed the growing pressure and cut jobs. Accordingly, the total number of full time Employees (EMP) displays its second structural break and starts a long descending run. In addition, both Total Equity Capital (TEC) and Tier 1 Risk Based Capital (T1RBC) show their first decline in the past decade. The failure of Washington Mutual, IndyMac Bank, and Lehman Brothers in the third quarter of 2008 launched a massive bailout plan by the U.S. government. At the same time profitability measures including Net Income (NI), Net Interest Income (NII), Pre-Tax Net Operating Income (PTNOI), Return on Assets (ROA), and Return on Equity (ROE) took another dive with second respective structural breaks. Following the Emergency Economic Stabilization Act and a

tighter regulatory supervision in the fourth quarter of 2008, and after a continuous rise in the use of derivatives (DER) over the past several years, this measure became more stable.

In the first quarter of 2009 the U.S. unemployment rate continued to rise, the stock markets fell, and for the first time Market Total Assets (MTA) weakened. On the other hand, due to closer monitoring by regulatory and governmental agencies, Tier 1 Risk Based Capital (T1RBC) moves back to its original path with a second structural path. At this point, Net Charge-Offs (NCO) begins a new upward run, which activates a structural break and a significant drop in Total Risk Weighted Assets (TRWA) from the second quarter of that year. Despite several policy acts, the total number of reporting institutions (INST) attains its single structural break in the third quarter of 2009 and declines even faster than before. In the fourth quarter of 2009 there are a few signs of economic stabilization, thus Market Total Assets (MTA), Total Liabilities (TL), and total market Financial Standby Letters of Credit (FSLC) become more stable.

Although the U.S. unemployment rate reached its record high during 2010, there are more signs of economic stabilization thereafter. In late 2010 the Failed Bank Total Assets (FBTA), Failed Bank Total Deposits (FBTD), Percentage of Failed banks Total Assets (PFTA), and Percentage of Failed banks Total Deposits (PFTD) are already close to their long-term mean, the number of full time employees (EMP) becomes more steady, though at a much lower height than before, Net Charge-Offs (NCO) reverts, although not to its traditional levels, and Net Income (NI) and Pre-Tax Net Operating Income (PTNOI) are significantly higher than their record lows at the end of 2008. We therefore predict a slow recovery for the U.S. banking industry in the coming years; however, this salvation will likely reside within new equilibrium points in several market key variables.

5. Summary

The analysis of structural breaks is naturally considered a suitable methodology for analyzing the full extent of a theme, identifying the precise sequence of the major turning events within, and testing whether distresses to a specific time-series have a temporary or a permanent effect. The presence of a statistically significant unit root practically indicates that a specific shock creates a meaningful structural shift, and the subsequent series has no immediate tendency to revert to its equilibrium value or pre-established path. In contrast, a rejection of the unit root hypothesis suggests that an explicit shock to a series merely conveys a temporary impact, and the later series returns to its fundamental behavior. In some occasions however, two separate unit roots may divert the series from its original path, but then roughly realign it to its long-term course. Furthermore, when time-series structural breaks appear in numerous aspects of a complex subject, we can learn about the logical progression of the turning events within as well as portray the entire scope of the transformation under investigation.

We therefore examine key changes in the U.S. banking industry throughout the first decade of the third millennium and deploy different estimation methods for time-series structural breaks over the current U.S. banking crisis, after the second quarter of 2006. We first validate the existence of a time-series white noise through the Ljung and Box (1978) and the Stoffer and Toloi (1992) tests. We then execute the Zivot and Andrews (1992) tests for single endogenous structural breaks and further conduct the Lumsdaine and Papell (1997) tests for two separate structural breaks. Finally we corroborate the results with the Chow (1960) tests for endogenous structural breaks and Hamilton (1989) time-series regime switches.

Our empirical results evidently suggest that the current U.S. banking crisis extends far beyond the failure of a large number of financial institutions. The depth and breadth of the realized time-series structural breaks in the 28 examined aggregate variables teaches us the long-lasting real impact of this crisis. We identify numerous structural changes that unambiguously imply a permanent and robust shift in this economic sector. We therefore conclude that it will take a while before the U.S. banking industry can rebuild itself. Moreover, we deduce that the expected recovery will likely reside within new equilibrium points in several key market variables.

Barth, Caprio, and Levine (2012) state that the rapid pace of financial innovation has clearly contributed to the recent economic downfall, yet this was not the root cause of the current financial meltdown. The authors further argue that the crisis is about defective regulatory and political systems that did not respond appropriately to escalating danger largely because of an army of lobbyists that induce politicians to enact supportive laws and encourage politicians to pressure regulators to interpret those laws in favorable ways. Moreover, the authors suggest that the public lacks effective mechanisms for obtaining relevant information on what regulators and the institutions they regulate are doing.

In light of this criticism, we advise regulators to comprehend that the U.S. banking industry, which has a disproportionate influence on the overall economy, has gone through a major contraction cycle. In addition, significant changes are also observed in both consumer behavior and conduct of operations within this vital economic sector. In this study we provide vigorous evidence of these structural changes that could help policy makers to prudently design their future necessary steps.

In particular, to develop a sound regulatory system that will provide much necessary economic growth, policy makers must address these structural breaks in the banking industry and aim their reforms towards a tighter supervision on banks and depository institutions alike and a greater transparency of this supervision. Regulatory agencies must also acknowledge the unique warning signs for this major economic shift, and further deploy mechanisms that will alert the public before the next crisis.

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