Welfare analysis of bank mergers with financial instability *

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Abstract

In this study, we analyze the effect of a merger between banks by extending a structural model of the banking industry with the possibility of bank runs developed by Egan et al. (2017). We use our framework to analyze whether the 2008 merger between Wells Fargo and Wachovia was beneficial for social welfare. The results suggest that the stability of the financial system is critical for evaluating mergers in the banking industry.

Keywords: Financial stability, Bank merger, Imperfect competition, Bank run

JEL Classification Numbers: G21, G34, L13

1 Introduction

In the banking industry, mergers have had a significant impact on the competitive environment. In the United States, there have been more than 500 mergers each year, mainly in the 1990s. In Japan, more than ten city banks have merged into three mega-banks.

While mergers may lower the level of competition in the banking industry, they may also improve the profitability of individual banks and help to stabilize the financial system. Bank mergers are subject to review by a country's supervisory authority, which requires a set of criteria. Considering the impact on social welfare, it is necessary to incorporate both competition and stability perspectives in these criteria.

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Previous studies on bank mergers have mainly examined the impact of mergers that have already taken place through reduced-form empirical analysis. To evaluate new mergers, counterfactual simulations using structural models are required. Existing structural models for evaluating mergers evaluate only competition and do not evaluate bank mergers in terms of both competition and financial system stability. While mergers may improve the profit structure of banks and enhance the stability of the financial system, they may also have adverse effects by lowering deposit rates and raising lending rates. The ultimate impact on social welfare remains unclear. Thus, the construction of an evaluation framework for bank mergers would be useful for reviewing mergers.

The objective of this study is to develop a framework to study the effects of a merger in the banking industry on social welfare when there is a possibility that the financial system could be unstable. To achieve this goal, we extend the structural model of imperfect competition in the banking industry with a bank run developed by Egan et al. (2017) to include a merger between banks.

This study is related to the literature on structural models of banking. Corbae and D'erasmo (2013) builds a banking industry dynamics model in which there are banks with market power Corbae and D'Erasmo (2019) and Corbae et al. (2018) uses the structural model for policy analysis. In addition, Egan et al. (2017) builds a structural model of the banking industry with the possibility of bank runs. We contribute to this literature by extending their approach to the analysis of banking mergers.

This study is also related to the empirical analysis of banking mergers. Berger et al. (1999) summarizes the earlier literature. Recently, several studies (e.g., Sapienza (2002); Montoriol-Garriga (2008); Erel (2011)) use contract-level data on bank loans to study the effect of bank mergers on loans. Our study contributes to this literature by developing a structural model of banking mergers for a counterfactual analysis, which is difficult to conduct with observational data. Akkus et al. (2016) estimate the matching function of acquirer and target banks in the merger market. Although their model is also structural, their focus is on the relationship between the acquirer and target bank, rather than the merger and its implications for the financial system.

The contributions of this study are that it is the first to present a tractable structural model of mergers in the banking industry that can simultaneously examine the impact of mergers on both competition in the deposit market and the stability of the financial system, and to evaluate mergers, including their impact on social welfare.

We use the estimation result of Egan et al. (2017), who uses the data of large banks in the United States in 2008 to conduct our analysis of the 2008 merger of Wells Fargo and Wachovia. The results suggest that the stability of the financial system is critical in evaluating mergers in the banking industry.

2 The model

The model in this study is based on Egan et al. (2017)[1]. Time is discrete with an infinite horizon. There are three types of agents: M^I consumers for insured deposits, M^N consumers for uninsured deposits, and K banks. Each bank supplies its own deposit brand. When mergers are introduced into the model, we assume that the merged bank supplies multiple brands. The timing of the model in each period t is as follows.

1. Each bank k sets interest rates for insured and uninsured deposits, $i^I_{k,t}$ and $i^N_{k,t}$.
2. Consumers choose where to place their funds.
3. Banks invest deposits and a profit shock occurs.
4. Banks choose whether to repay deposits and the coupon on the long-term debt, or default.

There are K banks in this model. We assume that K is exogenously given, and is constant over periods. Banks maximize equity value by competing for deposits. Bank k receives a return on deposit net of non-interest costs, denoted by $R_{k,t} \sim N(\mu_k, \sigma_k)$. Banks need to pay additional costs c_k to serve insured deposits. Let $s^i_{k,t}$ denote the market share of bank k at time t in market $i = I, N$. Banks have issued a Consol bond in the past, and thus, they need to repay b_k every period. This assumption is needed to ensure that banks choose to default with positive probabilities.

The profit of bank k at time t is then given by

$$\pi_{k,t} = M^I s^I_{k,t}(R_{k,t} - c_k - i^I_{k,t}) + M^N s^N_{k,t}(R_{k,t} - i^N_{k,t}).$$

At time t, the bank uses the net cash inflow $\pi_{k,t} - b_k$ to pay dividends (no retained earnings).

If $\pi_{k,t} - b_k < 0$, equity holders can choose to finance the loss.

In the case of default, equity holders lose their claim on future dividends. The bank is liquidated to repay the depositors and bondholders. Then, exactly the same bank enters the market. Although this assumption is unrealistic, it ensures that the environment is always stationary, so the computation of equilibria is very simple.

2.1 Merger analysis

Do bank mergers lead to financial stability? In this subsection, we introduce mergers into the model in the previous subsection to quantitatively analyze the effect on a financial system and, hence, social welfare. We follow Nevo (2000) to introduce mergers into models with imperfect competition. Here, we focus on the case in which two banks are involved in mergers. Let m denote the index

[1] Ino and Matsuki (2020) describes the model in detail.

for the merged bank, and m_1, m_2 denote the deposit brand that bank m owns. To make the analysis tractable, we assume that after the merger, the return on loans is equalized at $R_m = \omega R_{m_1} + (1-\omega)R_{m_2}$, $\omega \in [0,1]$, where ω is the weight of the lending technology of bank m_1. After the merger, the merged bank still pays the same insurance cost $\mathbf{c}_m \equiv \begin{bmatrix} c_{m_1}, & c_{m_2} \end{bmatrix}$. The merged bank can also pay a different interest rate $\mathbf{i}_m \equiv \begin{bmatrix} i_{m_1}, & i_{m_2} \end{bmatrix}$ for each deposit brand. Then, the profit of merged bank m can be written as

$$\begin{aligned} \pi_m = & [M^I s_m^I(\mathbf{i}^I) + M^N s_m^N(\mathbf{i}^N, \rho)] R_m \\ & - M^I \mathbf{s}_m^I(\mathbf{i}^I)\mathbf{c}_m^T + (M^I \mathbf{s}_m^I(\mathbf{i}^I) + M^N \mathbf{s}_k^N(\mathbf{i}^N, \rho))\mathbf{i}_m^T, \end{aligned} \tag{1}$$

where $\mathbf{i}^j, ; j = I, N$ is the insured/uninsured interest rates of all the banks, and the joint market share is defined as

$$s_m^j(\mathbf{i}^j, \rho) \equiv s_{m_1}^j(\mathbf{i}^j, \rho) + s_{m_2}^j(\mathbf{i}^j, \rho), \quad j = I, N. \tag{2}$$

$\mathbf{s}_m$ is a vector collecting the market share of the merged bank

$$\mathbf{s}_m^j(\mathbf{i}^j, \rho) = \begin{bmatrix} s_{m_1}^j(\mathbf{i}^j, \rho) & s_{m_2}^j(\mathbf{i}^j, \rho) \end{bmatrix}. \tag{3}$$

$\mathbf{x}^T$ denotes the transpose of the vector $\mathbf{x}$.

In this case, we can apply almost the same analysis in the case without a merger, except for the interest rate first-order conditions. In the following, market share functions omit dependency on interest rate and default probability to shorten the notation. The default threshold is given by the solution to

$$\begin{aligned} & b_m - [M^I s_m^I + M^N s_m^N]\overline{R}_m + [M^I \mathbf{s}_m^I(\mathbf{c}_m + \mathbf{i}_m^I)^T + M^N \mathbf{s}_m^N(\mathbf{i}_m^N)^T] = \\ & \frac{1}{1+r}(M^I s_m^I + M^N s_m^N)\left[\mu_m - \bar{R}_m + \sigma_m \lambda\left(\frac{\bar{R}_k - \mu_m}{\sigma_m}\right)\right]\left[1 - F(\bar{R}_m)\right]. \end{aligned} \tag{4}$$

The first-order condition with respect to the interest rates are given by

$$\begin{aligned} \frac{1}{\alpha} = & (1 - s_{m_1} - s_{m_2})\left[\mu_m + \sigma_m \lambda\left(\frac{\bar{R}_m - \mu_m}{\sigma_m}\right)\right] \\ & -(1 - s_{m_1} - s_{m_2}) m c_m \end{aligned} \tag{5}$$

$$\left[\mu_m + \sigma_m \lambda\left(\frac{\bar{R}_k - \mu_k}{\sigma_k}\right)\right] - m c_m = \frac{1}{\alpha(1 - s_m)}. \tag{6}$$

3 Simulation Results

In this section, we present the simulation results of the case of the 2008 merger between Wells Fargo and Wachovia.

We use the estimation results from Egan et al. (2017). Their main analysis focuses on the five largest banks (in terms of deposit shares) in the United States: Bank of America, JP Morgan, Wells Fargo, Citi Bank, and Wachovia.

Parameter	value	description
α_I	58.79	Depositor sensitivity to interest rate (Insured)
α_N	16.64	Depositor sensitivity to interest rate (Uninsured)
γ	-12.60	Depositor sensitivity of bank default
r	0.05	Discount rate
M^I	4440000000	Insured deposit market size
M^N	4140000000	Uninsured deposit market size
ω	0.439	Weighting parameter for merged lending
b_k	[6547896, 23100000]	Consol bond
μ_k	[0.074, 0.081]	Mean return on loans
c_k	[0.046, 0.055]	Non-interest cost of loans
σ_k	[0.11, 0.29]	Standard error of loan return

Table 1: Parameter values for merger analysis

They calibrate the model to the data of interest rates and default probabilities at March 31, 2008. The parameter values are summarized in Table 1.

We add a new parameter for merged bank lending ω, which represents the weight of the acquirer bank's lending technology to the merged bank's lending technology. We calibrate ω so that it corresponds to the share of Wells Fargo's lending in the total lending of Wells Fargo and Wachovia before the merger, which is 0.439.

3.1 Effects of mergers on interest rates and default rates

We first compute several equilibria for the case without mergers, and then use these equilibria as an initial guess to compute equilibria with mergers to reduce the possibility of comparing different equilibria (see Table 2). We utilize Table 4 of Egan et al. (2017), which displays the observed equilibrium, best equilibrium, and bank run equilibrium for each bank.

Table 3 presents the simulation results. In the observed equilibrium, as expected, lower interest rates were set, the earnings environment for banks improved, the probability of default fell, and the instability of the financial system declined.

At the best equilibrium, there was a significant drop in interest rates for the merged banks, but not much change for the other banks. The probability of default also declined for merged banks but rose slightly for some banks.

In the equilibrium with bank runs, the results are somewhat complicated. Even though the number of banks is decreasing, some banks set higher interest rates.

In the equilibrium where a bank run occurs at Wells Fargo, the interest rate at Wells Fargo is considerably lower than that at Wachovia, another branch. At the equilibrium where a bank run occurs at Bank of America, the insured interest rates are higher for the merged banks and lower elsewhere. The uninsured interest rates are particularly large for the merged banks. In the equilibrium

where a bank run occurs at JP Morgan, interest rates are higher for the merged banks, while for Bank of America and Citi, interest rates are lower. The default probability is smaller. Finally, in Citi's case, interest rates are lower at JP Morgan and Bank of America, and higher at the merged bank; there is no change in Citi's rate setting. The default probability is lower for all except Citi.

Overall, interest rates change in a variety of ways, while the probability of default is lower. This result roughly supports the claim that mergers reduce financial system instability. It should be noted, however, that if a bank run occurs at a merged bank, the probability of default for all banks increases, and the impact is particularly pronounced at the merged bank.

3.2 Effects of mergers on welfare

Once we have computed the equilibrium with and without mergers, we can compute social welfare to evaluate whether the merger is beneficial for society. Note that we can evaluate social welfare only for each equilibrium because we do not have any information about the likelihood of which equilibrium arises. In this model, social welfare is the sum of consumer surplus, producer surplus, which is the value of banks, and the cost of deposit insurance.

Following chapter 3 of Train (2009), under the assumption that the error term follows i.i.d extreme distributions, we can write the consumer surplus as

$$CS = \frac{M^I}{\alpha^I} \ln \left[\sum_{l=1}^{K} \exp(\alpha^I i_l^I + \delta_l^I) \right] + \frac{M^N}{\alpha^N} \ln \left[\sum_{l=1}^{K} \exp(\alpha^N i_l^N + \delta_l^N + \gamma \rho_l) \right]. \tag{7}$$

The annualized equity value of banks is given by

$$AEV = \sum_{l=1}^{K} r E_l. \tag{8}$$

Assuming a 40% recovery rate, the expected deposit insurance cost is

$$EC = 0.6 \sum_{l=1}^{K} \rho_l M^I s_l^I. \tag{9}$$

Then, the change in welfare can be computed as

$$\Delta W = \Delta CS + \Delta AEV - \Delta EC. \tag{10}$$

The result is shown in Table 4. Social welfare rises in all equilibria except for the case in which a bank run occurs at the merged bank. While the effects of mergers vary by equilibrium, and lower interest rates may reduce consumer surplus, the positive effects of mergers on bank values and insurance costs contribute to better social welfare. In the equilibrium where a bank run occurs at the merged bank, While the insurance cost is lower with the merger, the interest rate is also lower because of reduced competition. This reduces consumer surplus, resulting in lower social welfare.

4 Conclusion

In this study, we extend the structural model of the banking industry with a possibility of bank runs to allow mergers between banks, and use it to analyze whether the merger between Wells Fargo and Wachovia was beneficial for social welfare. The merger increased the market share of the merged bank and thus, allowed it to set lower deposit rates, which implies higher markup. Changes in interest rates associated with the merger vary by equilibrium. Overall, the default probability was reduced and the merger stabilized the financial system. The merger would improve social welfare due to the stabilizing effect of the financial system, except in equilibrium, where a bank run occurred on the merged bank. In this equilibrium, the merger would worsen social welfare, because the financial system would be destabilized. This result suggests that the stability of the financial system is critical for evaluating mergers in the banking industry.

Bank name	Obs. eqm	Best	Bank run at Wells Fargo	Bank of America	JP Morgan	Citi
Insured interest rate						
JP Morgan	1.73	0.98	2.46	2.65	10.48	3.17
Bank of America	1.98	1.53	2.13	7.34	2.44	2.46
Wells Fargo	2.13	2.05	10.05	3.06	3.57	3.68
Citi	2.23	2.11	3.01	3.21	3.72	12.26
Wachovia	2.08	2.04	2.59	2.62	2.93	2.98
Uninsured interest rate						
JP Morgan	1.73	0.94	2.41	2.56	20.35	3.02
Bank of America	1.97	1.4	1.94	11.43	2.23	2.24
Wells Fargo	2.32	2.25	17.41	3.21	3.71	3.81
Citi	2.23	2.13	2.94	3.09	3.52	24.35
Wachovia	2.23	2.19	2.67	2.71	3.00	3.04
Default probability						
JP Morgan	1.5	0.19	2.86	3.29	48.35	4.36
Bank of America	1.82	0.03	1.85	53.33	3.27	3.40
Wells Fargo	1.5	1.34	46.61	3.56	4.81	5.06
Citi	2.11	1.92	3.36	3.74	4.62	48.19
Wachovia	3.28	3.14	4.75	4.92	5.96	6.13

Table 2: Equilibria without mergers (%) from Egan et al. (2017)

Bank name	Obs. eqm	Best	Bank run at Wells Fargo	Bank of America	JP Morgan	Citi
Insured interest rate						
JP Morgan	1.66	1.0	2.62	2.22	10.48	2.47
Bank of America	1.96	1.52	2.24	7.33	1.85	1.57
Wells Fargo	1.06	1.06	7.37	3.32	3.97	4.13
Citi	2.16	2.05	3.18	2.61	2.91	12.26
Wachovia	1.11	1.1	7.41	3.37	4.02	4.17
Uninsured interest rate						
JP Morgan	1.66	0.98	2.53	2.35	20.39	2.83
Bank of America	1.96	1.41	2.08	11.43	1.81	1.65
Wells Fargo	0.9	0.92	11.66	3.28	3.95	4.06
Citi	2.17	2.07	3.06	2.85	3.28	24.41
Wachovia	0.9	0.92	11.66	3.28	3.95	4.06
Default probability						
JP Morgan	1.36	0.23	3.21	2.44	48.34	3.68
Bank of America	1.77	0.03	2.47	53.33	2.59	2.74
Wells Fargo	0.0	0.0	50.39	0.45	1.27	1.64
Citi	2.0	1.82	3.67	2.96	3.95	48.19
Wachovia	0.0	0.0	50.39	0.45	1.27	1.64

Table 3: Equilibria with mergers (%)

Bank name	Obs. eqm	Best	Bank run at Wells Fargo	Bank of America	JP Morgan	Citi
Without mergers						
Insurance Cost	13.7	9.0	1080.8	979.3	1085.5	1117.3
Social Welfare	0.0	19.53	-1143.11	-1205.73	-1333.02	-1365.18
With mergers						
Insurance Cost	6.9	1.2	940.7	962.5	1074.1	1109.2
Social Welfare	7.92	23.14	-1149.34	-1125.49	-1255.22	-1295.08

Table 4: Welfare of each equilibrium (billion dollars). Social welfare is relative to the observed equilibrium without mergers.

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