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THE IMPACT OF DERIVATIVES REGULATIONS ON THE LIQUIDITY AND PRICING EFFICIENCY OF EXCHANGE TRADED DERIVATIVES

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This paper looks at the impact of derivatives regulation on liquidity and mispricing of US derivatives markets. In particular, we test the hypothesis that Dodd-Frank derivative provisions may improve the efficiency of the exchange traded markets due to an increase of arbitrage by traders on the exchange traded markets, as opposed to the OTC markets. The alternative hypothesis is that Dodd-Frank adversely affects the OTC markets relative to the exchange traded markets, as trading in both the former and the latter may be confounded due to additional "noise." To test these hypotheses, we examine the impact of key Dodd-Frank events on market activity for financial derivatives (futures and option contracts on US T bonds, Eurodollar futures and options, and S&P 500 Futures contracts) and on foreign exchange derivatives (futures and options contracts on EUROs, British Pounds, and Canadian dollars). First, we look at how liquidity on the markets has been affected. Next, we test for mispricing of derivatives contracts. We find that measured liquidity does fall for US financial futures and options but rises for foreign exchange futures and options subsequent to the introduction of the Treasury guidelines for over-the-counter (OTC) trading. We also find that the efficiency of the US exchange traded futures markets has improved, as reflected by a reduction in mispricing in the S&P futures contracts; some improvement in pricing efficiency is also shown for nearby Eurodollar futures contracts. These results are consistent with an increase of arbitrage by traders on the exchange traded markets, as opposed to the OTC markets, in contrast to the "noise" model.

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The financial crisis has given rise to increased regulatory activism around the world. In the United States, policy makers responded to widespread calls for regulatory reform to address perceived supervisory deficiencies with the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank). One of the criticisms of Dodd-Frank is that the uncertainty of its provisions, such as section 13 of the Bank Holding Company Act (the "Volker Rule"), will increase volatility and adversely affect market efficiency. Some commentators, for example Greenspan (2011) and Duffie (2012), have suggested that Dodd-Frank will have undesirable implications to the markets in general, by lowering the quality of information about fundamentals, which would reduce efficient price discovery, as well as through a reduction of liquidity. However, this may be offset through a migration of market making and investment activities to other trading venues. Duffie (2012) discusses problems associated with migration to non-bank firms such as hedge funds and insurance companies. This paper looks at the implications of another possible conduit for trade migration: ***the redirection of trades from the OTC markets to that of exchange traded derivatives.*** Such a redirection could be expected to the extent that the exchange traded markets substitute for the OTC markets (see, e.g., Switzer and Fan 2007). A migration from the OTC markets that increases activity in exchange traded derivatives in general, which benefit from volatility, might be posited to improve the efficiency of the latter.

How regulatory changes per se affect market liquidity and efficiency remain open questions in the literature. The events surrounding key Dodd-Frank regulations provide a useful setting to add to the literature on how the regulatory process can affect the behavior of market participants, as reflected in trading volume and efficient pricing of exchange traded derivatives. The remainder of this paper is organized as follows. In Section I, we look at the impact of key Dodd-Frank event dates on the liquidity of US financial derivatives markets. In Section II we look at pricing efficiency based on the cost-of carry for S&P futures contracts. In Section III, we look at deviations of futures from implied forward prices for Eurodollar contracts. The paper concludes with a summary in Section IV.

I. DODD-FRANK AND THE LIQUIDITY OF DERIVATIVES MARKETS

In this section, we look at the impact of Dodd Frank on the liquidity of US derivatives markets. A key driver in previous studies of market liquidity is volatility, which, as mentioned previously, might be expected to increase, given the uncertainty in the implementation of Dodd-Frank regulations. Clark (1973) asserts that an unobservable factor that reflects new information arrival affects both volume and volatility. Tauchen and Pitts (1983) propose two theoretical explanations for the co-movement of volatility and trade volume in markets. Chen, Cuny, and Haugen (1995) examine how volatility affects the basis and open interest of stock index futures. In their model, an increase in volatility entices more traders into the market to share the risk. Rather than reducing risk exposure through selling stocks, investors take advantage of the derivatives markets; for example, they share risk by selling the S&P 500 futures, which causes open interest to increase. Their results are consistent with this model. When there is a large positive shift in volatility, a strong positive relation between volatility and open interest is observed.

Our model reexamines the linkages for volume and volatility, extending the Chen et al. (1995) and Bhargava and Malhotra (2007) studies using more recent data. We also incorporate structural shifts associated with key Dodd-Frank announcement days for a wider variety of derivative products into the models. We look at financial derivatives: futures and option contracts on US T bonds and Eurodollars as well as S&P 500 futures contracts. We also look at foreign exchange derivatives: futures and options contracts on EUROs, British Pounds, and Canadian dollars.

Our objective is to look at a full range of market derivative products as they might be affected by Dodd-Frank. We chose to look at the derivative products separately, which allows us to abstract from possible distortionary effects that may affect specific instruments. For example, futures contracts would not be subject to "moneyness" biases such as are typically found in exchange traded options.

The basic regression of open interest extends Chen et al. (1995) and Bhargava and Malhotra (2007) as follows:

$$OpenInterest_r = a_0 + a_1\, OpenInterest_{t-1} + a_2 HistoricalVar_t + a_3\, DoddFrank_t + \in_t \quad (1)$$

where OpenInterest is the sum of open interest across the relevant contracts, and HistoricalVar is the historical volatility of the underlying asset. *DoddFrank* is a dummy variable equal to one at the date of and subsequent to three "watershed" Dodd-Frank announcement dates.[1] We use open interest, rather than trading volume, as our measure of liquidity to capture how restrictions on OTC markets entice new participants to migrate to the exchange traded markets. This is in the same spirit as Chen et al. (1995), who focus on the role of volatility in inducing new market participants. Using volume as a measure of liquidity would not necessarily capture market migration effects. Trading volume could increase in a market due to entry or exit, which would not allow us to isolate the direction of the migration effect.

The selection of key announcement dates involved the consideration of a number of issues relevant to testing for the impact of financial regulations. First, we wanted to ensure that the announcement dates do not coincide with any other major regulatory announcements, or financial industry specific announcements. In addition, we wanted to identify major events in which specific measures by which regulatory intent will be implemented. Dodd-Frank follows standard procedure in the development of US financial regulation: Its promulgation is a consideration for politicians, while its

1. The Dodd-Frank dummy variables are equal to one beginning on the date of each announcement until the end of the sample. This allows us to test if the announcements have separate effects, as well as to identify when the Dodd-Frank measures get imparted into the markets. For example, if each of the breakpoint dummy variables is significant, this would suggest that Dodd-Frank is a continuous process with distinct episodes.

implementation is the responsibility of the regulatory agencies mandated by the legislation itself (Fullenkamp and Sharma 2012). As a result, one must draw a distinction between regulatory events relating to Dodd-Frank, which we will refer to as “mandates,” that is, those which specify what regulatory deficiency is to be addressed and by whom, versus “implementation” related events, which specify actions that will be taken, or specify measures to be included in rules enforced by regulators. We choose as announcement events “implementation” date events, since they are most relevant to market participants.

Our first event occurs on **August 11, 2009**, when the Treasury formally submitted to Congress, a “Proposed OTC Derivatives Act,” which called for central clearing and more stringent oversight of OTC markets through stricter recordkeeping and data-reporting requirements. In addition, the Treasury proposal outlined the need for greater capital and margin requirements for OTC market participants, with the intention of increasing the overall stability of the financial system. This event represents an important moment in defining the shape of OTC legislation, and was the basis for much of what would later become the OTC portion of HR 4173 (the House version of what would later become Dodd-Frank). This proposal was highly implementation-related and provided financial institutions around the world a foretaste of forthcoming OTC regulation, and the concomitant compliance costs.

The second selected event occurs on **June 25, 2010**, with the completion of the reconciliation of the House and Senate versions of the bill. By the afternoon of the 25th an outline of the final version of Dodd-Frank was released to the public. The implementation of the Act was widely expected to have a negative impact on the operation of many financial institutions. However, the impact of the announcement on the markets might be expected to be somewhat muted, given the advanced scrutiny of market participants of the House and Senate proposals. Furthermore, many components of the reconciled version of the bill were considered as *favorable news*, since they were less harsh than initially proposed in the original House and Senate versions (Paletta 2010).

Our third selected event is **October 6, 2011**, which is the first trading day following the leak of a memorandum containing a draft of the Volcker Rule, ahead of the scheduled (October 11) FDIC conference (McGrane and Patterson 2011). The Volcker Rule prohibits banks or institutions that own banks from engaging in proprietary trading on their own account, that is, trading that is not at the behest of clients. Furthermore, banks are proscribed from owning or investing in hedge funds or private equity funds. From a financial economics perspective, the rule may seem to undermine market completeness, by potentially eliminating arbitrage activities by important financial agents. The Volker rule leak event is a surprise that contains salient material information that was confirmed at the formal release date. In an efficient market, one might expect that the market response to this event subsumes the effects of the formal release date announcement. Switzer and Sheahan-Lee (2013) show that this is indeed the case in their study of bank stock price reactions to the Volker rule.

Table 1. Open Interest Regressions for Futures Contracts.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Treasury Date		intercept	DoddFrank	HistVar	Lag(OI)		
Eurodollar	Model1	9251274	-1065095			.01	.118
		(163.6)**	(-13.88)**				
	Model2	9830834	-1599466	-331296.7		.01	.163
		(114.5)**	(-16.6)**	(-8.8)**			
	Model3	44314.62	-10497.8	-5957	.996	2.104	.99
		(1.76)	(-1.24)	(-4.2)**	(378.8)**		
10 yr treasury bond	Model1	1943392	-336060.8			.005	.107
		(103.2)**	(-13.144)**				
	Model2	2807549	-694123	-11779.5		.042	.81
		(190.96)**	(-54.37)**	(-72.81)**			
	Model3	11180	-1240.9	-46.88	.995	2.03	.996
		(2.28)*	(-.5953)	(-2.9)**	(484.9)**		
S&P 500	Model1	583236.5	-263534.9			.18	.768
		(207.1)**	(-68.89)**				
	Model2	591289	-268520.7	-7.99		.18	.77
		(166.2)**	(-66.37)**	(-3.68)**			
	Model3	48535.6	-21778	.72	.915	2.37	.962
		(7.62)**	(-6.745)**	(1.28)	(84.6)**		
EURO	Model1	181030.9	53776.24			.082	.21
		(88.98)**	(19.45)**				
	Model2	212982	49879.5	-235.37		.097	.33
		(77.16)**	(19.45)**	(-15.79)**			
	Model3	9322.5	2494.2	-9.11	.955	2.324	.937
		(5.57)**	(2.84)**	(-2.52)*	(124.97)**		

Table 1, continued. Open Interest Regressions for Futures Contracts.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Treasury Date		intercept	DoddFrank	HistVar	Lag(OI)		
British pound	Model1	113906.8	13799.4			.085	.04
		(88.16)**	(7.86)**				
	Model2	130831.8	7317.9	-111.27		.097	.16
		(77.43)**	(4.3)**	(-14.33)**			
	Model3	5492.44	541.96	-2.85	.96	2.247	.92
		(5.16)**	(1.024)	(-1.53)	(122.35)**		
Canadian dollar	Model1	111022	7549.5			.084	.017
		(100.7)**	(5.04)**				
	Model2	141505.8	-2678.46	-169.02		.147	.434
		(112.58)**	(-2.27)*	(-32.5)**			
	Model3	6033.59	262.38	-3.61	.95	2.124	.92
		(5.63)**	(.59)	(-2.55)*	(117.3)**		
Conference Date							
Eurodollar	Model1	8753293	-206776.1			.0088	.0036
		(168.46)**	(-2.48)*				
	Model2	8708810	-166234.9	32889.16		.0089	.0035
		(122.1)**	(-1.76)	(.91)			
	Model3	31502.5	-5360.91	-5663.5	.997	2.106	.99
		(1.42)	(-0.67)	(-4.066)**	(402.9)**		
10 yr treasury bond	Model1	1806861	-117851.4			.004	.012
		(105.5)**	(-4.285)**				
	Model2	2492980	-402082.2	-10124.98		.0145	.55
		(122.8)**	(-20.27)**	(-41.17)**			
	Model3	10707	-1659.6	-46.48	.996	2.035	.996
		(2.67)**	(-.88)	(-3.08)**	(538.8)**		

Table 1, continued. Open Interest Regressions for Futures Contracts.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Conference Date		intercept	DoddFrank	HistVar	Lag(OI)		
S&P 500	Model1	530416.6	-231922.6			.096	.57
		(159.7)**	(-43.5)**				
	Model2	518902	-226227.7	14.12		.098	.577
		(127.98)**	(-41.77)**	(4.97)**			
	Model3	23971.96	-10292	.887	.95	2.41	.96
		(5.49)**	(-4.2)**	(1.57)	(116.9)**		
EURO	Model1	184746.7	65595.9			.093	.297
		(111.37)**	(24.61)**				
	Model2	217938.6	65304.77	-260.92		.118	.44
		(96.247)**	(27.51)**	(-19.34)**			
	Model3	10787.87	3331.4	-10.29	.95	2.3165	.937
		(6.11)**	(3.485)**	(-2.84)**	(116.1)**		
British pound	Model1	113494.2	20359.54			.089	.085
		(104)**	(11.61)**				
	Model2	128487.6	13379.33	-101.94		.0998	.184
		(83.59)**	(7.69)**	(-13.15)**			
	Model3	5648.17	804.2	-2.68	.95	2.245	.92
		(5.4)**	(1.45)	(-1.44)	(119.9)**		
Canadian dollar	Model1	110797.8	11135.5			.086	.0356
		(117.3)**	(7.34)**				
	Model2	140981.8	-2300.15	-169.26		.147	.433
		(117.88)**	(-1.86)	(-31.71)**			
	Model3	6034.4	445.7	-3.45	.95	2.124	.92
		(5.71)**	(.97)	(-2.41)*	(116.89)**		

Table 1, continued. Open Interest Regressions for Futures Contracts.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Volker Date		intercept	DoddFrank	HistVar	Lag(OI)		
Eurodollar	Model1	8747749	-461355.5			.012	.0089
		(197.86)**	(-4.2)**				
	Model2	8718387	-434382	28606.4		.011	.009
		(156.5)**	(-3.8)**	(.867)			
	Model3	31516	-7810.8	-5582.9	.997	2.106	.99
		(1.43)	(-.75)	(-4.078)**	(401.3)**		
10 yr treasury bond	Model1	1771717	-65440.87			.004	.0015
		(120.44)**	(-1.79)				
	Model2	2335538	-322681.5	-9182.8		.011	.469
		(121.7)**	(-11.66)**	(-35.45)**			
	Model3	9545.3	-785.55	-43.55	.996	2.03	.996
		(2.53)*	(-.32)	(-2.95)**	(546.99)**		
S&P 500	Model1	475707	-217245.9			.0576	.285
		(130.2)**	(-23.95)**				
	Model2	452209.1	-210602.6	33.65		.061	.328
		(104.8)**	(-23.87)**	(9.6)**			
	Model3	13382.7	-6170.3	.834	.97	2.437	.96
		(4.33)**	(-2.45)*	(1.468)	(151.6)**		

Table 1, continued. Open Interest Regressions for Futures Contracts.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Volker Date		intercept	DoddFrank	HistVar	Lag(OI)		
EURO	Model1	192693.3	108303.7			.124	.461
		(155.3)**	(35.05)**				
	Model2	223700	105547.4	-241.1		.162	.585
		(120.8)**	(38.88)**	(-20.7)**			
	Model3	14633.4	7525.6	-11.27	.93	2.3	.938
		(7.3)**	(5.22)**	(-3.11)**	(100.43)**		
British pound	Model1	112739	53600.8			.124	.34
		(142.24)**	(27.15)**				
	Model2	123867	48111.02	-84.96		.139	.41
		(110)**	(25.19)**	(-13.2)**			
	Model3	7451.7	3005.98	-2.95	.94	2.23	.92
		(6.5)**	(3.56)**	(-1.63)	(100.54)**		
Canadian dollar	Model1	112293.8	17473.83			.087	.05
		(140.15)**	(8.76)**				
	Model2	137568.4	7977.5	-160.88		.149	.44
		(136.78)**	(5.12)**	(-31.73)**			
	Model3	6242.1	931.03	-3.56	.95	2.123	.92
		(5.96)**	(1.55)	(-2.55)*	(115.5)**		

This table shows the results of the regressions for open interest for Exchange Traded Futures Contracts' three models:

Model 1: $OpenInterest_r = a_0 + a_1\, DoddFrank_t + \in_t$ (1a)

Model 2: $OpenInterest_r = a_0 + a_1\, HistoricalVar_t + a_2 DoddFrank_t + \in_t$ (1b)

Model 3: $OpenInterest_r = a_0 + a_1\, OpenInterest_{t-1} + a_2 HistoricalVar_t + a_3\, DoddFrank_t + \in_t$ (1c)

The panels: Treasury Date, Conference Date, and Volker Date show the results for the three Dodd-Frank structural break points: Aug.11, 2009, Jun.25, 2010, and Oct. 6, 2011, respectively. The numbers in the table give the coefficient estimate of the explainable variables and t-statistics in the parenthesis, with * significant at .05 level and ** significant at .01 level.

Table 2. Open Interest Regressions for Call Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Treasury Date		intercept	DoddFrank	HistVar	Lag(OI)		
Eurodollar	Model1	11110293 (116.3)**	-6015890 (-46.63)**			.0454	.606
	Model2	10759291 (72.32)**	-5692162 (-34.23)**	199953.7 (3.07)**		.045	.608
	Model3	236525.7 (3.7)**	-147278 (-3.47)**	-2604.47 (-.52)	.98 (179.8)**	1.37	.98
10 yr treasury bond	Model1	1044361 (88.2)**	-295457.5 (-18.4)**			.11	.19
	Model2	1316545 (73.3)**	-408107.6 (-26.2)**	-3713.78 (-18.78)**		.14	.352
	Model3	62063.6 (5.55)**	-17932.94 (-2.85)**	-37.22 (-.85)	.94 (105.94)**	2.004	.91
S&P 500	Model1	280235.3 (119.7)**	-98541.67 (-31.02)**			.18	.402
	Model2	292412 (99.82)**	-106068.5 (-31.9)**	-12.01 (-6.74)**		.187	.42
	Model3	25197.6 (7.81)**	-8884.03 (-5.2)**	.36 (.755)	.91 (81.65)**	2.022	.898
EURO	Model1	57010.93 (53.25)**	40980.92 (28.2)**			.132	.357
	Model2	61767.56 (39.42)**	40386.56 (27.8)**	-34.92 (-4.14)**		.134	.364
	Model3	3851.2 (5.27)**	2786.324 (4.29)**	-.945 (-.403)	.93 (99.1)**	2.078	.92

Table 2, continued. Open Interest Regressions for Call Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
		intercept	DoddFrank	HistVar	Lag(OI)		
Treasury Date							
British pound	Model1	14434	5351.49			.069	.095
		(45)**	(12.3)**				
	Model2	13760.5	5610.7	4.41		.069	.0975
		(30.7)**	(12.44)**	(2.15)*			
	Model3	480.4	204.13	.166	.96	2.097	.938
		(3.37)**	(1.65)	(.41)	(139.7)**		
Canadian dollar	Model1	17127.6	3574.84			.145	.085
		(75.26)**	(11.58)**				
	Model2	18252.39	3195.3	-6.22		.147	.097
		(53.7)**	(10.03)**	(-4.43)**			
	Model3	1301.78	247.2	-.378	.93	2.007	.87
		(6.5)**	(1.99)*	(-1.06)	(93.25)**		
Conference Date							
Eurodollar	Model1	9846937	-5189630			.03	.434
		(99.765)**	(-32.95)**				
	Model2	8682386	-4128451	862583.6		.034	.497
		(68)**	(-24.5)**	(13.32)**			
	Model3	122577.7	-78891.6	-561.69	.99	1.37	.98
		(2.57)*	(-2.21)*	(-.11)	(215.6)**		
10 yr treasury bond	Model1	954910.7	-182905.5			.096	.07
		(86.96)**	(-10.4)**				
	Model2	1148330	-262925.9	-2856.9		.108	.167
		(63.11)**	(-14.8)**	(-12.95)**			
	Model3	48142.63	-10401.12	-13.86	.95	2.012	.912
		(5.18)**	(-1.79)	(-.33)	(115.75)**		

Table 2, continued. Open Interest Regressions for Call Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Conference Date		intercept	DoddFrank	HistVar	Lag(OI)		
S&P 500	Model1	252705.4	-66912.3			.13	.177
		(106.4)**	(-17.58)**				
	Model2	253385.6	-67318.75	-.664		.131	.177
		(86.53)**	(-17.24)**	(-.324)			
	Model3	16474.3	-4314.2	.4896	.933	2.045	.896
		(6.51)**	(-2.89)**	(1.02)	(96.39)**		
EURO	Model1	70475.94	22605.8			.094	.104
		(64.5)**	(12.88)**				
	Model2	77757.68	22523.93	-57.1		.096	.12
		(46.88)**	(12.98)**	(-5.79)**			
	Model3	3554.784	879.3	-1.88	.95	2.096	.92
		(4.85)**	(1.56)	(-.8)	(118.7)**		
British pound	Model1	15762.41	4059.68			.0658	.052
		(55.59)**	(8.92)**				
	Model2	15254.19	4296.9	3.45		.0659	.053
		(36.1)**	(8.99)**	(1.62)			
	Model3	536.5	52.03	0.033	.97	2.099	.939
		(3.82)**	(.42)	(0.08)	(143.25)**		
Canadian dollar	Model1	18241.72	2129.7			.137	.0285
		(89.99)**	(6.55)**				
	Model2	19629.34	1510.4	-7.76		.139	.046
		(59.13)**	(4.4)**	(-5.25)**			
	Model3	1325.2	92.56	-.462	.93	2.012	.87
		(6.565)**	(.74)	(-1.27)	(96.5)**		

Table 2, continued. Open Interest Regressions for Call Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Volker Date		intercept	DoddFrank	HistVar	Lag(OI)		
Eurodollar	Model1	8568632	-4635147			.02	.198
		(85.6)**	(-18.74)**				
	Model2	7197107	-3375860	1343922		0.028	.38
		(65.04)**	(-14.94)**	(20.43)**			
	Model3	66109	-52370.7	344.7	.99	1.37	.984
		(1.85)	(-1.33)	(.07)	(254.4)**		
10 yr treasury	Model1	930473.3	-288697.6			.1	.1
bond		(100.9)**	(-12.6)**				
	Model2	1090577	-361633.8	-2610.87		.112	.186
		(69.56)**	(-16.02)**	(-12.32)**			
	Model3	47163.43	-14413.33	-10.9	.95	2.011	.912
		(5.28)**	(-1.86)	(-.26)	(113.7)**		
S&P 500	Model1	239697.8	-80069.5			.126	.145
		(115.96)**	(-15.63)**				
	Model2	236505.4	-79205.1	4.65		.126	.148
		(94.1)**	(-15.44)**	(2.28)*			
	Model3	15337.2	-5402.96	.574	.935	2.046	.896
		(6.56)**	(-2.8)**	(1.2)	(97.7)**		

Table 2, continued. Open Interest Regressions for Call Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Volker Date		intercept	DoddFrank	HistVar	Lag(OI)		
EURO	Model1	78804.4	2755.5			.084	.00018
		(79.9)**	(1.12)				
	Model2	86238.8	2082.26	-57.69		.086	.02
		(51.9)**	(.86)	(-5.53)**			
	Model3	3579.6	102.3	-2.02	.96	2.101	.92
		(4.82)**	(.14)	(-.86)	(125.8)**		
British pound	Model1	18091.86	-4666.6			.065	.039
		(74.2)**	(-7.69)**				
	Model2	18897.13	-5064.56	-6.14		.066	0.044
		(51.6)**	(-8.17)**	(-2.94)**			
	Model3	618.2	-182.95	-.104	.97	2.099	.939
		(4.17)**	(-1.145)	(-.26)	(144.4)**		
Canadian dollar	Model1	18987.46	503.57			.133	.00023
		(108.1)**	(1.153)				
	Model2	20569.95	-92.3	-10.06		.138	.033
		(72.69)**	(-.21)	(-7.06)**			
	Model3	1354.88	-29.276	-.55	.93	2.013	.87
		(6.73)**	(-.184)	(-1.55)	(98)**		

Table 3. Open Interest Regressions for Put Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Treasury Date		intercept	DoddFrank	HistVar	Lag(OI)		
Eurodollar	Model1	9913346	-2859060			1.964	.0017
		(8.645)**	(-1.85)				
	Model2	8733923	-1771163	671011		1.965	.0015
		(4.87)**	(-.88)	(.86)			
	Model3	10114784	-3204726	-245737	.025	2.017	.0014
		(7.8)**	(-1.96)*	(-.81)	(.93)		
10 yr treasury bond	Model1	1113088	-244650			.123	.0994
		(77.59)**	(-12.58)**				
	Model2	1509601	-408757	-5410.2		.176	.358
		(73.59)**	(-22.97)**	(-23.95)**			
	Model3	79340.91	-18492.6	-84.34	.93	2.0145	.89
		(5.9)**	(-2.42)*	(-1.49)	(98.04)**		
S&P 500	Model1	597100.8	-282730			.112	.474
		(102.8)**	(-35.89)**				
	Model2	675232.7	-331318.2	-77.08		.143	.582
		(102.7)**	(-44.4)**	(-19.28)**			
	Model3	34925.35	-16810.2	-1.289	.944	2.051	.944
		(6.06)**	(-4.565)**	(-1.389)	(107.9)**		
EURO	Model1	889901.9	-754256			2.008	-.000004
		(1.597)	(-.997)				
	Model2	1500167	-830512	-4480		2.01	.000015
		(1.829)	(-1.09)	(-1.014)			
	Model3	1167628	-809494.7	-1922.1	-.0017	2.006	-.0012
		(1.575)	(-1.058)	(-.56)	(-.0625)		

Table 3, continued. Open Interest Regressions for Put Options.

Underlying asset	model	Independent variables: intercept	DoddFrank	HistVar	Lag(OI)	Durbin Watson statistic	Adj. R squared
Treasury Date							
British pound	Model1	2979498	-2955388			2.009	.00013
		(1.49)	(-1.087)				
	Model2	4540749	-3556383	-10230.8		2.009	-.00013
		(1.62)	(-1.26)	(-.8)			
	Model3	3314802	-3122135	-1927.6	-.0016	2.006	-.00125
		(1.29)	(-1.104)	(-.197)	(-.06)		
Canadian dollar	Model1	839297.2	-817494.9			2.0085	.00012
		(1.5)	(-1.08)				
	Model2	1012879	-876036.7	-959.92		2.009	-.00053
		(1.21)	(-1.115)	(-.277)			
	Model3	868780.9	-833018	-122.58	-.0015	2.006	-.0013
		(1.21)	(-1.067)	(-.052)	(-.055)		
Conference Date							
Eurodollar	Model1	9162239	-2081242			1.962	.00052
		(9.26)**	(-1.32)				
	Model2	7886180	-918272.8	943672.6		1.965	.0011
		(5.8)**	(-.51)	(1.37)			
	Model3	9155846	-2247551	-166877	0.03	2.017	.000028
		(8.31)**	(-1.38)	(-.56)	(.98)		
10 yr treasury bond	Model1	1027769	-122566			.113	.0234
		(79.59)**	(-5.92)**				
	Model2	1331522	-248233	-4486.6		.14	.207
		(65.3)**	(-12.48)**	(-18.15)**			
	Model3	64898.8	-9391.67	-53.88	.94	2.02	.891
		(5.66)**	(-1.29)	(-.98)	(104.3)**		

Table 3, continued. Open Interest Regressions for Put Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Conference Date		intercept	DoddFrank	HistVar	Lag(OI)		
S&P 500	Model1	523333	-205390			.0766	.239
		(86.7)**	(-21.23)**				
	Model2	559737.2	-223977.8	-43.23		.081	.276
		(77.06)**	(-23.13)**	(-8.51)**			
	Model3	19887.7	-7674.96	-.531	.963	2.068	.943
		(4.71)**	(-2.5)*	(-.583)	(132.7)**		
EURO	Model1	694985.3	-552382			2.008	-.00034
		(1.44)	(-.71)				
	Model2	1208766	-558159	-4028.7		2.009	-.000456
		(1.635)	(-.72)	(-.92)			
	Model3	917542.6	-577733	-1652.9	-.0012	2.006	-.0016
		(1.38)	(-.74)	(-.483)	(-0.05)		
British pound	Model1	2233283	-2209540			2.008	-.00026
		(1.29)	(-.795)				
	Model2	3684264	-2886892	-9841.3		2.009	-.00056
		(1.425)	(-.99)	(-.76)			
	Model3	2444251	-2327163	-1295.9	-.001	2.006	-.00165
		(1.06)	(-.802)	(-.13)	(-.044)		
Canadian dollar	Model1	632770.4	-610887.9			2.008	-.00026
		(1.31)	(-.79)				
	Model2	800416.8	-685691	-938.3		2.008	-.000916
		(1.004)	(-.83)	(-.264)			
	Model3	650308.1	-621690	-75.5	-.001	2.006	-.0017
		(.99)	(-.767)	(-.03)	(-.04)		

Table 3, continued. Open Interest Regressions for Put Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Volker Date		intercept	DoddFrank	HistVar	Lag(OI)		
Eurodollar	Model1	8717814	-2273364			1.961	.000134
		(10.34)**	(-1.09)				
	Model2	7690599	-1330059	1004727		1.965	.0012
		(7.25)**	(-.61)	(1.595)			
	Model3	8605641	-2327582	-116573	.027	2.017	-.00046
		(9.28)**	(-1.101)	(-.4)	(1.002)		
10 yr treasury bond	Model1	998020.3	-110962			.112	.0106
		(89.95)**	(-4.03)**				
	Model2	1240796	-221560	-3959		.134	.1615
		(67.95)**	(-8.43)**	(-16.04)**			
	Model3	60580.97	-7454.3	-43.7	.94	2.022	.891
		(5.68)**	(-.79)	(-.81)	(105.4)**		
S&P 500	Model1	474348.5	-190152			.066	.117
		(85.41)**	(-13.82)**				
	Model2	490943.4	-195047	-23.36		.067	.128
		(72.99)**	(-14.21)**	(-4.28)**			
	Model3	15606.6	-6391.75	-.312	.968	2.074	.943
		(4.42)**	(-1.71)	(-.345)	(143.5)**		

Table 3, continued. Open Interest Regressions for Put Options.

Underlying asset	model	Independent variables				Durbin Watson statistic	Adj. R squared
Volker Date		intercept	DoddFrank	HistVar	Lag(OI)		
EURO	Model1	545736.8	-403232.8			2.007	-.00059
		(1.33)	(-.39)				
	Model2	1074041	-451076.3	-4099.85		2.009	-.0007
		(1.53)	(-.44)	(-.93)			
	Model3	761500.4	-445672.4	-1627.4	-.001	2.006	-.0018
		(1.25)	(-.43)	(-.475)	(-.038)		
British pound	Model1	1637637	-1621303			2.007	-.00056
		(1.1)	(-.44)				
	Model2	2614011	-2103776	-7442		2.008	-.001
		(1.17)	(-.56)	(-.586)			
	Model3	1631748	-1621132	95.41	-.0008	2.0056	-.002
		(.83)	(-.43)	(.01)	(-.03)		
Canadian dollar	Model1	467626.5	-445398			2.007	-.00057
		(1.135)	(-.435)				
	Model2	500648.7	-457831.5	-209.93		2.007	-.0013
		(.74)	(-.44)	(-.06)			
	Model3	424198.3	-425316.4	282	-.0008	2.006	-.002
		(.762)	(-.41)	(.12)	(-.03)		

Table 4. Mispricing Series for S&P 500 Futures February 2004 – August 2012 (Pre vs. Post-OTC Guidelines[a]).

Panel A. Daily Data	02/04 – 08/09	08/09 – 08/2012	02/04 – 08/12
1. Average Mispricing			
N	1411	750	2161
Mean (%)	.000713	-.000130	.000420
Standard Deviation (%)	.002251	.001486	.002058
Minimum (%)	-.012880	-.007074	-.012880
Maximum (%)	.018113	.007743	.018113
t-statistic	11.89*	-2.39*	9.49*
t-statistic of difference between periods[b]			9.24*
2. Average Absolute Mispricing			
N	1411	750	2161
Mean (%)	.001487	.001085	.001348
Standard Deviation (%)	.001833	.001023	.001611
Minimum (%)	$1.89*10^{-7}$	$5.89*10^{-7}$	.000000189
Maximum (%)	.018113	.007743	.018113
t-statistic	30.47011*	29.04008*	38.90*
t-statistic of difference between periods[b]			5.56*

[a]The mispricing series are as defined in the equation $x_t = (F(t,T) - F^e(t,T))/P_t$ where $F_{(t,T)}$ is the actual index price, and $F^e_{(t,T)} = P_t e^{(r-d)(t-T)}$.

[b] The *t*-statistic measures the difference between the average mispricing between the Pre- and Post-OTC guideline periods.

(*) indicates significant at .01 level.

A. Data

Daily data of open interest for futures and options are collected from Bloomberg. The data cover the period from January 2007 to June 2012 (1,436 observations). The underlying assets include Eurodollar, 10 year Treasury Bond, S&P 500, and three foreign currencies (the EURO, the British Pound, and the Canadian dollar). The variances are estimated by historical 90 day and 10 day volatility of the underlying assets and are obtained from Bloomberg.

B. Empirical Results and Discussion

Table 1 below shows the estimation results for three variants of equation (1) for the futures contracts. The panels denoted — Treasury Date, Conference Date, and Volker Date — provide the results when the Dodd-Frank announcement date is August 11, 2009, June 25, 2010, and October 6, 2011, respectively.

Three variants of (1) are estimated:

Model1:

$$OpenInterest_r = a_0 + a_1\, DoddFrank_t + \epsilon_t \quad (1a)$$

Model 2:

$$OpenInterest_r = a_0 + a_1\ HistoricalVar_t + a_2 DoddFrank_t + \in_t \quad (1b)$$

Model 3:

$$OpenInterest_r = a_0 + a_1\ OpenInterest_{t-1} + a_2 HistoricalVar_t + a_3\ DoddFrank_t + \in_t \quad (1c)$$

On the whole, the results show some variation in the goodness of fit of the models across the different derivatives products examined, with better fits observed for the initial US treasury proposal on derivatives (August 11, 2009), so our discussion will focus on these results. Similar to Chen et al. (1995), we observe a positive effect of volatility on open interest for the S&P 500 futures contracts, when including lagged open interest in the equation (Model 3). This is consistent with the hypothesis that market volatility helps to induce participation in the S&P 500 futures contracts. However, the result is not statistically significant. In addition, it does not hold for the other futures contracts. On the contrary, volatility appears to reduce open interest for Eurodollar futures, T bond futures, and the three currencies examined.

The Dodd Frank structural breakpoints appear to be negatively associated with open interest, but only for the financial futures, that is, Eurodollar futures contract, T-bond future contracts and the S&P futures contracts. However, this relationship is not significant for the Eurodollar contracts and the T-bond contracts.[2] For two of the foreign currency futures contracts, the EURO and British pounds, open interest actually increases significantly subsequent to Dodd-Frank dates. For the Canadian dollar futures contracts, the open interest enhancing effects of Dodd-Frank are not significant, after taking into account historical volatility and lagged open interest effects. In sum, the results suggest that the assertion that Dodd-Frank has detrimental liquidity effects across all exchange traded derivatives products is not sustained.

Table 2 provides the estimates of the open interest regressions for the call option contracts. The results for call options are for the most part, qualitatively

2. It may be the case, as the referee pointed out, that the Dodd-Frank variable should not be expected to be the most significant factor underlying the secular decline in liquidity of the Eurodollar futures contract, which we further document in Section III below. This decline may be related to other important but extraneous factors, including the extremely low Federal funds rate (approximately zero) since January 2009. This may explain why, as we show in Table 1, the Dodd-Frank dummy variable becomes insignificant when we include historical volatility and lagged open interest as regressors. Another extraneous factor that may be important is the impact of LIBOR manipulation (the LIBOR scandal). In this vein Park and Switzer (1995) document evidence of market manipulation through private information in LIBOR settlement over the period June 1982–June 1992, many years before the formal exposure of the LIBOR scandal. If such manipulation is persistent through time, its effects along with any secular decline in open interest would be internalized in the lagged open interest variable, which is significant. We explore this issue further in Section III below. The first fines imposed concerning the LIBOR scandal occur on June 27, 2012, after our event date and estimation period date, when Barclays Bank was fined $200 million by the Commodity Futures Trading Commission, $160 million by the United States Department of Justice, and £59.5 million by the UK Financial Services Authority. Awareness of the breadth of the scandal accelerated in July 2010 when the US Congress began its investigation into the case.

similar to those of the futures contracts, with some exceptions. Historical volatility is positively associated with open interest for the S&P 500 contracts, as in Chen et al. (1995), but this effect is not significant when lagged open interest is included. Lagged open interest also appears to subsume volatility effects for the other contracts. Dodd-Frank dummy variables remain significantly negative, but only for the financial futures contracts. They are positive for the currency call options.

Table 3 provides the estimates of the Open Interest regressions for the Put Option contracts. The results differ for these contracts relative to the futures contracts and the call options contracts. In contrast with the call options, volatility has a negative effect on open interest, but similar to the call options regressions it is insignificant in the full model (Model 3) when lagged open interest is added as a regressor. Similar to the call options and futures contracts, the Dodd-Frank structural break points are associated with significantly declining open interest levels for the S&P futures and T-Bond futures contracts. However, the Dodd Frank dummy variables are not significant for any of the other market traded derivatives contracts.

To summarize, based on these results, measured liquidity does appear to fall for many US financial futures and options. Interestingly, the relationship is not significant for US T-bond futures or call options. This result may be due to expectations that T-bonds would be exempted from Dodd-Frank and the Volker rule. Such expectations have been justified by subsequent regulatory rulings. The significantly negative association of Dodd-Frank with the liquidity of the other financial derivative products is consistent with Duffie (2012). Increased liquidity of foreign currency derivatives, however, is not consistent with the fear expressed by Greenspan (2011), that "a significant proportion of the foreign exchange derivatives market would leave the US." However, this result need not rule out increased participation in the US foreign exchange derivative markets due to planned migration of asset holders and investors to foreign venues in order to escape the regulatory tax (Houston, Lin, and Ma 2012).

In the next section, we will examine the effects of Dodd-Frank on the efficiency of exchange traded futures contracts.

II. THE IMPACT OF DODD FRANK ON MISPRICING OF S&P FUTURES CONTRACTS

In this section, we test the hypothesis that Dodd-Frank derivative provisions may improve the efficiency of the exchange traded markets due to an increase of arbitrage by traders on the exchange traded markets, as opposed to the OTC markets. The alternative hypothesis is that Dodd-Frank adversely affects the OTC markets relative to the exchange traded markets, as trading in both the former and the latter may be confounded due to additional "noise" (see, e.g., Verma 2012).

The approach we take is to test for changes in mispricing of derivative contracts as a result of the introduction of Dodd-Frank regulations pertinent to derivatives markets.

A. Empirical Modeling

As in Switzer et al. (2000) the theoretical futures price used to test for market efficiency is the Cost of Carry relationship. As noted therein, the relationship is obtained from an arbitrage strategy that consists of a long position in the index portfolio, with a price P_0 and a short position in an equal amount of index futures, priced at F_0. Over time, the hedged strategy will yield a fixed capital gain of $F_0 - P_0$, as well as a flow of dividends. In the absence of dividend risk, the position is riskless and hence should earn the riskless rate of interest. To prevent profitable arbitrage, the theoretical equilibrium futures price at time t F_t^e can be written as:

$$F_t^e = P_t e^{r(T-t)} - D_{(t,T)} \tag{2}$$

where T is the maturity date and $D(t,T)$ is the cumulative value of dividends paid assuming reinvestment at the riskless rate of interest r up to date T is held until the futures contract expires.

We adopt a commonly used formula for mispricing for index futures (e.g., MacKinlay and Ramaswamy 1988; Bhatt and Cakici 1990; Switzer et al. 2000; Andane, Lafuente, and Novales 2009; and others). Assuming a constant dividend yield d, mispricing is measured as the difference between the actual futures price and its theoretical equilibrium price, deflated by the underlying index:

$$x_t = (F(t,T) - F_t^e)/P_t \tag{3}$$

where $F(t,T)$ is the actual index futures price, and $F_t^e = P_t e^{r-d(T-t)}$.

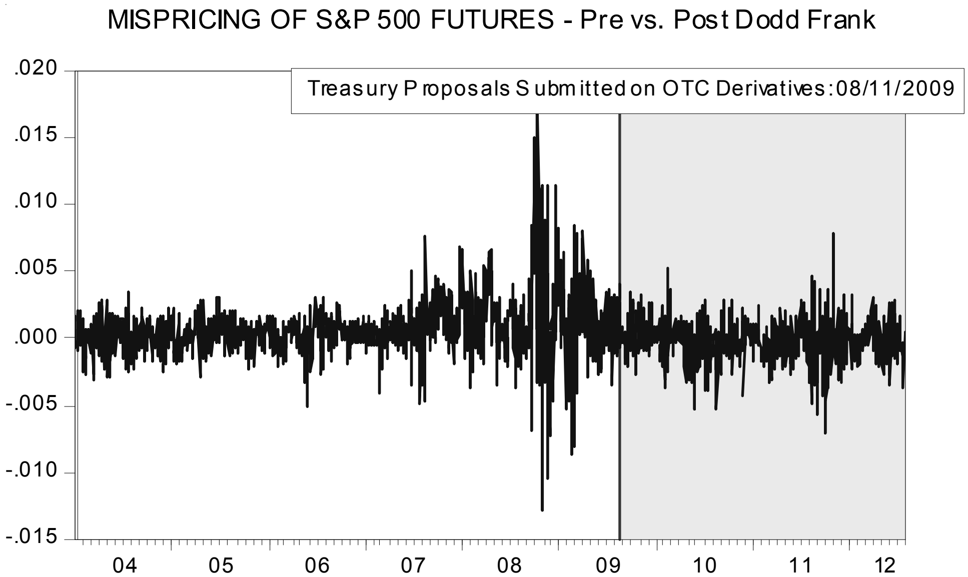
B. Description of the Data

The futures data used in this study are for the nearby Chicago Mercantile Exchange (CMER) S&P 500 Index futures contracts, and for the Eurodollar Futures Contracts for the period February 1, 2004, through July 31, 2012. We perform the analyses using daily data (2,161 observations). We use the actual daily dividend series for the S&P 500 obtained from Standard and Poor's. Daily three-month Treasury Bill rates from Bloomberg are used for the riskless rate of interest.

C. Empirical Results

Figure 1 shows the path of mispricing over the sample period. As is noted therein, the most severe periods of the financial crisis in 2008 were associated with extremely large levels of mispricing. The structural break point that we use is the onset of the Dodd-Frank regulatory period, which we define as the date of the Treasury submission of specific legislative proposals regarding derivatives to Congress, August 11, 2009. Our hypothesis is that arbitrage activities in the exchange traded markets would increase in anticipation of the final mandated restrictions on using OTC markets for this purpose. There is evidence of market participants'

Figure 1. Mispricing of S&P Futures Contracts for the Period 02/01/2004 to 31/07/2012.



reacting to anticipated changes in the regulatory environment. Indeed, an internal report from Deutsche Bank's head of government affairs for the Americas (leaked to the media on July 7, 2010) states that "opportunities for global regulatory arbitrage could be significant."[3] We noted in the previous section that this date appeared most significant as a watershed for open interest variations associated with Dodd-Frank across a wide variety of exchange traded contracts. Some evidence of a reduction of mispricing can be observed in Figure 1 in the shaded area to the right of the August 11, 2009 vertical line. This is confirmed in the statistical analyses. Table 4 shows that average mispricing has declined in the period subsequent to Dodd-Frank. Indeed the t statistics for a reduction in mispricing and a reduction in absolute mispricing are both significant at the 1% level.

Table 5 shows regression results for the signed mispricing series and for the absolute mispricing on a dummy variable that is equal to 1 on the day of and subsequent to of the Treasury OTC report release date dummy variable. Panel A shows the results for the signed mispricing regression, while Panel B uses the absolute mispricing series as the dependent variable. In both cases, the dummy variable coefficients are significant at the 1% level. These results provide further confirmation of the improved efficiency hypothesis, as opposed to the induced noise hypothesis. There was a very significant increase in mispricing prior to the Dodd-Frank related events that can be linked to the global financial crisis. Our basic point is that this mispricing has come down coincidentally to the new legislative efforts to regulate the markets. We might conjecture that given the high degree of volatility

3. See http://www.foxbusiness.com/markets/2010/07/07/deutsche-bank-rips-financial-reform/#ixzz2HmqZt0pX.

Table 5. Estimates of Daily Futures Mispricing.

Panel A

Dependent Variable is the signed mispricing series:

$$x_t = \alpha_0 + \alpha_1 dum_t + e_t$$

where dum is equal to 1 after August 11, 2009 (Treasury OTC Report Release Date) and 0 otherwise.

	Parameter	t-statistic	
a_0	.000713	13.260*	
a_1	-.000843	-9.238*	$R^2 = .0380$

Panel B

Dependent Variable is the absolute mispricing series

$$|x_t| = \beta_0 + \beta_1 dum_t + e_t$$

where dum is equal to 1 after August 11, 2009 (Treasury OTC Report Release Date) and 0 otherwise.

	Parameter	t-statistic	
a_0	.001487	34.927*	
a_1	-.000402	-45.568*	R^2=.0142

(*)indicates significance at .01 level

lingering in the markets, which may in part be associated with the continued regulative uncertainty, that it may be a long while before markets return to pre-crisis mispricing levels.

III. DODD FRANK AND THE DEVIATIONS OF EURODOLLAR FUTURES VERSUS FORWARD CONTRACTS

As a final test, we explore the impact of Dodd-Frank on pricing efficiency using the metric of the deviation of Eurodollar futures yields from implied forward contract rates. We use Eurodollar futures prices and 1, 3, 6, 9, and 12 month LIBOR quotations in the analysis. Daily Eurodollar futures prices and daily spot LIBOR quotations are obtained from the Bloomberg. Our sample period is from January 2007 through June 2012.

Three-month implied forward rates are computed from LIBOR spot quotations based on the the Grinblatt and Jegadeesh (1996) formula (with time measured in years):

$$f(s, s+0.25) = d(s, s+0.25)*[P(0, s)/P(0, s+0.25)-1] \quad (4)$$

where f(s, y) is the annualized Eurodollar forward rate at time 0 over the period s to y; d(s,y) is the LIBOR conversion factor, computed as 360/number of days between

Table 6. Futures-Forward Yield Differences – with Treasury Date Breakpoint.

Panel A

Year	DIFF0.25_0.5			DIFF0.5_0.75			DIFF0.75_1			T	
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Avg. Volume	Avg. O.I.
01/07-06/12	-38.70 (-20.42)**	-27.08	285	-49.27 (- 25.20)**	-48.74	285	-62.43 (-26.17)**	-73.62	272	273,669	1,168,244
01/07-08/09	-46.76 (-13.00)**	-31.25	136	-39.87 (-10.96)**	-18.89	136	-42.48 (-10.90)**	-21.77	136	327,113	1,309,352
08/09-06/12	-31.29 (-25.02)**	-25.86	149	-57.84 (-41.37)**	-52.69	149	-82.39 (-62.25)**	-78.22	136	223,799	1,036,576

Table 6, continued. Futures-Forward Yield Differences – with Treasury Date Breakpoint.

Panel B

Year	DIFF1		DIFF2		DIFF3	
	Mean	Median	Mean	Median	Mean	Median
01/07-06/12	-39.02	-26.24	-50.39	-46.10	-64.53	-76.53
	(-6.04)**		(-7.71)**		(-7.57)**	
01/07-08/09	-46.65	-27.52	-43.20	-25.41	-47.57	-26.51
	(-3.45)**		(-3.28)**		(-3.20)*	
08/09-06/12	-33.15	-25.70	-56.38	-52.74	-81.49	-81.45
	(-6.86)**		(-11.51)**		(-17.51)**	

This table shows the difference in basis points between the futures and forward Eurodollar yields expressed in basis using weekly (Thursday) data from January 2007 through June 2012, using the Treasury Date 08/11/2009 as the Breakpoint. The table also reports the average volume and average open interest of weekly (Thursday) data of the four (or three) nearest maturity futures contracts for different sample periods. In Panel A, implied forward yields are computed from quoted LIBOR rates and futures yields are obtained by interpolating between the futures transaction prices. DIFF0.25_0.5 is the time t difference between the annualized futures and forward yields for the interval t+0.25 to t+0.5. DIFF0.5_0.75 and DIFF0.75_1 are the time t yield difference for the intervals t+0.5 to t+0.75 and t+0.75 to t+1, respectively.. Panel B reports the results using the spot LIBOR interpolation method to compute the implied forward rates. We use the 1, 3, 6, 9, and 12 month LIBOR quotations to fit a cubic spline to obtain the entire term structure of spot LIBOR rates for each date in our sample period. The implied forward rate, f(s, s+0.25), is computed from those interpolated LIBOR rates using equation (4), and is compared with futures rate F(s, s+0.25) of each of the three nearest maturing futures contracts. DIFF1 is the difference between the annualized 3-month futures and forward yields on the date of maturity of the nearest maturity futures contract. DIFF2 is the difference between annualized 3-month futures and forward yields on the date of maturity of the next-to-nearest maturity futures contract. DIFF3 is the difference between annualized 3-month futures and forward yields on the date of maturity of the third-to-nearest maturity futures contracts. N is the number of observations. The t-statistics are presented in parentheses ; ** denotes significance at the 1% level; *denotes significant at the 5% level.

Table 7. Futures-Forward Yield Differences – with Conference Date Breakpoint.

Panel A

Year	DIFF0.25_0.5			DIFF0.5_0.75			DIFF0.75_1				
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Avg. Volume	Avg. O.I.
01/07-06/12	-38.70 (-20.42)**	-27.08	285	-49.27 (-25.20)**	-48.74	285	-62.43 (-26.17)**	-73.62	272	273,669	1,168,244
01/07-06/10	-43.19 (-15.35)**	-28.59	182	-47.47 (-15.89)**	-47.21	182	-54.25 (-16.31)**	-59.64	182	303,299	1,221,864
06/10-06/12	-30.68 (-23.34)**	-26.26	103	-52.44 (-45.82)**	-49.51	103	-78.98 (-52.78)**	-76.38	90	219,607	1,070,411

Table 7, continued. Futures-Forward Yield Differences – with Conference Date Breakpoint.

Panel B

Year	DIFF1		DIFF2		DIFF3	
	Mean	Median	Mean	Median	Mean	Median
01/07-06/12	-39.02 (-6.04)**	-26.24	-50.39 (-7.71)**	-46.10	-64.53 (-7.57)**	-76.53
01/07-06/10	-42.48 (-4.25)**	-26.79	-50.17 (-5.00)**	-46.61	-59.69 (-5.05)**	-63.41
06/10-06/12	-33.63 (-5.73)**	-26.05	-50.77 (-10.13)**	-46.10	-75.82 (-12.39)**	-76.53

This table shows the difference in basis points between the futures and forward Eurodollar yields expressed in basis using weekly (Thursday) data from January 2007 through June 2012, using the Conference Date 06/25/2010 as the Breakpoint. The table also reports the average volume and average open interest of weekly (Thursday) data of the four (or three) nearest maturity futures contracts for different sample periods. In Panel A, implied forward yields are computed from quoted LIBOR rates and futures yields are obtained by interpolating between the futures transaction prices. DIFF0.25_0.5 is the time t difference between the annualized futures and forward yields for the interval t+0.25 to t+0.5. DIFF0.5_0.75 and DIFF0.75_1 are the time t yield difference for the intervals t+0.5 to t+0.75 and t+0.75 to t+1, respectively.. Panel B of Tables 6 and 7 reports the results using the spot LIBOR interpolation method to compute the implied forward rates. We use the 1, 3, 6, 9, and 12 month LIBOR quotations to fit a cubic spline to obtain the entire term structure of spot LIBOR rates for each date in our sample period. The implied forward rate, f(s, s+0.25), is computed from those interpolated LIBOR rates using equation (4), and is compared with futures rate F(s, s+0.25) of each of the three nearest maturing futures contracts. DIFF1 is the difference between the annualized 3-month futures and forward yields on the date of maturity of the nearest maturity futures contract. DIFF2 is the difference between annualized 3-month futures and forward yields on the date of maturity of the next-to-nearest maturity futures contract. DIFF3 is the difference between annualized 3-month futures and forward yields on the date of maturity of the third-to-nearest maturity futures contracts. N is the number of observations. The t-statistics are presented in parentheses ; ** denotes significance at the 1% level; *denotes significant at the 5% level.

s and y and $P(s,y) = 1/[1+L_s(y-s)/d(s,y)]$ is the time s price of \$1 paid out at y in the Eurodollar market, and $L_s(y-s)$ is the (y-s) year LIBOR rate prevailing at time s. The futures rate is computed with the daily closing price of the futures contract (Futures $Price_t$) that matures on date s from the expression:

$$F(s, s+0.25; t) = 1\text{-Futures Price}_t/100. \qquad (5)$$

where F(s,y,t) is the annualized futures rate at time t for the interval s to y.

The futures rate intervals do not in general coincide with the forward rate intervals. We replicate the two interpolation methods used by Grinblatt and Jegadeesh (1996) to align the intervals. With the futures interpolation method, we fit a cubic spline to the futures rates of the four nearest maturing contracts to construct an interpolated term structure of futures rates. We focus on futures contracts maturing in March, June, September, and December in our sample period. For each sampling date, we use the future prices of the four nearest maturing contracts on that date to fit a curve, and pick interpolated futures rates for intervals that coincide with the forward rate intervals to get F(0.25, 0.5), F(0.5, 0.75), and F(0.75, 1). We then compare these interpolated rates with the implied forward rates, f(0.25, 0.5), f(0.5, 0.75), and f(0.75, 1).

The analysis is performed using two breakpoints. Table 6 uses the Treasury Date (08/11/09) as the breakpoint, while Table 7 shows the results using the Conference date (06/25/2010) breakpoint. These tables present the differences between the futures and forward Eurodollar yields expressed in basis points employing weekly (Thursday) data from January 2007 through June 2012. We also include the average volume and average open interest of weekly (Thursday) data of the four (or three) nearest maturity futures contracts for different sample periods.

In Panel A of Tables 6 and 7, implied forward yields are computed from quoted LIBOR rates and futures yields are obtained by interpolating between the futures transaction prices. DIFF0.25_0.5 is the time t difference between the annualized futures and forward yields for the interval t+0.25 to t+0.5; DIFF0.5_0.75 and DIFF0.75_1 are the time t yield difference for the intervals t+0.5 to t+0.75 and t+0.75 to t+1, respectively; N is the number of observations.

Panel B (of both Tables 6 and 7) reports the results using the spot LIBOR interpolation method to compute the implied forward rates. We use the 1, 3, 6, 9, and 12 month LIBOR quotations to fit a cubic spline to obtain the entire term structure of spot LIBOR rates for each date in our sample period. The implied forward rate, f(s, s+0.25), is computed from those interpolated LIBOR rates using equation (4), and is compared with futures rate F(s, s+0.25) of each of the three nearest maturing futures contracts. DIFF1 is the difference between the annualized three-month futures and forward yields on the date of maturity of the nearest maturity futures contract. DIFF2 is the difference between annualized three-month futures and forward yields on the date of maturity of the next-to-nearest maturity futures contract. DIFF3 is the difference between annualized three-month futures and forward yields on the date of maturity of the third-to-nearest maturity futures contracts. We interpolated the four nearest maturity futures contracts starting from 1/2/2007 to 3/19/2012 to obtain F(.25, .5), F(.5, .75), and F(.75, 1). We interpolated the three nearest maturity futures contracts starting from 3/20/2012 to 6/19/2012 to obtain F(.25, .5) and F(.5, .75).

As is shown in these tables, aggregate trading volume and open interest in the Eurodollar contracts decline in the period of the study. Again, this is in part likely a consequence of the low Fed funds rate since January 2009. In general, we find that futures rates are below forward rates throughout the sample. This phenomenon is also observed in the latter part of the Grinblatt and Jegadeesh (1996) sample, which covers the period 1987–1992. The downward bias appears to be exacerbated in our sample, amounting to over 30 basis points for nearby contracts, and considerably more for the more distant contracts.

Some evidence of improved price efficiency is shown for the Dodd-Frank breakpoints for nearby contracts — ranging between 13 and 15 basis points, depending on whether we use the Treasury or Conference dates as breakpoints. The differential between futures and forward rates widens, however, for more distant contracts. This widening may be due to a shift to shorter maturity preferences for futures traders, with the increase in market uncertainty.

IV. SUMMARY AND CONCLUSIONS

This report provides new evidence on the impact of key Dodd-Frank events on market activity for financial derivatives (futures and option contracts on US T bonds, Eurodollar futures and options, and S&P 500 Futures contracts) and on foreign exchange derivatives (futures and options contracts on EUROs, British pounds, and Canadian dollars). First, we look at how liquidity on the markets has been affected. Next, we test for mispricing of derivatives contracts.

We find that measured liquidity does fall for US financial futures and options but rises for foreign exchange futures and options subsequent to the introduction of the Treasury guidelines for OTC trading. Specifically, the Dodd-Frank structural breakpoints appear to be negatively associated with open interest, but only for certain financial futures. However, this relationship is not significant for the Eurodollar contracts and the T-bond contracts. The lack of significance for the Eurodollar contracts may be due to the overwhelming effects of a decline in interest rates over the sample period, with the Fed maintaining the Fed funds rate at close to zero since January 2009. The lack of significance for T-bonds could be due to the expectation (which has been subsequently justified) of an exemption of T-bonds from Dodd-Frank and the Volcker Rule.

The significantly negative association of Dodd-Frank with the other financial derivative products is consistent with Duffie's (2012) hypothesis of a withdrawal of participants in markets for US assets (OTC and exchange traded) due to a reduction of quality of fundamentals. The increased liquidity of foreign currency derivatives, however, is not consistent with Greenspan's (2011) warning of an exodus of foreign exchange derivatives from the United States. However, our result may not preclude increased participation in the US foreign exchange derivative markets due to planned migration of asset holders and investors to foreign venues in order to escape the regulatory tax (Houston et al. 2012).

Finally, our study shows mixed results on how Dodd-Frank derivative provisions affect the efficiency of the exchange traded markets. An increase in efficiency reflected by lower deviations of futures prices from their cost of carry is observed for the S&P futures contracts. This may reflect an increase of arbitrage by traders on the exchange traded markets, as opposed to the OTC markets. Increased pricing efficiency based on lower spreads between futures and implied forwards for nearby Eurodollar contracts is also observed. This is not the case, however, for more distant futures.

At this juncture in time, the implementation of the individual provisions of Dodd-Frank has been piecemeal and heavily delayed. The implications of such delays are certainly worth investigating as topics for future research, along with additional comparative impact studies of Dodd-Frank on US versus foreign derivatives markets and financial institutions.

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