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# LIBOR: Origins, Economics, Crisis, Scandal, and Reform

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## **LIBOR: Origins, Economics, Crisis, Scandal, and Reform**

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### **Abstract**

The London Interbank Offered Rate (LIBOR) is a widely used indicator of funding conditions in the interbank market. As of 2013, LIBOR underpins more than \$300 trillion of financial contracts, including swaps and futures, in addition to trillions more in variable-rate mortgage and student loans. LIBOR's volatile behavior during the financial crisis provoked questions surrounding its credibility. Ongoing regulatory investigations have uncovered misconduct by a number of financial institutions. Policymakers across the globe now face the task of reforming LIBOR in the aftermath of the scandal and crisis.

Key words: LIBOR, financial crisis, scandal, interbank, banking, reference rate, interest rate

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## **Overview**

The London Interbank Offered Rate (LIBOR) is the reference rate at which large banks indicate that they can borrow short-term wholesale funds from one another on an unsecured basis in the interbank market. Beginning in 2007, regulators and market observers noted that LIBOR had failed to behave in line with expectations given other market prices and rates. Investigations by U.S. and foreign regulators have uncovered explicit manipulation by banks to influence rate fixings with the intent of projecting financial soundness during the crisis and benefiting proprietary trading positions. Four banks – Barclays, UBS, RBS, and Rabobank – have combined to pay settlements upward of \$3.5 billion. A collaborative effort on the part of policymakers internationally is underway to reform the reference rate. NYSE Euronext won the competitive bid to administer LIBOR. Actual transfer of duties from the British Bankers' Association (BBA) to NYSE will occur in early 2014.

## **History and Methodology**

LIBOR's origination has been credited to a Greek banker by the name of Minos Zombanakis, who in 1969 arranged an \$80 million syndicated loan from Manufacturer's Hanover to the Shah of Iran based on the reported funding costs of a set of reference banks (Ridley and Jones 2012). In addition to providing loans at rates tied to LIBOR, banks whose submissions determined the fixing had also begun to borrow heavily using LIBOR-based contracts by the mid-1980s, creating an incentive to underreport funding costs. As a result, the British Bankers' Association (BBA) took control of the rate in 1986 to formalize the data collection and governance process. In that year, LIBOR fixings were calculated for the U.S. dollar, the British pound, and the Japanese yen. Over time, the inclusion of additional currencies and integration of existing ones into the euro left the BBA with oversight of fixings over ten currencies as of 2012. Fifteen maturity terms were reported for each currency, ranging from overnight to a 1 year term. However, the number of currency-maturity pairs has fallen in the aftermath of the LIBOR probes (see Exhibit A).

As of October 2013, the BBA is still nominally responsible for administering LIBOR and publishes the rate each business day at approximately 11:30am GMT (6:30am EST). Actual collection of responses and calculations are performed by Thomson Reuters. The official LIBOR fixing for each currency-maturity pair is calculated as the interquartile trimmed mean of submissions: the set of individual bank submissions are ordered, then the top and bottom four responses are discarded, and the remaining values are averaged to arrive at the LIBOR fixing for that currency-maturity pair. The banks that comprise the LIBOR panel tend to be the largest and most creditworthy ones with London operations, with the constituents varying based on currency, though changes in composition within currencies occasionally occur. Of the ten LIBOR currencies that were reported in recent years, nine had panels consisting of 16 respondents, yielding precisely an interquartile trimmed mean. The USD panel, on the other

## Exhibit A

Active and inactive LIBOR currencies and maturities as of January 13, 2014.

LIBOR Currencies		LIBOR Maturities	
<i>Active</i>	<i>Inactive</i>	<i>Active</i>	<i>Inactive</i>
U.S. Dollar	Australian Dollar	1 Day	2 Weeks
Euro	Canadian Dollar	1 Week	4 Months
British Pound Sterling	New Zealand Dollar	1 Month	5 Months
Japanese Yen	Danish Krone	2 Months	7 Months
Swiss Franc	Swedish Krona	3 Months	8 Months
		6 Months	9 Months
		12 Months	10 Months
			11 Months

hand, has 18 respondents as of October 12, 2013, yielding a 23% trimmed mean after the top and bottom four submissions are discarded.

The survey question posed to the panel banks is the following: “At what rate could you borrow funds, were you to do so by asking for and then accepting interbank offers in a reasonable market size just prior to 11am?”

Shortcomings of this survey methodology have come under the spotlight in recent years. Key phrases in the survey question pertaining to timing and size are highly subjective and open to interpretation. A “reasonable market size” and “just prior to 11am” may have different meanings for different respondents, though Ellis (2011) has suggested a few hundred million dollars as the industry standard. Perhaps most importantly, the offer rate being calculated is a hypothetical one not based on actual market transactions. An institution claiming an ability to borrow \$100 million for 3 months at 350 basis points (bps) is not required to corroborate that assertion with factual evidence. In theory, the trimmed mean result should correspond closely with actual market transactions, though parity need not necessarily hold in practice.

### **LIBOR Usage and Substitutes**

LIBOR serves two primary purposes in modern markets: as a reference rate and as a benchmark rate. A reference rate is a rate that financial instruments can contract upon to establish the terms of agreement. A benchmark rate reflects a relative performance measure, oftentimes for investment returns or funding costs. LIBOR serves as the primary reference rate for short-term floating rate financial contracts like swaps and futures. At its peak, estimates placed the value of such contracts at upwards of \$300 trillion (Brousseau et al. 2009; Chen 2013; Ellis 2011; Gensler 2012).<sup>1</sup> Variable rate loans, primarily adjustable rate mortgages (ARMs) and

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<sup>1</sup> Other sources have estimated values as high as \$800 trillion (Wall Street Journal September 21, 2013).

private student loans, are also often tied to LIBOR. As a benchmark rate, it is also an indicator of the health of financial markets. The spreads between LIBOR and other benchmark rates can signal changing tides in the broad financial environment.

The rationale for the wide usage of LIBOR in contracts stems from its construction. Because LIBOR represents the terms at which the world's largest and most financially sound institutions are able to obtain funding on a short-term basis, it serves as the lower bound for the borrowing rate of other less creditworthy institutions and individuals, *ceteris paribus*. Rates are typically expressed as "LIBOR + x," where x is the premium charged in basis points for each particular borrower on top of the LIBOR rate of the corresponding maturity term. The financial contracts most commonly tied to LIBOR include interest rate swaps and other derivatives, fixed income securities, as well as ARMs. In this sense, banks extending variable rate loans can guarantee a positive net interest margin by ensuring that the interest rates they charge are tied to their cost of funds, with a positive premium built in.

LIBOR's growth to prominence as a reference rate is closely tied to the historical popularity of unsecured term interbank borrowing rates. A Bank for International Settlements (BIS) working group notes that these rates were the first to be introduced and have evolved over time into the industry standard because of early adoption by market participants (BIS 2013). More generally, however, reference rates allow for easier standardization of financial contracts while reducing the complexity with which terms on floating rate legs are determined. Recent episodes have also underscored the potential weaknesses of a universally adopted reference rate. Adequate market liquidity and depth – a rare concern prior to the financial crisis – has emerged as a top criterion for regulators. Prudent oversight and robustness even under financial duress are now necessary components of any conversation about reference rates.

Though the USD LIBOR fixing is the most dominant and widely recognized benchmark rate in the world, many other reference rates exist that seek to capture funding conditions in global financial markets. EURIBOR is perhaps the second most widely used benchmark rate next to LIBOR and is calculated based on the funding abilities of a larger panel of European banks.<sup>2</sup> Other financial centers like Tokyo, Mumbai, Singapore, and Hong Kong feature their own internally calculated rate fixings in TIBOR, MIBOR, SIBOR, and HIBOR, respectively. The various rates all employ similar methodologies, though they have on occasion arrived at different fixings. Another strand of unsecured interbank borrowing rates relies on past transactions for quotes. The Euro Overnight Index Average (EONIA) is perhaps the most well-known in this set and serves as a complement to EURIBOR since the panel of banks were historically the same for the two rates.<sup>3</sup>

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<sup>2</sup> Though both rates reflect measures of term borrowing for wholesale Euro deposits, EURIBOR is more widely used than LIBOR for the Euro currency. Widening spreads between the two rates during the crisis provoked questions of misconduct.

<sup>3</sup> The European Banking Federation (EBF) announced in May 2013 that the composition of the EONIA and EURIBOR panels will no longer be identical going forward.

It is worthwhile to examine the theoretical components of LIBOR to better understand its behavior during the crisis. LIBOR can be thought of as a combination of term and risk spreads:

$$\text{LIBOR} = \text{overnight risk free rate over the term} + \text{term premium} + \text{bank term credit risk} \\ + \text{term liquidity risk} + \text{term risk premium}$$

The first term is the traditional hypothetical overnight interest rate at which a riskless institution could expect to borrow over the LIBOR loan period. The *term premium* represents the intertemporal rate of substitution for the term of the loan. Because LIBOR banks are not inherently risk free borrowers, we must add on the borrower's counterparty *credit risk* component, commensurate with loan maturity. The *term liquidity risk* compensates for maturity risk incurred by the lender by tying up funds for a longer period of time, which could include market illiquidity for interbank funds that may increase the lender's rollover refinancing costs. Finally, the *term risk premium* builds in compensation for the risk that any of these components may have realizations that differ from their expected amounts.

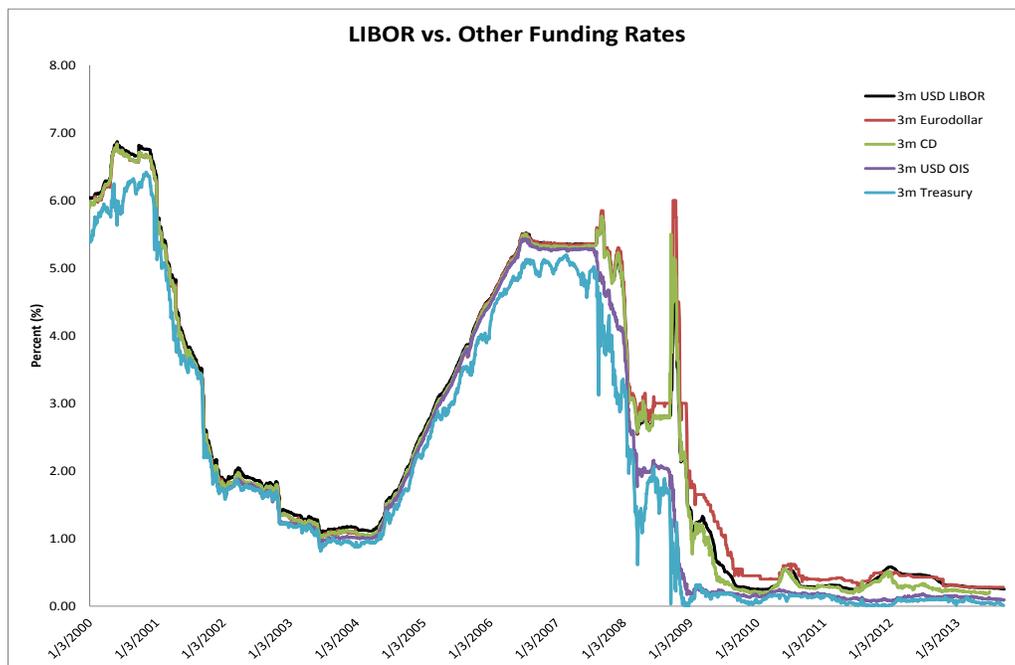
Academic studies have attempted to pin down the fractional contribution to LIBOR attributable to each of these constituent pieces. Acharya and Skeie (2011) attribute the majority of the risk to liquidity, suggesting that liquidity hoarding during stress drives rising interbank rates. This view is shared by McAndrews, Sarkar, and Wang (2008), Michaud and Upper (2008), as well as Schwarz (2010) among others. Taylor and Williams (2008a, 2008b), on the other hand, argue that counterparty credit risk as proxied by CDS spreads was the key determinant of driver of interbank rates. Smith (2012) finds that up to 50% of the variation in money market spreads can be explained by the term risk premium.

### **Behavior during the Crisis**

Prior to mid-2007, LIBOR tended to move closely with other short-term interest rates such as Treasury yields and the Overnight Index Swap (OIS) rate. However, LIBOR began to display greater volatility in August 2007 with the onset of the financial crisis. A combination of counterparty credit and liquidity concerns drove the 3-month USD LIBOR to 5.62% on August 31, 2007, compared to an average of 5.36% in the six months prior, during a time of stable expectations for the overnight federal funds policy target rate for the Federal Reserve. The maturity-matched OIS rate measures expectations over the tenor of unsecured overnight bank borrowing rates, which in the U.S. correspond to the effective average federal funds rate. The LIBOR-OIS spread is a measure of the bank credit spread, term liquidity spread, and term risk premia for interbank loans (Thornton 2009). This spread is a closely monitored barometer of the health of the banking system and averaged less than 10 bps from 2005 to mid-2007. However, it

## Exhibit B

LIBOR began to display greater volatility relative to other funding rates in the second half of 2008. Spreads to other funding rates widened drastically during the peak of the crisis, while LIBOR rates at times fell below what might be expected based on related rates.



climbed to more than 360 bps shortly following the Lehman Brothers bankruptcy on September 15, 2008 and remained elevated well into 2009 (see Exhibit B).

Rising spreads signaled the intensification of the crisis as liquidity and credit concerns drove interbank lenders to pare back funding while simultaneously demanding higher returns. Banks' inability to access funding in interbank markets fueled perceptions of loss in creditworthiness, fueling a positive feedback loop that increased the credit risk component of LIBOR, ultimately driving spreads wider.

Reasons cited for elevated interbank rates stem from both the supply and demand sides. On the supply side, banks' were unwilling to tie up funds for long periods of time due to balance sheet uncertainty brought about by the blossoming subprime ordeal (term liquidity risk). Conversely, this fear of funding instability drove the same banks to demand more long-term funding for liquidity purposes. Burgeoning demand chasing a shrinking supply of interbank funds, compounded by perceived increases in credit risk arising from subprime sectors, drove up LIBOR rates to new heights. Furthermore, the shifts in supply and demand noted above apply most conspicuously in longer-term transactions, meaning that as past funding matures, they are replaced with shorter term contracts that are more susceptible to rollover risk for the borrower. These movements in tandem negatively impact credit fundamentals for the financial institutions in question, which further drives up LIBOR rates through the credit risk component (Wrightson 2007).

## **Scandal**

Beginning in June 2012, LIBOR came under public scrutiny due to controversy over individual panel bank submissions during the height of the financial crisis. Allegations arose that banks had purposefully underreported their borrowing costs by significant amounts in order to project financial strength amidst market uncertainty. In addition, banks were alleged to have manipulated the rate to realize gains on LIBOR-based contracts. Whereas financial strength can be signaled by underreporting one's own submission, gains in LIBOR-based contracts often involved concerted action by multiple individuals to influence the final fixing.

Though many banks were allegedly involved in misreporting, the most prominent to have reached settlements to date are Barclays, UBS, RBS, and Rabobank. Commodity Futures Trading Commission (CFTC) probes ultimately concluded that the firms had acted in violation of the Commodity Exchange Act's false reporting provision (Gensler 2012). In addition to paying a settlement of \$453.6 million to U.S. and British financial authorities,<sup>4</sup> Barclays also lost a number of senior executives in the aftermath of the scandal, including CEO Robert Diamond who resigned on July 3, 2012. UBS settled on December 19, 2012 for \$1.52 billion,<sup>5</sup> RBS on

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<sup>4</sup> \$200 million to the CFTC, \$160 million to the Department of Justice, and \$93.6 million to the U.K. Financial Services Authority.

<sup>5</sup> \$700 million to the CFTC, \$500 million to the Department of Justice, \$259 million to the U.K. Financial Services Authority, and \$64 million to the Swiss Financial Market Supervisory Authority.

February 6, 2013 for \$612 million (WSJ September 21, 2013),<sup>6</sup> and Rabobank on October 29, 2013 for \$1.07 billion (Bray 2013).<sup>7</sup> Rabobank Chairman Piet Moerland also resigned as a result of the scandal.

Wrightson ICAP's weekly newsletter from September 3, 2007 may have been the first to publicly report the low level of LIBOR fixings. However, their analysis did not conclude that manipulation was the culprit, but instead settled on a dearth of interbank activity and the stickiness of official fixings to explain the observed divergence in rates (Wrightson 2007). The mainstream media did not catch on until a series of Wall Street Journal articles in 2008 exposed the possibility of targeted misquotes (Mollenkamp 2008; Mollenkamp and Whitehouse 2008b).<sup>8</sup> The journalists raised two possible motives for misreporting. The first involved a bank's desire to keep its submissions low in order to project an image of soundness. Robust capitalization would help fend off media and market speculation surrounding funding difficulties during the crisis. The second motive involved falsification with the expressed intent of benefiting the bank's derivatives positions. While early reports placed greater emphasis on the former argument instead of the latter, the authors provided no conclusive statistical evidence of actual manipulation. A subsequent Financial Times article by former Morgan Stanley trader Douglas Keenan suggested that LIBOR manipulation had been a fixture of financial markets as early as 1991 (Keenan 2012).

Further controversy arose in the U.S. when it was revealed that the Federal Reserve Bank of New York had first become aware of manipulative activities in 2007, with senior Federal Reserve officials being briefed by early 2008 (Reuters 2012). Though the Fed had neither regulatory responsibility nor jurisdiction with regard to LIBOR, then New York Fed President Tim Geithner did communicate to Bank of England authorities a June 1, 2008 email memo putting forth "Recommendations for Enhancing the Credibility of LIBOR." These recommendations included the establishment of best practices for calculating and reporting rates, the expansion of the USD LIBOR panel to a broader set of banks, the addition of a second USD LIBOR fixing to reflect transactions that occur during US market hours, the specification of the transaction size at which submitted rates are applicable, the reduction of the number of maturities reported, and the elimination of incentives to misreport (FRBNY 2012).

During the course of investigation, Barclays pointed out that allegations of rate fixing during the peak of the crisis were inconsistent with the fact that its submissions were often in the top quartile of survey responses and thus omitted in the calculation of the interquartile mean. It is important to note, however, that misreporting did not imply that the individual LIBOR submissions were consistently lower than those of competitors, but rather that submissions were lower than the bank's true cost of funding in the interbank market. Barclays, as well as any

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<sup>6</sup> \$325 million to the CFTC, \$150 million to the Department of Justice, and \$137 million to the U.K. Financial Services Authority.

<sup>7</sup> \$475 million to the CFTC, \$325 million to the Department of Justice, \$170 million to the U.K. Financial Conduct Authority, and \$96 million to Dutch authorities.

<sup>8</sup> See Exhibit C for a timeline of the LIBOR scandal.

financial institution, could misreport and still have rates among the highest submitted because of its borrower risk profile. The system's design, in which rate quotes are provided by market participants who hold large financial positions indexed to LIBOR, introduces an inherent conflict of interest (Ellis 2011). Net creditors benefit from higher fixings, while net debtors benefit from misquotes in the opposite direction. Though rate calculation via a trimmed mean reduces the market impact of each individual submission, individual behavior and collaboration among panel banks can still result in meaningful divergences from true rates.

While statistical evidence of wrongdoing by banks both in isolation and in tandem remains difficult to pinpoint even today, internal communications unearthed during the probes proved instrumental in showing purposeful intent to misreport. The CFTC uncovered documents showing that Barclays' traders requested specific actions from those in the bank responsible for LIBOR survey submissions. Manipulation ran rampant across multiple currencies and tenors for the expressed intent of benefiting the bank's proprietary trading positions. The CFTC also uncovered a management directive to "keep LIBOR submissions lower to protect Barclays' reputation" (Gensler 2012).

LIBOR's divergence from related funding rates – including effective federal funds, repos, and Treasuries – raised warning flags for a market already unnerved by early subprime mortgage fears. Signs of rate tampering, however, were perhaps most clearly demonstrated in movements of Credit Default Swap (CDS) prices. The price of CDS reflects the cost of insuring against the default of the underlying institution, and heightened fears of insolvency reflected in rising prices should in theory be mirrored by increases in a firm's cost of funding in the interbank market, to the extent that they have similar maturities. Rate submissions by the individual panel banks, however, failed to keep pace with CDS market activity, prompting questions from market observers.

Statistical evidence of reference rate manipulation has been limited. Abrantes-Metz et al. (2008) build on the methodology used in the original WSJ article to tease out suspicious patterns in the data, though they are also unable to definitively find evidence of manipulation. The markers they identify are of data patterns inconsistent with what is expected under normal market functioning, though manipulation does not necessarily entail the creation of these markers, nor do these markers necessarily imply the existence of manipulation. Brousseau et al. (2009) show that strong statistical relationships among various rates that existed prior to the Lehman collapse disappeared in the aftermath of the failure, though they stop short of attributing the disappearance to LIBOR manipulation rather than to the exogenous shock of the crisis itself. Ellis (2011) summarizes the key empirical findings, highlighting in the process the dearth of concrete evidence for rate manipulation. Snider and Youle (2012) are perhaps the least reticent in their diction. They report that rationalizing banks' LIBOR submissions proved difficult in light of data from other currencies and measures of funding cost. The positive spread between Eurodollar bid rates and LIBOR from August 2007 to mid-2011 generally ranged from 10-40 bps and is reflective of anomalous market conditions, as offer rates should generally exceed bid rates

in markets of similar financial products (Exhibit B). Furthermore, they highlight significant financial incentives to underreport actual borrowing costs, citing their statistical analyses that suggest the existence of frequent manipulation. Kuo, Skeie and Vickery (2012) are more tempered in their assessment, discussing many potential factors that may have caused the rate divergences of roughly 30 basis points during the crisis peak.

One feature of survey design that garnered heavy attention is the identity of the hypothetical interbank borrower. During the crisis, there existed protracted periods when a large gap existed between LIBOR and EURIBOR for the US dollar, even though both rates target the same funding conditions. While LIBOR asks each respondent the rate at which the bank itself can borrow, EURIBOR takes a more high-level approach by asking about the funding ability of the average panel bank. The benefit of the latter methodology is to better approximate the true rate of borrowing by dampening the psychological impact of overconfidence. This documented effect suggests that a majority of the banks surveyed would think that they're above the median in funding ability, and as a result drive the rate fixing below its true value in the aggregate. On the other hand, if the psychological impact of the differing survey designs weren't material, then LIBOR's persistently low volatility relative to EURIBOR would cast further doubt on the rate's credibility (Gensler 2012).

The lack of conclusive results is further belied by criticism of the methods used to test for manipulation. Michaud and Upper (2008) suggest that analyses comparing LIBOR submissions to other publicly disclosed costs of funding are not able to disentangle liquidity premia from credit risk, making comparison among inherently different funding rates difficult to justify. They hold the opinion that liquidity, or the lack thereof, played a greater role in individual banks' borrowing rates than perceived credit quality. Gefang, Koop, and Potter (2010) similarly demonstrate that the widening of the LIBOR-OIS spread during the financial crisis was more reflective of illiquidity than credit concerns, but that the importance of the two competing risks depended on the location within the term structure. The statistical methods used in distinguishing liquidity effects from counterparty credit risk have come under question. A BIS study took the more optimistic angle that the divergence in comparable market interest rates, while unusually large, was a product of design rather than evidence of tampering. Differential influences due to credit quality and liquidity likely drove the wedge between interbank rates without necessitating manipulation on the part of individual banks. Differing methods of dealing with outliers also contributed to the misalignments observed in market rates (Gyntelberg and Wooldridge 2008).

Though manipulation may be a remnant of the past, investigation into wrongdoing is far from over. More than 40 private lawsuits against the LIBOR panel banks have surfaced in the scandal's aftermath, with plaintiffs ranging from individual bondholders to cities like Baltimore and Philadelphia (McCoy 2013). These suits have met with limited success in the legal arena as large portions of their claims have been struck down (Raymond and Mollenkamp 2013). Estimates of total potential settlements to be paid by LIBOR panel banks range from \$8 billion to \$88 billion (Gongloff 2012).

## Exhibit C:

### Timeline of the LIBOR scandal.

- September 3, 2007 Wrightson piece questioning low level of LIBOR
  
- April 16, 2008 First WSJ article on possible LIBOR manipulation
- June 1, 2008 Email from Tim Geithner to Mervyn King and Paul Tucker detailing recommendations for enhancing the credibility of LIBOR
  
- June 27, 2012 Barclays settles LIBOR fines totaling \$453.6 million
- July 3, 2012 Barclays CEO Robert Diamond resigns
- July 10, 2012 Federal Reserve Bank of New York revealed to have known about LIBOR manipulation as early as 2007
- July 17, 2012 Federal Reserve Chairman Ben Bernanke testifies in front of Senate Banking Committee on LIBOR
- July 27, 2012 FT article by former Morgan Stanley trader suggesting LIBOR manipulation since 1991
  
- September 24, 2012 Gary Gensler offers remarks in front of the Economic and Monetary Affairs Committee of the European Parliament
- September 28, 2012 Final Report of the Wheatley Review of LIBOR
  
- December 19, 2012 UBS settles LIBOR fines totaling \$1.52 billion
  
- February 6, 2013 RBS settles LIBOR fines totaling \$612 million
- March 1, 2013 LIBOR fixing for New Zealand dollar is discontinued
- April 1, 2013 LIBOR fixings for Danish Krone and Swedish Krona are discontinued
  
- June 3, 2013 LIBOR fixings for Australian Dollar and Canadian Dollar are discontinued, along with 2 week and 4/5/7/8/9/10/11 month maturities
- July 9, 2013 Announcement that NYSE Euronext will take over administration of LIBOR, effective in 2014
- July 17, 2013 IOSCO publishes final report on "Principles for Financial Benchmarks"
  
- October 29, 2013 Rabobank settles LIBOR fines totaling \$1.07 billion

What started out as the LIBOR scandal has not been confined to the one rate or the one market. Regulatory inquiries have abounded amidst heightened sensitivities in the post-crisis environment. EURIBOR has experienced similar rate manipulation allegations, while several banks are under investigation for manipulative practices in the energy, commodity and foreign exchange markets. See Exhibit C for a timeline of events surrounding the LIBOR scandal.

### **Repair and Reform, or Replace**

Financial regulatory bodies across the world including the International Organization of Securities Commissions (IOSCO) and BIS have joined in a coordinated effort toward reference rates reform in the wake of the LIBOR scandal. At the heart of these deliberations sits the Financial Stability Board (FSB), an international body established in 2009 to oversee global financial system reform. The FSB has convened an Official Sector Steering Group composed of central bankers and other regulators to “coordinate consistency of reviews of existing interest

rate benchmarks.” It has similarly convened a Market Participants Group to represent private sector interests and address issues that may arise in implementation and transition (FSB 2013).

One potential upside of the LIBOR scandal is that it has provided the political impetus to reexamine the general structure of reference rates. A decline in unsecured term interbank activity following the financial crisis and a gradual shift toward reliance on secured funding begs the question of whether a LIBOR-like rate, even if equipped with ample governance, is appropriate going forward. The move toward central clearing of derivatives mandated by the Dodd-Frank Act further reduces the economic relevance of reference rates with significant counterparty credit risk built in. Limiting derivative exposures to a small number of central counterparties (CCPs) drastically reduces the interconnectivities among financial institutions, thereby shielding the system from contagion should isolated defaults occur (BIS 2013). CFTC Chairman Gary Gensler has pointed out that the interbank market itself has changed dramatically since the 1980s when LIBOR was first popularized. Interbank unsecured funding has been gradually falling out of favor among market participants, particularly in the aftermath of the financial crisis as capital and liquidity rules were put in place that effectively disincentivized this form of lending. Term funding has also shifted toward the shorter end of the spectrum, placing tension on market depth among the longer LIBOR maturities (Gensler 2012). It remains to be seen whether these changes in the interbank market are now permanent fixtures of global finance or temporary responses to the anomalous macroeconomic environment.

The numerous questions facing policymakers today surround key attributes of the desired reference rate. Should it be structured like LIBOR to reflect bank credit risk, or should it be conceived as a risk-free rate in the vein of OIS? Should it remain an uncollateralized rate or reflect collateralized lending? Should it be constructed as a single rate or as a composition of multiple rates? Should it be quoted for a range of maturities or solely reported on an overnight basis? Should it be calculated using terms on actual market transactions or rely on discretionary submissions?

Regardless of the answers to the above, regulators are still tasked with managing the continuity risk surrounding existing financial contracts. Any substantive overhaul of reference rates could entail significant legal complications involving the reference rate cited in legacy obligations. Pricing discontinuities and operational difficulties within back offices could pose potentially high costs. Inefficiencies and costs stemming from potential private party lawsuits dealing with legacy LIBOR contracts are not insignificant concerns. One potential solution for legacy contracts is to continue management and reporting of the traditional LIBOR-based rates until all contracts have effectively matured or dissolved. One potential drawback of this approach is that market adoption of the new reference rate(s) might face stronger resistance with LIBOR still in existence.

On the other hand, once transition to the new regime has taken place, clear positive externalities are realized in the use of the same single reference rate. Network effects suggest that

individual market participants benefit in a nonlinear fashion from the total number of users. Adoption of a single reference rate entails greater liquidity and maximizes opportunities to trade and hedge against financial instruments tied to that rate; liquidity and market depth concerns would be all but eliminated. Such scale benefits would be harder to realize within a multi-reference rate regime, although risk diversification among numerous rates could prove beneficial should further shortcomings be discovered in any one of the rates. One further issue that comes into play is that of coordination. Heavy path dependency in the adoption process, akin to LIBOR's historical development, suggests a prominent role for policymakers. What is generally viewed as the socially optimal outcome may not be able to achieve critical mass if the adoption process for this public good is undertaken by the private sector in isolation.

One of the first official responses tackling the LIBOR issue came from the Chancellor of the Exchequer in the form of the Wheatley Review. The report highlighted the thinness of the market for a number of currency-maturity pairs, a trait that has persisted long past the crisis peak. It is striking to note that even the USD LIBOR, the most liquid of the ten LIBOR currencies, suffers from this lack of market depth, as more than half of the fifteen quoted maturities have reported little to no trading activity in recent years. The report proposes cutting out illiquid currency-maturity pairs and focusing instead on markets with sufficient trading data to support a transactions-based approach even in non-normal times.<sup>9</sup> Moreover, the review concluded that transactions data should be explicitly used to corroborate discretionary submissions, without proposing that actual transactions be used in calculating the LIBOR fixing. It's further proposed that LIBOR oversight be transferred from the BBA to a government sponsored administrator with statutory authority to bring about greater transparency and credibility. To combat the incentive to underreport funding costs and hence project an image of stability, the Wheatley Review recommends that bank-level submissions be published with a 3-month lag. Delayed public disclosure of component rates will also help repress rumors of changes in creditworthiness. The number of banks in the reporting panel should also be expanded to mitigate the effect of misreporting. Overall, public response to the Wheatley report has been positive. Rather than suggesting a complete overhaul of the system, the report seemed more focused on reforming the way in which the rate was administered (Wheatley 2012, Wrightson 2012). The BIS report arrives at many similar recommendations as the Wheatley Review, including increased usage of transactions data. Where the two reports differ is that the former pushes in particular for increased transparency in those markets where reference rates are derived, and encourages the development of alternative reference rates with minimal credit risk components (BIS 2013).

Other proposals for repairing rather than replacing LIBOR abound. One option that has gained traction is to convert LIBOR into a transaction-based rate whereby a weighted-average of actual rates is used to calculate the fixing. Proponents of this approach view it as a quick low-cost method to restore the integrity of the reference rate, while critics caution about the potential

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<sup>9</sup> The reduction in reported currency-maturity pairs has already been implemented. Please see Table 1 for an up-to-date list.

for heightened volatility. Lack of market liquidity for less widely used currency-maturity pairs, especially during times of stress when interbank markets freeze, has been cited as an important stumbling block. Using Fedwire<sup>®</sup> Funds Service inferred interbank transactions, Duffie, Skeie, and Vickery (2013) find that USD interbank volumes are concentrated at 1, 3, and 6 month maturities, and that there is a moderate flow of new transactions, even during the 2007 to 2009 crisis period. The authors also conclude that usage of sampling windows makes a transaction-based approach feasible even during times of market illiquidity. IOSCO guidance in this regard settles on the principle that a benchmark should be “anchored in an active market having observable, bona fide, arms-length transactions” (IOSCO 2013). The phrasing purposefully sidesteps the exclusive requirement for transactions data in determining benchmark values, allowing administrator discretion in using ancillary market data for supplementary purposes should the need arise.<sup>10</sup>

In 2008, Citigroup’s Scott Peng suggested a new NYBOR rate that would complement the controversy-laden LIBOR going forward. This rate would be calculated in much the same way as LIBOR but be based solely on NY banks’ cost of funds (Mollenkamp and Whitehouse 2008a). The New York Funding Rate (NYFR) came into existence in June of 2008, with rates published daily by interbank broker ICAP (Wrightson 2008a; Wrightson 2008b; Kuo, Skeie and Vickery 2012).

The NYFR survey was conducted at 9:30am NY time, with calculation and publication of the fixing around 10am. Rather than an offered rate, NYFR would ask for the mid-rate and only for the 1 and 3-month maturities. One further improvement on its ideological predecessor is that NYFR, like EURIBOR, asks for the rate at which a representative bank would likely be able to borrow, rather than the rate at which each respondent is individually able to borrow. Furthermore, the individual rate submissions would be published each day without accompanying identifying information on the respondent. NYFR also reflects broader market conditions for wholesale unsecured funding rather than just interbank deposits, extending the pool of potential lenders and instruments. Finally, NYFR began with a daily required minimum of 24 panelists, with the top and bottom six dropped and the remaining 12 averaged to produce the fixing. Gradual declines in reporting by banks forced ICAP to reduce the threshold to 16, then 12, institutions. On August 3, 2012, ICAP ceased to publish NYFR altogether due to an inability to meet its own survey response standards.

Coulter and Shapiro (2013) also attempt to transform LIBOR by positing a new committed-quote framework to address current shortcomings. Firstly, bank submissions would be based on actual transactions if available. In the absence of borrowing data, suspect submissions can be called into question by other panel banks. Third parties can then confirm

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<sup>10</sup> The interplay between EONIA and EURIBOR mentioned earlier can prove instrumental for policymakers in discussing the merits of a transaction-based approach to LIBOR reform. Drastic volatility in the spread between the two rates can signal misreporting during adverse financial climates and thus encourage the adoption of a transaction-based measure.

willingness to lend at the rate in question, or confirm the whistleblower's allegations of misreporting.

Those in favor of replacing LIBOR altogether have rallied behind Gary Gensler. The Overnight Index Swap (OIS) rate has been put forth as a leading candidate. 2010 witnessed the adoption of OIS rates by the London Clearing House and ICAP to discount various derivatives contracts (Brousseau et al. 2012). Some large investment banks have also joined the movement to discount payments on financial contracts using expected compounded overnight rates to mitigate the reliance on reference rates with a significant credit risk component (BIS 2013; Tett 2008). However, longer term OIS rates including 1-month and 3-month are not yet mainstream among market participants.

General collateral (GC) repo rates have also been proposed as a possible complement to the credit-risk dominated unsecured LIBOR. This proposal would use the General Collateral Finance Repurchase Agreement Index (GCF<sup>®</sup> Repo Index) in place of LIBOR, with the intent that the transaction-based index would better reflect true objective funding costs, demonstrate stronger resilience to illiquidity under market stress, and more effectively fend off attempts at manipulation due to central clearing. The index is calculated as the weighted average interest rate paid on overnight GCF<sup>®</sup> repo transactions, which are by definition fully collateralized by U.S. Treasury securities, agency debt, and agency MBSs. A key advantage of this approach in implementation is that no new administrative agency would need to be established for oversight purposes, as the Depository Trust & Clearing Corporation (DTCC) currently calculates the index and could continue in this role with minimal interjection. Furthermore, repo contracts are known to be an important wholesale funding source for large banks. Though the DTCC only began publishing the index in November 2010, the product to date has shown none of the shortcomings that have crippled LIBOR (DTCC 2013).

At an even more basic level than the GCF<sup>®</sup> Repo Index, Treasury rates themselves have been put forth as a potential replacement for LIBOR for many of the same reasons. The market for U.S. treasuries is likely the most liquid in the world, even under financial duress. Moreover, Treasury constant maturity rates were heavily used as a reference rate for ARMs prior to the popularization of LIBOR, and in fact is still referenced by many ARMs today (Schweitzer and Venkatu 2012). The possibility of replacement using a combination of several rates has also been discussed.

As of September 2013, many of the proposed changes for reforming LIBOR have already been put in place. Five less frequently traded currencies have been discontinued (NZD, DKK, SEK, AUD, CAD), while the five that remain now only report the 1 day, 1 week, as well as the 1, 2, 3, 6, and 12 month maturities. The total number of currency-maturity fixing pairs has been reduced from 150 to 35, with the possibility for further consolidation in the future. LIBOR submissions from individual banks now experience a 3-month delay in publication, effective as of July 1, 2013. Finally, keeping in line with the Wheatley Review proposal, the BBA was

relieved of its duties in administering LIBOR. NYSE Euronext won the competitive bid for LIBOR for a nominal price of 1 pound. The deal was announced on July 9, 2013, though actual transfer of duties is expected to occur in early 2014.

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