Online Appendix for
"Do low search costs facilitate like-buys-like mergers? Evidence from common bank networks."

Jiakai Chen, Joon Ho Kim, S. Ghon Rhee

Online Appendix A: Additional proofs of propositions

The online appendix contains proof of Lemma 2 in Appendix E, as well as the technical details of the PDEs as well as the solutions in the proof of Proposition 1.

Proof of Lemma 2:

We first define the value function of acquirer and candidate target in the bargaining round n as $\pi_n^A(s)$ and $\pi_n^B(s)$, where the s, which could be offered from either party, is the share of synergy obtained by the acquirer. Since the acquirer and candidate exchange the offers, we mark the acquirer's offer as s_A, and candidate's offer as s_B. The value function measures the present value of the amount of merger synergy, discounted by the interest rate r back to $t = 0$, the *beginning* of the bargaining process.

After the acquirer starts the bargaining by first offering a s_A, the candidate firm, at ϵ time after the beginning of the first round, can either reject the offer and make a counteroffer or accepts the offer immediately. The acceptance of the offer leads to a realization of merger synergy $\mu = \overline{\mu}(1 - |\theta_A - \theta_B|)$ at ϵ time after the start of the bargain. The candidate, conditional on receiving the offer at time ϵ, obtains a present value of $\pi_1^t(s_A) = e^{-\epsilon r}\mu(1 - s_A)$, where $e^{-\epsilon r}$ to the represent the discount due to the bargaining time. The acquirer, however, obtains a present value of $\pi_1^A(s_A) = \left(1 - e^{-\epsilon/\kappa}\right)e^{-\epsilon r}V(\theta_A) + e^{-\epsilon/\kappa}e^{-\epsilon r}\mu s_A$, since there is a probability that she meets with a new candidate before ϵ, a probability $\Pr(\tau < \epsilon) = 1 - e^{-\epsilon/\kappa}$ event upon which the bargaining gets canceled and the acquirer left with outside value $V(\theta_A)$.

If the candidate decided to give a counteroffer instead, the expected gain of the candidate offering at the second round is $\pi_2^B(s_B) = e^{-\epsilon/\kappa}e^{-2\epsilon r}\mu(1 - s_B)$. Similarly, there is a probability $\Pr(\tau < \epsilon) = 1 - e^{-\epsilon/\kappa}$ event upon which the bargaining gets canceled and the candidate left no synergy gain at all.

In case there is no new arrival of candidates, the acquirer, who faces the candidate's second round with a value $\pi_2^A(s_B) = e^{-2\epsilon r}\mu s_B$. She decides whether to accept the offer or counter it in the third round. Similar analysis gives us the present value of the expected gain of the counter-offer as $\pi_3^A(s_A) = \left(1 - e^{-\epsilon/\kappa}\right)e^{-3\epsilon r}V(\theta_A) + e^{-\epsilon/\kappa}e^{-3\epsilon r}\mu s_A$.

In equilibrium, both the acquirer and the candidate are indifferent between accepting the offer and countering the offer. In other words, we have

$$\pi_1^B(s_A) = \pi_2^B(s_B)$$

$$\pi_2^A(s_B) = \pi_3^A(s_A)$$

Or

$$e^{-\epsilon r}\mu(1-s_A) = e^{-\epsilon/\kappa}e^{-2\epsilon r}\mu(1-s_B)$$

$$e^{-2\epsilon r}\mu s_B = \left(1-e^{-\epsilon/\kappa}\right)e^{-3\epsilon r}V(\theta_A) + e^{-\epsilon/\kappa}e^{-3\epsilon r}\mu s_A$$

Which gives us

$$\left(1-e^{-2\epsilon(1/\kappa+r)}\right)\mu s_A = \left(1-e^{-\epsilon(1/\kappa+r)}\right)\mu + e^{-\epsilon(2r+1/\kappa)}\left(1-e^{-\epsilon\lambda}\right)V(\theta_A)$$

When ϵ is small, i.e., $\epsilon \downarrow 0$,we have $e^{\epsilon x} = 1-\epsilon x$. Therefore, we have the acquirer and target's shares of merger synergy as $s_A = \frac{1}{2} + \frac{V(\theta_A)}{2\kappa\mu}$, and $s_B = \frac{1}{2} - \frac{V(\theta_A)}{2\kappa\mu}$.

In other words, the acquirer can obtain a larger share of synergy s_A if her search cost κ is lower, or she has better the outside option $V(\theta_A)$. In equilibrium, the acquirer proposes s_A, and the candidate accepts it in the first round: counter offering gives out the same amount of value, and further rounds of counter offering lead to the same share of synergy whereas the present value gets discounted more due to the time spent in bargaining. Hence, the equilibrium offer is

$s(\theta_A, \theta_B, V(\theta_A)) = s_A = \frac{1}{2} + \frac{V(\theta_A)}{2\overline{\mu}\kappa(1-|\theta_A-\theta_B|)}$.

Additional Technical Details for Proof of Proposition1:

We further illustrate the solution of the bank debt value. Consider a delta-hedged portfolio of bank debt $f^i(V^i, t)$ and underlying firm value V^i with value $f^i - \frac{\partial f^i}{\partial V^i}V^i$ is risk-free, for both the acquirer where $i = A$, and the target where $i = B$. Since a perfect delta-hedging portfolio is risk-free, it must earn riskless return r by non-arbitrage argument. Apply Ito's lemma to the value of the portfolio gives us the bank debt f^i follows a parabolic PDE $\frac{\partial f^i}{\partial t} + \frac{1}{2}\frac{\partial^2 f^i}{\partial {V^i}^2}\sigma^2 = rf^i$, with boundary condition $f^i = min(e^{rT}D_0^i, V_T^i)$ at $t = T$. The solution of the PDE gives the value of bank debt at time $t = 0$ to be

$$V_0^i - \left[V_0^i - D_0^i\right]\Phi\left(\delta^i\right) - \frac{\sqrt{T}}{\sqrt{2\pi}}\sigma e^{-rT-\frac{\delta^{i2}}{2}}$$

where $\delta^i = \frac{e^{rT}(V_0^i - D_0^i)}{\sigma\sqrt{T}}$.

Similarly, the fair value of post-merger bank debt f^M follows the same parabolic PDE $\frac{\partial f^M}{\partial t} + \frac{1}{2}\frac{\partial^2 f^M}{\partial {V^M}^2}\sigma'^2 = rf^M$, with a different boundary condition $f^M = min(e^{rT}(D_0^A + D_0^B), V_T^M)$ at $t = T$. Solving this PDE gives us the present value of post-merger bank debt at $t = 0$ to be

$$V_0^M - [V_0^M - (D_0^A + D_0^B)]\Phi(\delta') - \frac{\sqrt{T}}{\sqrt{2\pi}}\sigma' e^{-rT-\frac{\delta'^2}{2}}$$

where $\delta' = \frac{e^{rT}(V_0^M-(D_0^A+D_0^B))}{\sigma'\sqrt{T}}$, and $V_0^M = V_0^A + V_0^B + \mu(\theta_A, \theta_B)$.

The value of loan portfolio change before and after the bank's participation in searching is the integral of bank loans over types of candidates with $\theta_B \in \Theta_B(\theta_A) = \{\theta_B: |\theta_A - \hat{\theta}_B^*(\theta_A)| \leq |\theta_A - \theta_B| \leq |\theta_A - \theta_B^*(\theta_A)|\}$, which gives us

$$\begin{aligned} &\hat{\Pi}(\hat{\theta}_B^*, \sigma') - \Pi(\theta_B^*, \sigma') \\ &\qquad = \int_{\Theta_B(\theta_A)} \mu(\theta_A, \theta_B)\Phi(-\delta') - \frac{\sqrt{T}}{\sqrt{2\pi}}\sigma' e^{-rT-\frac{\delta'^2}{2}} \\ &\qquad + \sum_{i\in\{A,B\}} [D_0^i - V_0^i][\Phi(\delta') - \Phi(\delta^i)] + \frac{\sqrt{T}}{\sqrt{2\pi}}\sigma e^{-rT-\frac{\delta^{i2}}{2}} \end{aligned}$$

in the proof of Proposition 1.

Online Appendix B: Data construction

Steps	Actions taken for data screening	Remaining obs. after each action
1	Start with raw SDC transactions involving acquirers and targets from 1992 to 2016 with CRSP entry	25,704
2	Exclude repurchases, recapitalizations, minority share purchases, exchange offers, spin-offs, subsidiary transactions, and privatizations	5,000
3	Exclude incomplete deals, deals with the acquirer's pre-deal target ownership being equal to or greater than 50%, and deals with post-deal ownership being less than 100%	3,682
4	Exclude deals with deal value less than $1 million or with the relative size of deal value to market value of acquirers measured seven days before announcement less than 1%	3,400
5	Exclude deals involving firms with headquarter locations outside the US, firms with CRSP share code other than 10 or 11, and firms with exchange code other than 1, 2, or 3 (NYSE, AMEX or NASDAQ)	2,843
6	Exclude deals with the target SIC code indicating financial (6000s) or utility (4949-4999s) industries, and deals with missing values for announcement return, firm, industry and deal characteristics in the baseline regression model (see Appendix A for variable definitions)	1,683

Online Appendix C: Bank network and search cost

This table presents estimation results for a logit model. The dependent variable is a binary variable that takes the value of 1 for the actual sample merger deals and 0 for control merger deals constructed by matching each acquirer and target in an actual deal with non-merger firms. We use two alternative matching techniques as described in Table 2 to construct the control merger groups by matching up to five pairs of non-merger Compustat firms. The key explanatory variable is the triple-interaction term consisting of -|AcqQ-TarQ|, CBN_Recent, and TarBankNetwork. TarBankNetwork-All borrowers is a log-transformed count variable that equals the total number of all borrowers with outstanding loans from loan syndicates led by the same targets' lead banks, capturing the size of the banks' entire lending network. In generating TarBankNetwork-Target peers, we only count the borrowers that are operating in the same sector (i.e., same two-digit SIC code) and in similar size (i.e., the difference in market equity being within 10%) as the acquirer firms, capturing the size of the acquirer candidate pool in the lending network of the targets' banks. To save space, we do not report the estimates for other control variables. All models include year fixed effects. See Appendix A for the detailed variable definitions. Student t-statistics from standard errors clustered at the deal level is reported in the parentheses. ***, **, * indicate significance at 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Matching methods:	Matching 1	Matching 1	Matching 2	Matching 2
Target bank network variable:	All borrowers	Acquirer peers	All borrowers	Acquirer peers
-|AcqQ-TarQ| × CBN_Recent × TarBankNetwork	**0.3528**	**0.3871**	**0.4241**	**0.1986**
	(0.9550)	**(1.0388)**	**(0.9817)**	**(0.5521)**
-|AcqQ-TarQ| × TarBankNetwork	0.0439	0.0883	0.0470	0.1279
	(1.3075)	(0.7202)	(1.4838)	(1.0863)
CBN_Recent × TarBankNetwork	-0.2096	-0.1839	-0.1488	-0.0536
	(-1.3334)	(-1.2004)	(-0.9631)	(-0.3681)
-|AcqQ-TarQ| × CBN_Recent	-1.7353	-0.0621	-2.0309	0.4324
	(-0.7078)	(-0.0794)	(-0.7016)	(0.5538)
CBN_Recent	1.6819	0.8294**	1.4751	0.6757**
	(1.6193)	(2.4856)	(1.4445)	(2.0927)
-|AcqQ-TarQ|	0.7978***	0.8326***	0.8576***	0.8930***
	(9.1430)	(9.9678)	(9.6838)	(10.6042)
TarBankNetwork	-0.0312	-0.0745	-0.0323	-0.0450
	(-1.2756)	(-1.0885)	(-1.3107)	(-0.6553)
Constant	0.6131***	0.6395***	0.6181***	0.6127***
	(2.9050)	(3.0430)	(3.2545)	(3.2002)
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Pseudo R^2	0.107	0.109	0.0969	0.0959
N	9,703	9,703	9,946	9,946

Online Appendix D: Sensitivity tests on the effect of the 14 proxies for asymmetric information

This online appendix reports the results from the sensitivity tests based on Eq. (7) using each of the 14 proxies for information asymmetry, which we employ to perform the factor analysis as reported in Table 5. The test sample consists of the actual merger deals and the propensity score-matched hypothetical deals discussed in Table 2.

Panel A: Information asymmetry for acquirers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
-|AcqQ-TarQ| × CBN_Recent	**0.9168****	**0.9169****	**0.8957****	**0.8648****	**0.9192****	**0.9593*****	**0.9937*****
	(2.4855)	**(2.5140)**	**(2.4797)**	**(2.3196)**	**(2.4974)**	**(2.6631)**	**(2.6881)**
-|AcqQ-TarQ|	0.7182**	1.1179***	0.9780***	0.4238	0.5820*	0.7794***	0.9084***
	(2.5564)	(4.1187)	(3.7352)	(1.1891)	(1.7443)	(2.9839)	(3.5292)
CBN_Recent	0.5049***	0.5116***	0.5061***	0.4831***	0.5037***	0.5176***	0.5231***
	(3.4626)	(3.5290)	(3.5157)	(3.2764)	(3.4514)	(3.5874)	(3.5751)
-|AcqQ-TarQ| × Acq Analysts	0.0994						
	(1.6236)						
Acq Analysts	-0.1016**						
	(-2.2468)						
-|AcqQ-TarQ| × Acq Idiosyncratic volatility		-6.9069*					
		(-1.9582)					
Acq Idiosyncratic volatility		-12.6693***					
		(-3.9562)					
-|AcqQ-TarQ| × Acq BidAsk spread			-2.2057				
			(-0.5386)				
Acq BidAsk spread			-10.5525***				
			(-3.7309)				
-|AcqQ-TarQ| × Acq Firm size				0.0686**			
				(1.9919)			
Acq Firm size				0.1055***			
				(4.9400)			
-|AcqQ-TarQ| × Acq Firm age					0.1208		
					(1.4847)		
Acq Abnormal accrual					-0.1637***		
					(-3.2874)		
-|AcqQ-TarQ| × Acq Tangibility						0.8070**	
						(2.1126)	
Acq Tangibility						-0.2183	
						(-1.2502)	
-|AcqQ-TarQ| × Acq Abnormal accrual							-0.0017
							(-0.3988)
Acq Abnormal accrual							0.0006
							(0.1582)
-|AcqQ-TarQ| × Same industry	0.2322	0.2608*	0.2125	0.2735*	0.2616*	0.2391	0.1993

	(1.5032)	(1.7227)	(1.3642)	(1.7631)	(1.7019)	(1.5790)	(1.2931)
Same industry	0.3235***	0.3311***	0.2992***	0.3337***	0.3278***	0.3421***	0.2913***
	(4.0123)	(4.1338)	(3.6559)	(4.1082)	(4.0765)	(4.2720)	(3.5896)
-|AcqQ-TarQ| × Acq-tar distance	-0.0014	-0.0070	-0.0106	-0.0036	-0.0044	-0.0099	-0.0019
	(-0.0357)	(-0.1811)	(-0.2605)	(-0.0928)	(-0.1134)	(-0.2522)	(-0.0469)
Acq-tar distance	-0.2359***	-0.2394***	-0.2362***	-0.2372***	-0.2374***	-0.2415***	-0.2337***
	(-9.2569)	(-9.4498)	(-9.1405)	(-9.3592)	(-9.3717)	(-9.5215)	(-9.1150)
Constant	0.4702**	1.3596***	1.5250***	0.4539*	0.5394**	0.7146***	0.6746***
	(2.0015)	(4.7455)	(4.7077)	(1.7936)	(2.2256)	(3.1008)	(2.9031)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.0969	0.0965	0.0962	0.0955	0.0953	0.0966	0.0949
N	9,931	9,931	9,773	9,931	9,931	9,931	9,722

Panel B: Information asymmetry for targets

	(8)	(9)	(10)	(11)	(12)	(13)	(14)
-|AcqQ-TarQ| × CBN_Recent	**1.0613*** **	**0.9188** **	**1.0266*** **	**0.9346** **	**0.8052** **	**0.9595*** **	**0.9751*** **
	(2.7561)	**(2.5052)**	**(2.8067)**	**(2.5252)**	**(2.0877)**	**(2.6778)**	**(2.6583)**
-|AcqQ-TarQ|	0.9613***	1.1068***	0.8913***	0.6400**	0.5482*	0.7925***	0.9657***
	(3.6389)	(3.9586)	(3.4394)	(2.0710)	(1.6802)	(3.1069)	(3.7416)
CBN_Recent	0.5263***	0.4914***	0.5509***	0.5090***	0.4566***	0.5199***	0.5246***
	(3.4519)	(3.3605)	(3.7790)	(3.4611)	(2.9861)	(3.6068)	(3.6036)
-|AcqQ-TarQ| × Tar Analysts	-0.0608						
	(-0.8573)						
Tar Analysts	0.1567***						
	(2.9663)						
-|AcqQ-TarQ| × Tar Idiosyncratic volatility		-3.9451					
		(-1.5308)					
Tar Idiosyncratic volatility		3.2710					
		(1.3907)					
-|AcqQ-TarQ| × Tar BidAsk spread			1.6610				
			(0.7820)				
Tar BidAsk spread			0.0979				
			(0.0561)				
-|AcqQ-TarQ| × Tar Firm age				0.1158			
				(1.4463)			
Tar Firm age				0.1653***			
				(3.2067)			
-|AcqQ-TarQ| × Tar Firm size					0.0733*		
					(1.7192)		
Tar Firm size					-0.1845***		

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
					(-6.6675)		
-|AcqQ-TarQ| × Tar Tangibility						0.7208**	
						(2.1325)	
Tar Tangibility						-0.0624	
						(-0.3999)	
-|AcqQ-TarQ| × Tar Abnormal accrual							-0.0060*
							(-1.7677)
Tar Abnormal accrual							-0.0038
							(-1.3438)
-|AcqQ-TarQ| × Same industry	0.2101	0.2222	0.1839	0.2371	0.2268	0.2206	0.2420
	(1.3665)	(1.4576)	(1.1942)	(1.5423)	(1.4877)	(1.4527)	(1.5846)
Same industry	0.3014***	0.3101***	0.3013***	0.3164***	0.3083***	0.3246***	0.3119***
	(3.7307)	(3.8747)	(3.7409)	(3.9361)	(3.8549)	(4.0459)	(3.8636)
-|AcqQ-TarQ| × Acq-tar distance	-0.0068	-0.0091	-0.0081	-0.0070	-0.0043	-0.0087	-0.0053
	(-0.1710)	(-0.2337)	(-0.2012)	(-0.1784)	(-0.1098)	(-0.2209)	(-0.1330)
Acq-tar distance	-0.2370***	-0.2387***	-0.2365***	-0.2378***	-0.2371***	-0.2401***	-0.2377***
	(-9.2712)	(-9.4327)	(-9.1922)	(-9.3603)	(-9.3644)	(-9.4485)	(-9.2931)
Constant	0.8151***	0.3733	0.9392***	0.5654**	0.5287**	0.6952***	0.7720***
	(3.4797)	(1.3201)	(2.9776)	(2.3812)	(2.1952)	(3.0255)	(3.3011)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.0966	0.0960	0.0949	0.0952	0.0953	0.0960	0.0950
N	9,931	9,931	9,846	9,931	9,931	9,931	9,747