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How Far Can Screens Go in Distinguishing Explicit from Tacit Collusion? New Evidence from the Libor Setting

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How Far Can Screens Go in Distinguishing Explicit from Tacit Collusion? New Evidence From the Libor Setting

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I. MOTIVATION

A class of empirical analysis known as "screening" uses commonly available data such as prices, costs, market shares, bids, transaction quotes, spreads, and volumes to identify patterns that are anomalous or highly improbable under ordinary competitive conditions. Screens can signal the possibility of cheating in a market or industry, as well as identify who may be engaging in that behavior. Surveys of screening methodologies and their multiple applications can be found in Abrantes-Metz & Bajari and in Harrington.[2] The use of these methods in litigation is detailed in the American Bar Association's 2010 volume *Proof of Conspiracy under Antitrust Federal Laws*.[3]

Recently, large-scale investigations have been launched around the world on allegations of possible collusion and manipulation of the London Interbank Offered Rate ("Libor"). These investigations followed empirical research that highlighted anomalous patterns in the Libor data, beginning with two articles published in *the Wall Street Journal* in April and May of 2008.[4] These were quickly followed by a paper we co-authored with Michael Kraten and Gim Seow in August 2008,[5] which applied empirical screens to identify several unexpected patterns of the Libor and the underlying banks' quotes for the period January 2007 through May 2008. Abrantes-Metz, Judge, & Villas-Boas presented another analysis in 2010, providing additional evidence of

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[2] R. Abrantes-Metz & P. Bajari, *Screens for Conspiracies and their Multiple Applications*, 6(2) COMPETITION POL'Y INT'L, 129-144 (Autumn, 2010), and 24(1) ANTITRUST MAG., (Fall 2009); J. Harrington, *Detecting Cartels*, HANDBOOK IN ANTITRUST ECONOMICS (P. Buccirossi, ed., 2008).

[3] AMERICAN BAR ASSOCIATION EDITIONS (2010). Proof of Conspiracy under Antitrust Federal Laws, Chapter VIII on the Role of the Economic Expert describes these methods in detail.

[4] C. Mollenkamp & L. Norman, *British bankers group steps up review of widely used Libor*, W. S. J., C7 (April 17, 2008); C. Mollenkamp & M. Whitehouse, *Study casts doubt on key rate; WSJ analysis suggests banks may have reported flawed interest data for Libor*, W.S.J., A1 (May 29, 2008).

[5] Rosa Abrantes-Metz, Michael Kraten, Albert D. Metz, & Gim Seow, LIBOR Manipulation? 36 J. BANKING & FINANCE 136-150 (2012).

unusual patterns beginning earlier in 2006,[6] which in turn was followed by additional research by other authors.[7]

The Libor is determined from sealed daily quotes submitted by sixteen member banks.[8] Empirical research has shown that for a period of nearly a year, the Libor was essentially constant. This is the first anomaly. The second anomaly, which is less well understood, is the virtual unanimity of individual quotes submitted by the member banks. These anomalies lead us to ask whether coordination of some type may have been involved.

While screens can highlight such anomalous patterns, it is unclear whether they can differentiate between the various possible causes of those patterns. In principle, this unanimity in quotes across banks could simply reflect a non-cooperative outcome, or it could be the result of collusion. But whether that collusion was explicit, or a form of tacit or strategic collusion, is not immediately obvious.

Though distinguishing explicit from tacit collusion may be very difficult through screening, this is the challenge we take up in this article. We explore, in the context of the Libor, whether screens can move one step further and distinguish illegal (explicit) from legal (tacit) collusion. While we have always argued that a purely empirical analysis of market outcomes can never be the final proof of illegal behavior, under particular circumstances screens can indeed provide additional evidence to assess the more likely form of collusion.

II. BACKGROUND: ANOMALIES IN THE LIBOR RATE

The Libor has been called "the world's most important number."[9] It is a primary benchmark for global short-term interest rates; the Libor is used as the basis for settlement of interest rate contracts on many of the world's major futures and options exchanges as well as most over-the-counter and lending transactions with an estimated value of U.S. $350-$400 trillion contracts, instruments and transactions referencing it.

The Libor is supposed to measure the rate at which large banks can borrow unsecured funds from other banks at various short-term maturities, and for a variety of currencies. The U.S. dollar-denominated Libor, for example, is set as follows: On a daily basis, the 16 participating banks are surveyed by the British Bankers Association and submit sealed quotes which answer "[a]t what rate could you borrow funds, were you to do so by asking for and then accepting inter-bank offers in a reasonable market size just prior to 11:00 a.m. London time?" The Libor is then computed by averaging over the middle eight quotes and disregarding the four highest and the four lowest.

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[6] George G. Judge & Sofia B. Villas-Boas, *Tracking the Libor Rate*, 18 APPLIED ECONOMICS LETTERS 893-899 (2011).

[7] Further uses of screens have also been clear in the complaints related to private litigation on the Libor. R. Abrantes-Metz, *Libor Litigation and the Role of Screening: The Need for Enhanced Compliance Programs,* 7(2) CPI ANTITRUST CHRON., (July 2011).

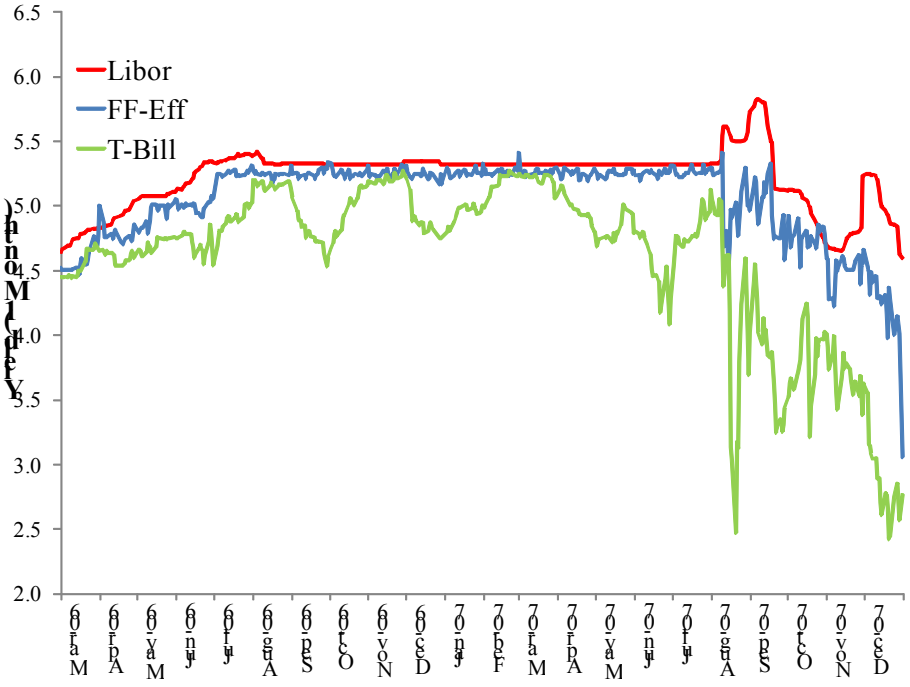
[8] The determination of the Libor has recently changed. In the context of this article, we will refer to the process of the setting of the Libor as that in place throughout our period of interest, 2006 through 2008.

[9] http://www.moneyweek.com/personal-finance/libor-the-worlds-most-important-number-13816.

If the banks did indeed manipulate the Libor (either individually or through coordinated behavior) it would have profound ramifications. With hundreds of trillions of dollars of securities and derivatives written referencing the Libor, even a small manipulation of its level could potentially distort capital allocations all over the world. The seriousness of this alleged conspiracy may have already inspired some of the new regulations on financial and commodities markets, namely those of the Commodities Futures Trading Commission related to price manipulation and fraud with extensions to the swaps market.[10]

Why might we suspect a conspiracy of the Libor in the first place? Below we compare one-month U.S. dollar Libor against some reasonable benchmarks, the effective Fed Funds effective rate ("FF-Eff") and the one-month Treasury Bill rate ("T-Bill").[11] We immediately see that from early August 2006 through early August 2007, the level of the one-month Libor is virtually constant, while the benchmark rates do not present such striking stability.

Figure 1: The One-Month Libor is Nearly Constant from August 2006 to August 2007



This seems highly anomalous, and prompts us to look further at the individual quotes submitted by the deciding banks. We calculate the coefficient of variation for the determining set

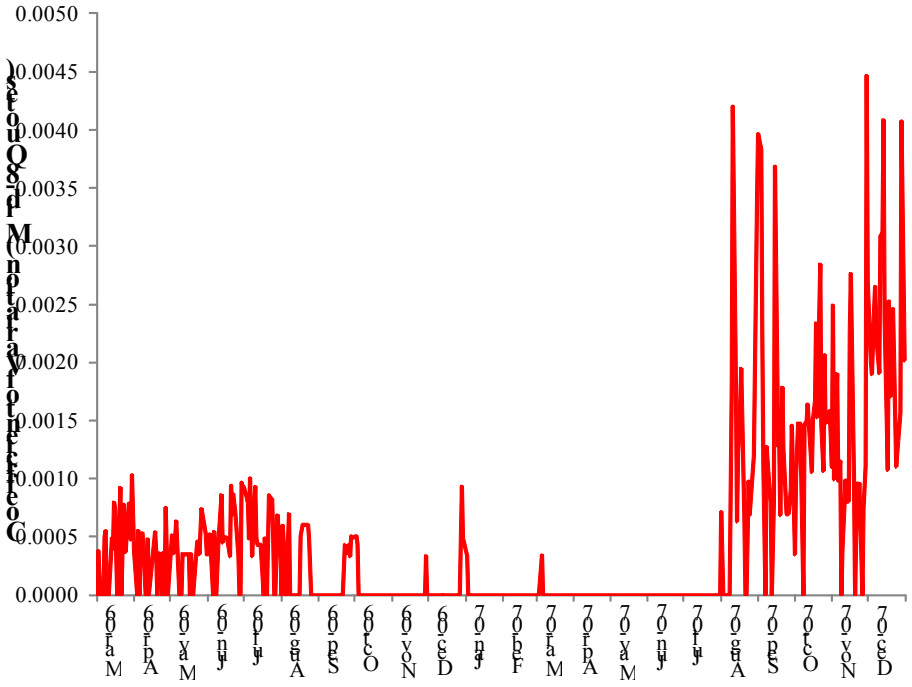
[10] *See* Rosa M. Abrantes-Metz, Gabriel Rauterberg, & Andrew Verstein, *Revolution in Manipulation Law: The New CFTC Rules and the Urgent Need for Economic and Empirical Analyses*, UNIV. PA. J. BUS. L., forthcoming, (February 2012).

[11] These are the same benchmarks used in our previous papers on the alleged Libor conspiracy and manipulation.

of the Libor quotes each day;[12] this measures the dispersion or variability in the daily quotes of the participating banks. If the banks were submitting unique quotes each day (which just happened to average to the same level day after day), the coefficient of variation would be large. But if the banks were all submitting essentially the same quote, it would be low, and in the extreme case where the middle eight quotes were identical, the coefficient of variation would be 0.

We present this coefficient of variation in Figure 2 below. It is clear that from early August 2006 through early August 2007, the middle eight quotes are essentially identical day in and day out. This, again, seems highly anomalous.

Figure 2: There is Almost No Variation Across the Middle Eight Quotes from August 2006 Through August 2007



III. THE THEORY OF EXPLICIT VERSUS TACIT COLLUSION

How can we account for the stability of the Libor and the convergence among the quotes? Let's consider some possible explanations. One possibility, of course, is that at least some of the banks were *explicitly colluding*. That is, they were in contact with each other and agreed in advance on a virtually identical quote to submit.

Another possibility is that there was *tacit collusion*. Tacit collusion, or conscious parallelism, exists when there is strategic coordination between participants. Each participant

[12] Recall that the coefficient of variation is the standard deviation divided by the mean. The mean, of course, is just the Libor level itself. We exclude from this computation the quotes we know did not enter the Libor computation on each given day.

attempts to optimize its strategy with consideration as to how the others may respond and adapts its actions based on learning from others' strategies. This can result in convergence of individual outcomes. Consider, for example, the phenomenon of equal gasoline prices across stations on each corner of an intersection. While that might be the result of explicit collusion, it might also be the result of tacit coordination.

Yet a third possibility is that convergence across quotes represents a non-cooperative outcome. Perhaps the banks are each independently reacting to (or anticipating) a common market driver. Without any consideration of how the other banks may react, the banks may individually arrive at the same number. Perhaps, in other words, many of the participating banks truly had identical borrowing costs, or at least expected to have identical borrowing costs at particular maturities.

Each of these—explicit collusion, tacit collusion, or non-cooperative outcomes—may result in an empirically similar outcome in the Libor setting: convergence across quotes. The question we turn to now is whether they are empirically *identical*. Can screens draw any distinctions among them in the Libor setting?

IV. THE EMPIRICS OF EXPLICIT VERSUS TACIT COLLUSION

These three different theories—explicit collusion, tacit collusion, and non-cooperative outcome—actually lead to subtle differences in empirical predictions in the Libor setting. Consider first the possibility that the convergence in quotes was simply a non-cooperative outcome; that the participating banks independently arrived at the same quote for some common legitimate fundamental reason. To accept this explanation we would have to understand why these banks, which differ in important ways, should nevertheless have identical borrowing costs. Not just "similar" borrowing costs, but *identical*. The member banks have varying sizes, varying asset portfolios of varying risk profiles, and varying liability structures. They participate to different degrees in different market segments. It seems highly unlikely that they should then have fundamentally identical borrowing costs, though we may expect them to be similar.

We would make a second point. To accept the non-cooperative outcome explanation we need to understand why the quotes weren't always common. In other words, as shown in Figure 2 above, why did the coefficient of variation suddenly drop to 0 after August of 2006? And why then did it abruptly increase after August of 2007? We know that the structural break on August 9, 2007 was due to particular events on that day which triggered the "official start" of the financial crisis.[13] On that day, the Libor quotes drastically changed and became immediately different from each other. Which also begs the question of why the triggering of the crisis did not affect banks' quotes equally, if market conditions were the reason why they were identical previously in the first place. What fundamentally changed during the 12 months from August 2006 to August 2007 that could account for this independent convergence? We require an

[13] On August 9, 2007, there were major news on the realization of a liquidity and subprime crisis: (i) there was a "coordinated intervention" by the European Central Bank, the Federal Reserve Bank, and the Bank of Japan; (ii) AIG warned that defaults were spreading beyond the subprime sector; and (iii) BNP Paribas suspended three funds that held mortgage backed securities.

explanation as to why those costs would be identical for a 12-month window, but not before, and not after.

So the data seem inconsistent with a non-cooperative outcome. That leaves us with two other possibilities. How might we empirically distinguish explicit from tacit collusion? If the banks slowly converged to the same common quote, and then repeated it over and over again, we would see results as in Figures 1 and 2, for the most part. But if the collusion were tacit, if the banks were "learning" from the strategic reaction of the other banks, then we would expect to see a transition period in Figure 2 in which the variation of intraday quotes would be decreasing towards zero. We don't. Instead, we see an abrupt transition to 0.

Further complicating the tacit collusion argument is the fact that the quotes are sealed. Only after the Libor is computed are the quotes made public. If the banks submitted largely the same quote day after day, and we saw that the other banks were learning and converging toward that common quote, we might more likely ascribe this to tacit, strategic collusion. But if we see that many banks submit a common (sealed) quote one day, and then submit a common but different (sealed) quote the next day, that is more difficult to understand as tacit behavior.

Table 1 below details the quotes of early August 2006. We have highlighted the quotes that were excluded from determining the Libor on those days. Table 2 summarizes the quotes by listing the unique values that determined the Libor on those days, and the number of banks that share that quote.

Table 1: Individual Quotes From Early August 2006

	2006				
	August 3	August 4	August 7	August 8	August 9
BTMU	5.410	5.430	5.370	5.370	5.330
Bank of America	5.400	5.420	5.380	5.370	5.325
Barclays	5.410	5.420	5.370	5.370	5.340
JPM Chase	5.410	5.420	5.380	5.370	5.330
Citi Bank	5.405	5.420	5.360	5.370	5.330
CSFB	5.405	5.420	5.360	5.370	5.330
Deutsche Bank	5.405	5.415	5.365	5.365	5.325
HBOS	5.410	5.420	5.350	5.370	5.330
HSBC	5.400	5.420	5.370	5.370	5.330
Lloyds	5.410	5.420	5.360	5.370	5.330
Norinchukin	5.410	5.420	5.370	5.370	5.340
Rabobank	5.405	5.415	5.370	5.370	5.330
Royal Bank of Canada	5.405	5.420	5.370	5.368	5.330
Royal Bank of Scotland	5.400	5.420	5.370	5.370	5.330
UBS AG	5.405	5.420	5.370	5.370	5.330
West LB	5.405	5.460	5.360	5.370	5.330

Table 2: The Distribution of "Middle 8" Quotes

		2006				
		August 3	**August 4**	**August 7**	**August 8**	**August 9**
Value 1		5.405	5.420	5.360	5.370	5.330
	Count	*7*	*12*	*4*	*14*	*12*
Value 2		5.410		5.365		
		6		*1*		
Value 3				5.370		
				8		

For example, on August 3, seven banks submitted the quote 5.405 and six banks submitted the quote 5.410. But then on August 4, twelve banks submitted a quote of 5.420—different from any of the quotes submitted the previous day. On August 7 there were three different values that were part of the "middle eight" quotes on that day, 5.360 (submitted by four banks), 5.365 (submitted by one bank) and 5.370 (submitted by eight banks). But then on August 8, fourteen of sixteen banks submitted a quote of 5.370.

One might interpret that as tacit learning: eight banks submitted 5.370 on August 7, and then seven more did on August 8 (with one bank changing its quote away from 5.370). But then consider the quotes of August 9. Twelve banks submitted a quote of 5.330. No bank had submitted that quote in the four days prior to August 9; in fact, no bank had submitted that quote since June 30, 2006 when two banks had. Yet, somehow, twelve banks moved to it on that date. This seems inconsistent with the tacit collusion or learning theory, especially when we recall that the quotes are submitted sealed.

And just as was the case with the non-cooperative outcome theory, to accept the tacit collusion theory we would have to understand why there was strategic learning leading to convergence in the period August 2006 through August 2007, but not before, and not after. What was different about those twelve months?

So the data seem inconsistent with tacit collusion as well. That leaves us with explicit collusion as the most likely explanation. Of course, we have repeatedly explained in previous work that the patterns identified through screening are not proof of explicit collusion; but this explanation simply seems more likely than the alternatives. From August 9, 2006 onwards there are a few rare episodes in which a few banks submit slightly different quotes from the majority, but for the most part, and as evident in Figure 2, the group of banks effectively determining the Libor submitted the same identical quote day in and day out for exactly one year, until August 9, 2007.

V. FINAL REMARKS

Screens are statistical tests based on theories of how cheating may occur in a particular market and how such behavior may be translated into the data available to the screening expert.

Just like any other statistical test, screens have type I and type II errors, even when properly developed and implemented.[14]

Strategic or tacit behavior may lead to the same outcome as explicit collusion, and therefore it may not be possible to disentangle this causation empirically. Nevertheless, there are particular circumstances under which screens can go one extra step in helping to distinguish explicit from tacit collusion. They correspond to situations in which one can observe the dynamics of collusion; in this case, the quoting patterns in order to identify how the bids/quotes may have become identical. Tacit and explicit collusion may have different implications for the transition from disparate to identical quotes, and hence it may be possible to empirically suggest a higher likelihood to one versus the other.

In the case of the Libor, given that quotes are submitted sealed, the likelihood of banks moving simultaneously to the same value from one day to the next without explicit coordination is extremely low, particularly given that their idiosyncrasies would not imply completely identical quotes under a non-cooperative outcome. And it is difficult to attribute it to tacit collusion or strategic learning, since the change is abrupt, the quotes are submitted sealed, and the quotes themselves sometimes change from one day to the next in an identical fashion. It would seem that explicit collusion is more likely to be the cause. Only time, and careful investigation, will answer definitively.

[14] R. Abrantes-Metz, *Design and Implementation of Screens and Their Use By Defendants*, 9(2) CPI ANTITRUST CHRONICLE, (September, 2011).