Internet Appendix to When do listed firms pay for market making in their own stock?

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Contents

This internet appendix contains additional and supplementary results to the paper *When do listed firms pay for market making in their own stock?* by Johannes Atle Skjeltorp and Bernt Arne Ødegaard.

I. Descriptive

In this section we complement the analysis in section 2 (Institutional detail and descriptive statistics) with more detailed and additional results.

A. Industry Distribution of DMM users

In appendix table IA.I we provide the industry distribution of the first hirings of DMMs listed in table 1 in the paper.

Table IA.I
Describing DMM deals at the OSE - Industry Distribution

The table shows the distribution across the 10 GICS industries for the DMM-using firms. Global Industry Classification Standard (GICS) is an industry taxonomy developed by MSCI and S&P. Data for 2004–2012.

GICS		Number of firms
10	Energy	12
15	Material	6
20	Industry	17
25	ConsDisc	4
30	ConsStapl	10
35	Health	14
40	Finan	18
45	IT	22
50	Telecom	0
55	Util	2

B. Summary Statistics

Appendix Table IA.II shows the descriptive statistics on a year by year basis. This complements Table 2 in the paper, which only showed the averages across the whole sample.

Table IA.II
Summary statistics - Firms with DMMs vs Firms without DMMs – Year by Year

The table shows various statistics for firms having a DMM and firms without a DMM. Each year, the first column shows the average for all firms *with* a DMM at some point during that year, while the second column shows the average for all the firms without a DMM (*other*) in the respective year. We split the statistics into four main types. The first set of statistics shows variables that capture *firm magnitude*. *Firm size* is total value of the firm's assets at year-end, *Operating income* is the book income for that accounting year. *Q* is an estimate of Tobins' Q, *Sales growth* is the percentage change in operating income. *N inside trades* is the number of trades (large sales) by corporate insiders. The third set of statistics measures the firms' *equity market activity* where *Fraction equity issuers* is the percentage fraction of companies that issues equity in a given year, and *Fraction planned repurchasers* is the percentage fraction of companies that have an active repurchasing plan at yearend, *Fraction actual repurchasers* is the percentage fraction of companies that repurchases stock at least once during the year. The last set of statistics measures the secondary market liquidity of the stocks where, *Spread* is the difference (in Norwegian kroner, NOK) between the best closing bid and ask price, the *Relative spread* is the NOK spread divided by the closing stock price, *LOT* is the Lesmond, Ogden, and Trzcinka (1999) estimate of transaction costs, *Amihud* is the Amihud (2002) illiquidity measure, *Turnover* is the average fraction of the firms outstanding stock that is traded over the year, and *Frac trading year* is the fraction of the trading year with trades in the stock.

	2005		2006		2007		2008		2009		2010		2011	
	with DMMs	other	with DMMs	other	with DMMs	other	with DMMs	other	with DMMs	other	with DMMs	other	with DMMs	other
Firm magnitude														
-Firm Size (mill)														
Average	2339	9896	1865	12533	1627	12381	1094	7486	1589	9845	2046	11913	1189	7740
Median	640	1446	707	2058	694	2193	307	1116	1168	1400	980	1745	332	975
-Operating Income (mill)														
Average	1543	7225	1268	9507	996	7543	1267	8603	1438	8057	1925	8767	496	9607
Median	485	568	249	838	305	986	360	956	443	1160	306	1028	373	1279
-Q	1.96	1.61	2.01	1.51	1.85	1.29	0.99	0.69	1.50	0.84	1.31	0.96	0.33	0.61
-Sales growth(%)	36.4	21.4	19.2	52.4	23.4	42.0	29.8	35.0	8.6	15.7	18.5	6.5	−11.2	−5.8
Individual owners														
-N inside trades	1.4	1.8	2.2	1.6	1.0	1.0	0.3	0.4	1.1	0.7	0.6	0.9	0.7	0.6
Equity market activity														
-Fraction equity issuers(%)	25.8	38.3	37.2	32.3	37.3	34.2	27.6	25.2	39.6	30.5	29.3	30.1	19.6	26.9
-Fraction planned repurchasers(%)	51.6	40.2	25.6	20.3	19.6	19.8	17.2	20.1	22.9	19.0	17.2	17.0	14.3	13.2
-Fraction actual repurchasers(%)	48.4	33.0	48.8	34.6	39.2	31.3	32.8	35.9	29.2	25.2	31.0	26.2	26.8	27.4
Stock liquidity measures														
-Spread (NOK)	0.8	2.4	0.8	2.5	0.8	2.5	0.7	2.7	0.7	1.4	1.1	1.1	1.1	1.1
-Relative spread(%)	1.91	2.31	2.18	2.31	2.15	2.62	3.43	4.21	3.98	4.36	3.45	3.21	3.65	3.49
-LOT(%)	3.19	3.68	3.01	3.58	3.08	3.43	5.46	5.49	5.88	7.14	4.27	4.54	4.62	4.30
-Amihud	0.172	0.219	0.199	0.227	0.223	0.266	0.534	0.840	0.583	1.015	1.460	3.524	4.116	4.831
-Annual -Turnover(%)	72.66	134.89	70.60	130.73	89.73	97.59	51.11	172.72	46.01	195.57	50.43	151.02	31.18	125.59
-Frac trading year(%)	85.29	83.76	80.71	83.38	85.41	81.82	76.99	74.23	73.54	74.58	75.60	82.92	71.96	80.39

Appendix Table IA.III shows correlations of annual data. This complements Table 2 in the paper, which only showed the averages across the whole sample.

Note that these are contemporaneous correlations of annual aggregates. When we later study the determinants of the decision to hire a DMM, we need to be more careful about timing. With that qualification in mind, it is still important to note that many of the potential explanatory variables are correlated.

Table IA.III
Summary statistics – Correlations

The table shows (contemporaneous) correlations between annual observations of many of the same variables as in Appendix Table IA.II. *Firm size* is total value of the firm's assets at year-end. *Q* is an estimate of Tobins' Q. *No inside trades* is the number of trades (large sales) by corporate insiders. *Issueequity next year* is a dummy variable equal to one if the firm issues equity during the next year. *Announced repurchases* is a dummy variable equal to one if the firm has announced an repurchase program at year-end. *Repurchase next year* is a dummy variable equal to one if the firm repurchases shares during the year. *Have DMM* is a dummy variable equal to one if the firm has a DMM sometime during the year. *Hire DMM* is a dummy variable equal to one if firm hires a DMM sometime during the year. *Listed within 2 years* is a dummy variable equal to one if the time since the firm was listed is less than 2 years. *Frac trading days* is the fraction of the trading year with trades in the stock. Correlations in bold indicate statistical significance below 5%. Period 2005-2011.

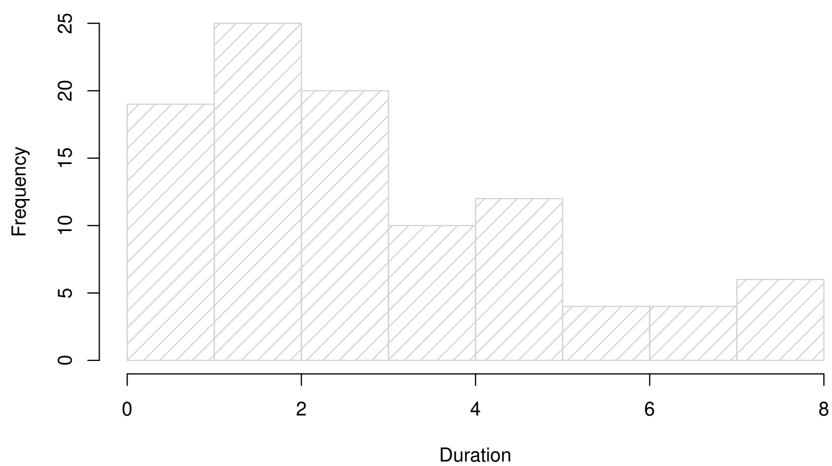
	Relative	Firm		Inside	Issue	Repurchases		Sales	Have	Hire	Frac
	Spread	Size	Q	sales	Equity	Announced	Actual	Growth	DMM	DMM	trad days
Firm size	**-0.59**										
Q	**-0.14**	-0.03									
No inside trades	**-0.14**	**0.14**	**0.21**								
Issue equity next year	**-0.05**	**-0.19**	**0.14**	0.01							
Announced repurchases	**-0.17**	**0.20**	**0.07**	**0.14**	**-0.17**						
Repurchase next year	**-0.16**	**0.27**	**0.09**	**0.12**	**-0.17**	**0.31**					
Sales growth	**-0.05**	0.00	0.02	-0.00	**0.06**	**-0.08**	-0.04				
Have DMM	0.01	**-0.23**	**0.07**	-0.01	-0.03	-0.03	0.03	-0.02			
Hire DMM	0.02	**-0.16**	**0.09**	0.03	0.02	0.00	-0.01	0.01	**0.58**		
Frac trading days	**-0.85**	**0.40**	**0.11**	**0.10**	**0.16**	**0.05**	0.02	**0.06**	**-0.07**	-0.04	
Listed within 2 years	**0.10**	**-0.15**	**0.05**	-0.00	**0.11**	**-0.19**	**-0.12**	**0.08**	**0.06**	**0.11**	**-0.07**

C. Duration of DMM contracts

Appendix Figure IA.1 describe the empirical duration of the DMM contracts in the sample, complementing the discussion in section 2 of the paper. Note that the use of a DMM is relatively long-term; only a small fraction of the companies employ a DMM for less than a year.

Figure IA.1
Duration of DMM contracts

The histogram shows the distribution of duration of DMM contracts, how long a company maintains a DMM. For each of the companies that has had a DMM, we measure the time (in years) starting at the first hiring of a DMM and ending in either the discontinuation of DMM services, delisting, or the end of the sample period (December 2012).

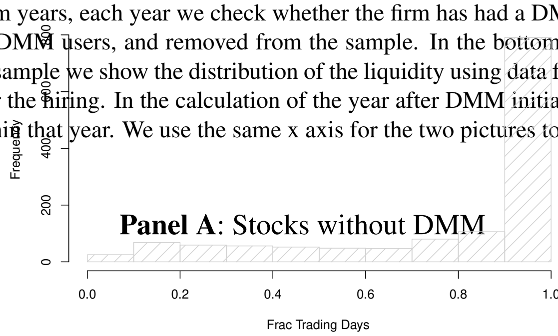


D. Liquidity Distribution

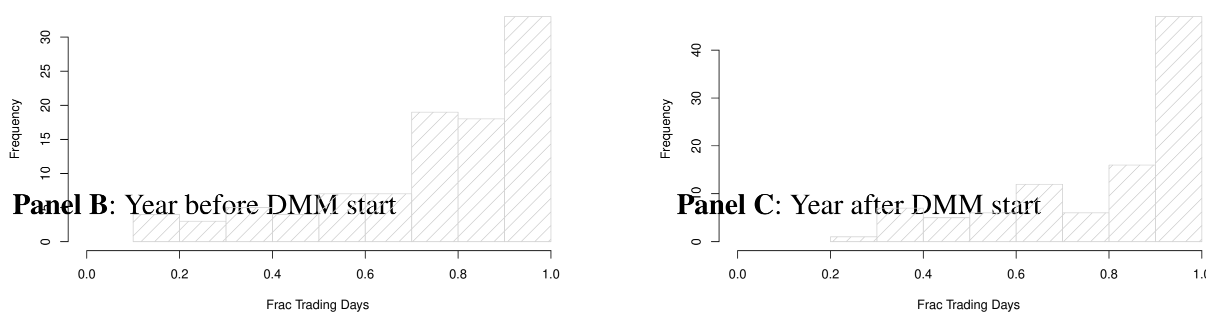
Appendix Figure IA.2 complements paper Figure 2, which shows distribution of relative spread. The Appendix figure shows the same results for another liquidity measure, fraction of year traded.

Figure IA.2
Distribution of liquidity (fraction of year traded) for DMM and non-DMM stocks

The figures show histograms of the distribution of a measure of stock liquidity, fraction of year traded. The panels shows empirical probability distributions for two groups of firms. The top panel (A) only use the firms on the exchange that do not have a DMM. The basis for the figure is firm years, each year we check whether the firm has had a DMM at some point during the year. If it has, this stock is in the group of DMM users, and removed from the sample. In the bottom panels we instead only consider the firms which hire a DMM. For this sample we show the distribution of the liquidity using data for the one year period before the firm hired the DMM, and one year after the hiring. In the calculation of the year after DMM initiation we remove periods without a DMM if the DMM services stops within that year. We use the same x axis for the two pictures to make them more easily comparable.



Panel A: Stocks without DMM



Panel B: Year before DMM start

Panel C: Year after DMM start

II. The corporate decision to hire a Designated Market Maker

In this section we give additional results to the analysis performed in section 4 in the paper.

A. First time hires of DMM

This complements the paper section 4.1 (First-time hires), and contains the robustness exercises discussed in section 4.4. The first specification is meant to capture time variation in the *dependent* variable (hiring DMM) not directly related to the explanatory variables. We include fixed annual effects to account for this. The results of this robustness exercise are in Appendix tables IA.IV (ex ante specification) and IA.V (ex post specification).

Table IA.IV
Hiring a Designated Market Maker - ex ante specification - with fixed annual effects

The tables reports the results from probit regressions. For each specification we show the coefficient estimates and standard errors (in parenthesis). Significance is indicated with stars. The dependent variable in each regression is whether the firm hires a DMM in a given calendar year. Success in the probit is hiring of a DMM. In the table below, each column gives results for a different probit regression. The regressions only use explanatory variables that are observable at the time the DMM contract is announced. We call this the *ex ante* specification, which includes the following explanatory variables: *Q* - The current estimate of Q (market/book value of firm), *Sales Growth* - Growth in accounting income previous two years, *Repurchase Program* - Whether the firm has a repurchase program in place and *Listed < 2 years* - Dummy variable equal to one if it is 2 years or less since the firm was listed. We also control for *Liquidity (RelSpread)* - The relative spread last year. We also include fixed annual effects, shown by the variables 2007–2011. For some of the variables we lose observations because the firms has not been listed long enough. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Hire DMM			
	(1)	(2)	(3)	(4)
Liquidity (Rel.Spread)	-1.72	-8.37^{**}		
	(2.95)	(4.16)		
Q	0.20^{***}		0.19^{***}	0.21^{***}
	(0.06)		(0.06)	(0.06)
Sales Growth		0.03		
		(0.15)		
Repurchase Program	0.02	-0.08	-0.01	-0.02
	(0.22)	(0.27)	(0.22)	(0.22)
Listed < 2 years	0.37^{*}	0.12	0.44^{**}	
	(0.19)	(0.27)	(0.18)	
2007	-0.35	-0.30	-0.42	-0.36
	(0.28)	(0.32)	(0.28)	(0.27)
2008	-0.35	-0.43	-0.46^{*}	-0.38
	(0.26)	(0.33)	(0.26)	(0.25)
2009	-0.89^{**}	-1.11^{**}	-1.06^{***}	-0.94^{***}
	(0.35)	(0.46)	(0.33)	(0.32)
2010	0.20	-0.58^{*}	0.06	0.02
	(0.24)	(0.33)	(0.23)	(0.22)
2011	-0.36	-0.93^{*}	-0.49	-0.52^{*}
	(0.33)	(0.47)	(0.32)	(0.32)
Constant	-1.33^{***}	-0.50^{*}	-1.35^{***}	-1.26^{***}
	(0.24)	(0.30)	(0.18)	(0.18)
Observations	481	322	510	510

Note: *p<0.1; **p<0.05; ***p<0.01

Table IA.V
Hiring a Designated Market Maker (ex-post specification) - with fixed annual effects

The table reports the results from Probit regressions with fixed annual effects. The dependent variable in each regression is whether the firm hires a DMM in a given calendar year. Success in the Probit is hiring of a DMM. For each specification we show the coefficient estimates and the number of firm-year observations. Each column gives results for a different Probit regression. The explanatory variables include corporate events after the hiring of a DMM. This "ex-post" specification includes the explanatory variables: *Liquidity (RelSpread)* - The relative spread last year, *Issue Equity* - Dummy variable equal to one if the firm issues equity the next three years, *Actual Repurchase* - Dummy variable equal to one if the firm actually repurchases equity the next three years, and *Insider sales* - Number of cases with large insiders sales during the next three years. We also include fixed annual effects, shown by the variables 2007–2011. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Hire DMM		
	(1)	(2)	(3)
Liquidity (rel.spread)	−1.74		
	(3.07)		
Issue Equity	0.48***	0.50***	0.50***
	(0.17)	(0.17)	(0.15)
Repurchase	0.23	0.23	0.30*
	(0.17)	(0.17)	(0.16)
Insider sales	0.06**	0.07***	
	(0.02)	(0.02)	
2007	0.02	−0.01	−0.07
	(0.25)	(0.25)	(0.23)
2008	−0.11	−0.18	−0.28
	(0.26)	(0.26)	(0.24)
2009	−0.84**	−0.95***	−1.07***
	(0.35)	(0.34)	(0.33)
2010	0.21	0.10	−0.005
	(0.25)	(0.23)	(0.21)
2011	−0.47	−0.55	−0.49*
	(0.38)	(0.37)	(0.29)
Constant	−1.44***	−1.51***	−1.36***
	(0.27)	(0.21)	(0.18)
Observations	462	490	547

Note: *p<0.1; **p<0.05; ***p<0.01

The fixed annual effects approach used above is primarily there to adjust for potential time variation in the dependent variable, hiring a DMM. Another potential source for confounding effects is time variation in the explanatory variables. The ones we will investigate is the ex ante measure of growth, Q and Sales Growth, since they have time variation related to the business cycle. To correct for such variation we subtract the time series mean of these variables to get clearer at the crossectional variation. Specifically, let us take Q as the example. In year t we calculate the mean of all observed Q estimates. Let Q_{it} be the estimate of Q for company i in year t. The crossectional mean is $\bar{Q}_t = \frac{1}{N_t}\sum_{i=1}^{N_t} Q_i$ where N_t is the number of firms active at time t. The *Relative Q* for firm i at time t is $RelQ_{it} = Q_{it} - \bar{Q}_t$. This Relative Q will identify the firms with better investment opportunities *at time t*. We do a similar calculation for sales growth to measure *Relative Sales Growth*.

Results using these definitions to measure investment opportunities are shown in Appendix Table IA.VI (ex ante specification).

Table IA.VI
Hiring a Designated Market Maker - ex ante specification - Relative Growth measures

The tables reports the results from probit regressions. For each specification we show the coefficient estimates and standard errors (in parenthesis). Significance is indicated with stars. The dependent variable in each regression is whether the firm haves a DMM in a given calendar year. Success in the probit is hiring of a DMM. In the table below, each column gives results for a different probit regression. The regressions only use explanatory variables that are observable at the time the DMM contract is announced. We call this the *ex ante* specification, which includes the following explanatory variables: *Q* - The current estimate of Q (market/book value of firm), *Sales Growth* - Growth in accounting income previous two years, *Repurchase Program* - Whether the firm has a repurchase program in place and *Listed < 2 years* - Dummy variable equal to one if it is 2 years or less since the firm was listed. We also control for *Liquidity (RelSpread)* - The relative spread last year. We also include fixed annual effects, shown by the variables 2007–2011. For some of the variables we lose observations because the firms has not been listed long enough. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Hire DMM			
	(1)	(2)	(3)	(4)
Liquidity (Rel.Spread)	-3.41	-11.80^{***}		
	(2.74)	(4.12)		
Relative Q	0.19^{***}		0.18^{***}	0.19^{***}
	(0.06)		(0.06)	(0.06)
Relative Sales Growth		0.03		
		(0.13)		
Repurchase Program	0.08	0.08	0.10	0.09
	(0.21)	(0.25)	(0.20)	(0.20)
Listed $<$ 2 years	0.20	0.09	0.26	
	(0.17)	(0.25)	(0.17)	
Constant	-1.14^{***}	-0.74^{***}	-1.37^{***}	-1.29^{***}
	(0.19)	(0.26)	(0.10)	(0.09)
Observations	481	322	510	510
Note:				*p<0.1; **p<0.05; ***p<0.01

B. Hiring and maintaining a DMM

This section complements the analysis in section 4.2 of the paper. Similarly to the above analysis of fist time hiring (only), to control for time variation in the dependent variable we include fixed annual effects as explanatory variables. The results are shown in Appendix tables IA.VII (ex ante specification) and IA.VIII (ex post specification).

Table IA.VII
Hiring or maintaining a Designated Market Maker - ex ante specification - with fixed annual effects

The tables reports the results from probit regressions. For each specification we show the coefficient estimates and standard errors (in parenthesis). Significance is indicated with stars. The dependent variable in each regression is whether the firm haves a DMM in a given calendar year. Success in the probit is hiring of a DMM. In the table below, each column gives results for a different probit regression. The regressions only use explanatory variables that are observable at the time the DMM contract is announced. We call this the *ex ante* specification, which includes the following explanatory variables: *Q* - The current estimate of Q (market/book value of firm), *Sales Growth* - Growth in accounting income previous two years, *Repurchase Program* - Whether the firm has a repurchase program in place and *Listed < 2 years* - Dummy variable equal to one if it is 2 years or less since the firm was listed. We also control for *Liquidity (RelSpread)* - The relative spread last year. We also include fixed annual effects, shown by the variables 2007–2011. For some of the variables we lose observations because the firms has not been listed long enough. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Have DMM			
	(1)	(2)	(3)	(4)
Liquidity (Rel.Spread)	-18.19^{***}	-24.15^{***}		
	(2.56)	(3.22)		
Q	0.25^{***}		0.25^{***}	0.26^{***}
	(0.05)		(0.05)	(0.05)
Sales Growth		-0.03		
		(0.10)		
Repurchase Program	0.27^{*}	0.24	0.36^{***}	0.35^{**}
	(0.15)	(0.17)	(0.14)	(0.14)
Listed < 2 years	0.25^{*}	0.09	0.22^{*}	
	(0.13)	(0.18)	(0.13)	
2007	0.10	0.12	0.18	0.20
	(0.20)	(0.23)	(0.19)	(0.19)
2008	0.15	-0.06	0.07	0.10
	(0.20)	(0.25)	(0.19)	(0.19)
2009	0.48^{**}	0.25	0.09	0.13
	(0.20)	(0.22)	(0.18)	(0.18)
2010	0.86^{***}	0.38^{*}	0.48^{***}	0.45^{**}
	(0.20)	(0.22)	(0.18)	(0.18)
2011	0.96^{***}	0.38	0.68^{***}	0.65^{***}
	(0.21)	(0.25)	(0.19)	(0.19)
Constant	-0.48^{**}	0.47^{**}	-1.23^{***}	-1.18^{***}
	(0.19)	(0.22)	(0.15)	(0.15)
Observations	622	437	653	653

Note: *p<0.1; **p<0.05; ***p<0.01

Table IA.VIII
Hiring or maintaining a Designated Market Maker - ex post specification - with fixed annual effects

The tables reports the results from probit regressions. For each specification we show the coefficient estimates, and the standard errors (in parenthesis). The dependent variable in each regression is whether the firm haves a DMM in a given calendar year. Success in the probit is hiring of a DMM. In the table below, each column gives results for a different probit regression. The explanatory variables includes corporate events after the hiring of a DMM. We term this the *ex post* specification. The "ex post" specification includes the explanatory variables: *Issue Equity* - Dummy variable equal to one if the firm issues equity the next three years, *Actual Repurchase* - Dummy variable equal to one if the firm actually repurchases equity the next three years, *Insider trades(sells)* - Number of cases with large insiders sells during the next three years. Common to both specifications is *Liquidity (RelSpread)* - The relative spread last year) We also include fixed annual effects, shown by the variables 2007–2011. For some of the accounting variables (e.g. sales growth) we lose observations because the firms has not been listed long enough. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Have DMM		
	(1)	(2)	(3)
Liquidity (rel.spread)	-18.61^{***}		
	(2.61)		
Issue Equity	0.27^{**}	0.27^{**}	0.31^{***}
	(0.12)	(0.11)	(0.11)
Repurchase	0.19	0.25^{**}	0.33^{***}
	(0.12)	(0.11)	(0.11)
Insider sales	0.05^{**}	0.06^{***}	
	(0.02)	(0.02)	
2007	0.20	0.33^{*}	0.23
	(0.19)	(0.18)	(0.18)
2008	0.20	0.16	0.02
	(0.20)	(0.19)	(0.18)
2009	0.36^{*}	0.02	-0.10
	(0.20)	(0.18)	(0.17)
2010	0.73^{***}	0.38^{**}	0.24
	(0.20)	(0.18)	(0.17)
2011	0.80^{***}	0.57^{***}	0.44^{**}
	(0.21)	(0.20)	(0.18)
Constant	-0.23	-1.07^{***}	-0.95^{***}
	(0.19)	(0.16)	(0.14)
Observations	603	633	696
Note:			*p<0.1; **p<0.05; ***p<0.01

Again, similary to the case for first-time hiring, we look at adjusted versions of the growth variables (Q and Sales Growth), where we look at the difference between the firm Q and the industry Q.

Table IA.IX
Hiring or maintaining a Designated Market Maker - ex ante specification - Relative Growth measures

The tables reports the results from probit regressions. For each specification we show the coefficient estimates and standard errors (in parenthesis). Significance is indicated with stars. The dependent variable in each regression is whether the firm haves a DMM in a given calendar year. Success in the probit is hiring of a DMM. In the table below, each column gives results for a different probit regression. The regressions only use explanatory variables that are observable at the time the DMM contract is announced. We call this the *ex ante* specification, which includes the following explanatory variables: *Q* - The current estimate of Q (market/book value of firm), *Sales Growth* - Growth in accounting income previous two years, *Repurchase Program* - Whether the firm has a repurchase program in place and *Listed < 2 years* - Dummy variable equal to one if it is 2 years or less since the firm was listed. We also control for *Liquidity (RelSpread)* - The relative spread last year. We also include fixed annual effects, shown by the variables 2007–2011. For some of the variables we lose observations because the firms has not been listed long enough. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Have DMM			
	(1)	(2)	(3)	(4)
Liquidity (Rel.Spread)	-15.17^{***}	-22.27^{***}		
	(2.27)	(2.94)		
Relative Q	0.25^{***}		0.24^{***}	0.24^{***}
	(0.05)		(0.05)	(0.05)
Relative Sales Growth		-0.02		
		(0.10)		
Repurchase Program	0.20	0.21	0.30^{**}	0.30^{**}
	(0.14)	(0.16)	(0.14)	(0.14)
Listed < 2 years	0.09	0.02	0.10	
	(0.13)	(0.17)	(0.12)	
Constant	0.16	0.57^{***}	-0.65^{***}	-0.62^{***}
	(0.13)	(0.17)	(0.07)	(0.06)
Observations	622	437	653	653
Note:			*p<0.1; **p<0.05; ***p<0.01	

C. Discontinuations

This section complements section 4.3 in the paper. Table IA.X gives the ex ante version of the specification given in table 7 in the paper.

Table IA.X
Ending a Designated Market Maker - ex ante specification

The tables reports the results from probit regressions. For each specification we show the coefficient estimates and standard errors (in parenthesis). Significance is indicated with stars. The dependent variable in each regression is whether the firm hires a DMM in a given calendar year. Success in the probit is hiring of a DMM. In the table below, each column gives results for a different probit regression. The regressions only use explanatory variables that are observable at the time the DMM contract is announced. We call this the *ex ante* specification, which includes the following explanatory variables: *Q* - The current estimate of Q (market/book value of firm), *Sales Growth* - Growth in accounting income previous two years, *Repurchase Program* - Whether the firm has a repurchase program in place and *Listed < 2 years* - Dummy variable equal to one if it is 2 years or less since the firm was listed. We also control for *Liquidity (RelSpread)* - The relative spread last year. We also include fixed annual effects, shown by the variables 2007–2011. For some of the variables we lose observations because the firms has not been listed long enough. In the sample we remove all firms with an already existing DMM contract. Also, we only consider firms that traded less than 90% of the available days the year before.

	Dependent variable: Quit DMM		
	(1)	(2)	(3)
Liquidity (Rel.Spread)	3.46		
	(4.70)		
Q	−0.02	−0.03	−0.03
	(0.06)	(0.06)	(0.06)
Repurchase Program	-0.48^{**}	-0.48^{**}	-0.48^{**}
	(0.24)	(0.24)	(0.23)
Listed < 2 years	0.05	0.05	
	(0.22)	(0.21)	
Constant	-0.76^{***}	-0.66^{***}	-0.65^{***}
	(0.21)	(0.14)	(0.13)
Observations	251	254	254
Note:			*p<0.1; **p<0.05; ***p<0.01

III. List of firms used

In this appendix we provide detailed lists of the companies used in the analysis. We show the periods during which the firms employ a DMM to make the market. We also provide the period through which the firms is listed, an indication of the size of the firm, and the industry of the firm. to show the size, we give the size quartile, where 1 contains the smallest firms, etc. Industry is indicated with one of the 10 different GICS classifications. GICS (Global Industry Classification Standard) is an industry categorization developed by MSCI and Standard & Poor's.

Table IA.XI
List of firms employing a DMM

Company	Date MM start	Date MM end	Listing dates first obs	Listing dates last obs	Industry	Size quartile
24SevenOffice	1 oct 2008	30 apr 2010	22 jun 2007	–	45	1
24SevenOffice	10 nov 2010	6 jul 2011	22 jun 2007	–	45	1
24SevenOffice	22 nov 2010	6 jul 2011	22 jun 2007	–	45	1
Active 24	1 mar 2006	5 oct 2006	12 nov 2004	23 aug 2006	45	2
Active 24	1 apr 2005	1 mar 2006	12 nov 2004	23 aug 2006	45	2
AF Gruppen A	1 feb 2010		8 sep 1997	–	20	2
AF Gruppen A	3 feb 2005	31 jan 2010	8 sep 1997	–	20	3
Borgestad A	18 apr 2005		2 jan 1980	–	20	2
Algeta	1 oct 2007	1 aug 2010	27 mar 2007	–	35	2
Allianse	21 nov 2005	19 jun 2006	25 may 2005	22 jun 2006	45	2
Apptix	21 jul 2006	9 oct 2008	8 apr 2002	–	45	2
Aqua Bio Technology	7 feb 2011		10 jan 2008	–	30	1
Artumas Group	10 may 2006	10 sep 2006	8 jul 2005	–	10	3
Aurskog Sparebank	1 apr 2010		12 aug 1998	–	40	1
Avocet Mining	16 apr 2011		16 jun 2010	–	15	4
Avocet Mining	28 apr 2011		16 jun 2010	–	15	4
Axxessit	27 jan 2005	7 sep 2005	4 jun 2004	2 aug 2005	45	2
Belships Co.	12 jan 2005		2 jan 1980	–	20	2
Biotec Pharmacon	2 jul 2007	25 jan 2009	4 nov 2005	–	35	2
Biotec Pharmacon	26 jan 2009	28 feb 2010	4 nov 2005	–	35	2
Bluewater Insurance	1 apr 2009	21 jun 2010	13 oct 2005	5 aug 2010	40	1
Bluewater Insurance	13 oct 2005	1 apr 2009	13 oct 2005	5 aug 2010	40	2
Borgestad A	1 oct 2008		2 jan 1980	–	20	2
Bridge Energy	6 dec 2011		21 may 2010	–	10	3
Camposol Holding	6 dec 2010		15 may 2008	–	30	1
Clavis Pharma	13 oct 2006	19 dec 2007	7 jul 2006	–	35	2
Clavis Pharma	20 dec 2007	1 apr 2011	7 jul 2006	–	35	2
Component Software Group	12 apr 2007		20 sep 2000	18 sep 2007	40	1
Comrod Communication	13 nov 2007	1 dec 2012	22 jan 2007	–	20	1
Confirmit	6 jul 2006	16 jul 2008	6 dec 2005	7 aug 2008	45	2
Conseptor	1 oct 2004		24 jun 2004	2 may 2007	30	3
ContextVision	6 jul 2005	25 jan 2009	17 mar 1997	–	35	2
ContextVision	13 jan 2009		17 mar 1997	–	35	1
Copeinca	3 aug 2009		29 jan 2007	–	30	3
Dannemora Mineral	15 jul 2010		17 jun 2010	–	15	3
DiaGenic	24 mar 2009		27 aug 2004	–	35	1
DiaGenic	27 feb 2006		27 aug 2004	–	35	1
Dockwise	4 sep 2008	5 mar 2009	2 oct 2007	–	10	4
Dolphin Interconnect Solutions	20 dec 2006	13 mar 2009	20 apr 2006	–	45	1
Eidesvik Offshore	23 may 2006		27 jun 2005	–	10	3
Teco Maritime	14 jun 2005	9 oct 2008	31 oct 1997	–	10	1
Teco Maritime	18 jul 2007	23 mar 2012	31 oct 1997	–	10	1
Exense	8 feb 2008	31 dec 2008	15 aug 2000	2 apr 2009	45	1
Exense	11 oct 2006	7 feb 2008	15 aug 2000	2 apr 2009	45	1
Expert	15 jul 2004	12 jul 2007	14 apr 2000	20 sep 2007	25	3
Fairstar Heavy Transport	3 aug 2009		17 nov 2006	–	20	2
Fairstar Heavy Transport	17 nov 2006	16 oct 2008	17 nov 2006	–	20	3
Fairstar Heavy Transport	27 oct 2008	20 may 2012	17 nov 2006	–	20	3
Fairstar Heavy Transport	21 may 2012		17 nov 2006	–	20	3
Fara	4 jan 2010	30 sep 2011	16 dec 2005	–	45	1
Confirmit	6 jul 2006	9 oct 2008	6 dec 2005	7 aug 2008	45	2
Goodtech	13 sep 2010	17 dec 2012	20 jan 1984	–	20	1
Goodtech	17 dec 2012		20 jan 1984	–	20	2
Guinor Gold Corporation	10 sep 2004	3 apr 2006	4 may 2004	2 mar 2006	15	3
Haag	16 nov 2004	2 jan 2006	1 apr 1992	20 feb 2006	20	2
Hafslund Nycomed A-aksjer	1 mar 2010	1 mar 2012	2 jan 1980	–	55	4

Table IA.XI
List of firms employing a DMM (Continued).

Company	Date MM start	Date MM end	Listing dates first obs	Listing dates last obs	Industry	Size quartile
Hafslund Nycomed B-aksjer	1 mar 2010	1 mar 2012	20 oct 1988	–	55	4
Hafslund Infratek	3 jan 2013		5 dec 2007	–	10	3
Hafslund Infratek	2 feb 2010	31 jan 2013	5 dec 2007	–	10	2
Hafslund Infratek	9 sep 2008	2 mar 2009	5 dec 2007	–	10	2
Norwegian Applied Technology	19 dec 2007		30 jan 1997	–	45	3
Hofseth BioCare	14 dec 2011		2 dec 2011	–	35	2
Hurtigruten	20 feb 2008	16 feb 2009	1 mar 2006	–	25	3
I.M. Skaugen	4 may 2011		18 feb 1997	–	20	3
I.M. Skaugen	9 nov 2009	23 nov 2010	18 feb 1997	–	20	3
I.M. Skaugen	26 apr 2005	26 oct 2009	18 feb 1997	–	20	3
IMAREX	1 mar 2007	16 feb 2009	4 apr 2005	–	40	2
IMAREX	16 feb 2009	31 dec 2011	4 apr 2005	–	40	3
Indre Sogn Sparebank	10 may 2010		20 jan 1997	–	40	1
Inmeta	1 feb 2005	29 feb 2008	8 oct 1999	–	45	2
Intelecom Group	1 aug 2008	5 dec 2008	13 jun 2001	12 dec 2008	45	1
Sonec	4 apr 2005	1 mar 2006	16 jan 1998	–	45	3
Sonec	17 dec 2008	31 dec 2010	16 jan 1998	–	45	2
Klepp Sparebank	1 dec 2010		3 may 2007	–	40	1
Kongsberg Automotive	29 nov 2007	14 nov 2012	24 jun 2005	–	25	3
London Mining	12 feb 2009		9 oct 2007	–	15	3
London Mining	30 jan 2008	10 oct 2008	9 oct 2007	–	15	3
Luxo	18 oct 2007	28 feb 2009	15 may 1998	18 may 2009	20	1
Mamut	15 nov 2006	20 may 2009	10 may 2004	–	45	2
Mamut	20 may 2009	30 sep 2011	10 may 2004	–	45	2
Norstat	10 oct 2005	3 may 2006	23 sep 2005	16 jan 2008	30	1
Norstat	26 jun 2006	14 may 2007	23 sep 2005	16 jan 2008	30	1
Norstat	14 may 2007		23 sep 2005	16 jan 2008	30	1
Melhus Sparebank	1 sep 2010		9 nov 1998	–	40	1
NattoPharma	12 jun 2009		30 jan 2008	–	35	1
NattoPharma	30 jan 2008	30 sep 2009	30 jan 2008	–	35	1
Natural	6 sep 2005	30 jun 2007	27 jan 1998	–	35	3
Navamedic	31 mar 2006	1 dec 2008	31 mar 2006	–	35	1
NEAS	13 nov 2007	10 aug 2009	23 mar 2007	–	40	1
Nes Prestegjelds Sparebank	1 jan 2010		19 oct 1998	–	40	1
NetConnect	15 jun 2010	30 mar 3011	15 jun 2010	–	45	1
DynaPel Systems	2 jan 2013		27 jan 2005	–	45	1
DynaPel Systems	3 oct 2012	2 jan 2013	27 jan 2005	–	45	1
NorDiag	27 aug 2008	23 nov 2008	14 dec 2005	–	35	1
Nordic Mining	4 feb 2008	23 nov 2008	14 sep 2007	–	15	1
Norway Pelagic	14 jan 2009		24 jun 2008	–	30	2
Eidsiva	21 mar 2011	31 jul 2012	2 jan 1980	–	20	1
Nutri Pharma	15 mar 2006	15 apr 2010	5 may 2000	–	35	2
Nutri Pharma	15 apr 2010		5 may 2000	–	35	1
Ocean HeavyLift	3 dec 2007	13 oct 2008	4 may 2007	30 dec 2008	10	3
Ocean Rig	16 nov 2004	31 mar 2008	7 jan 1997	1 jul 2008	10	3
Storli A	29 jun 2005		5 may 1986	–	20	4
Storli B	29 jun 2005		12 may 1989	–	20	4
Odfjell Invest	20 mar 2007	10 jul 2008	1 jun 2006	22 dec 2008	10	3
Office Line	1 feb 2005	24 may 2006	7 nov 2000	1 jun 2006	45	1
PCI Biotech Holding	14 nov 2012		18 jun 2008	–	35	2
Photocure	24 sep 2007	28 feb 2009	29 may 2000	–	35	3
Photocure	24 sep 2009	31 dec 2011	29 may 2000	–	35	2
Photocure	29 nov 2011		29 may 2000	–	35	3
Polimoon	25 jul 2005	18 mar 2007	26 apr 2005	5 jan 2007	15	3
Powel	2 nov 2005	1 oct 2006	24 oct 2005	22 jan 2010	45	2

Table IA.XI
List of firms employing a DMM (Continued).

	Date MM		Listing dates		Industry	Size
Company	start	end	first obs	last obs		quartile
Profdoc	16 jan 2008		28 may 1998	8 jul 2008	35	2
Profdoc	26 may 2005	30 jan 2006	28 may 1998	8 jul 2008	35	3
PSI Group	19 feb 2013		11 jun 2001	–	45	1
Rieber & Son	4 oct 2004		2 jan 1980	–	30	4
RomReal	4 aug 2008	10 aug 2010	11 jun 2007	–	40	2
RomReal	8 jun 2007	4 aug 2008	11 jun 2007	–	40	2
Rygge-Vaaler Sparebank	18 may 2010		1 nov 2005	–	40	1
Sandnes Spareban	1 oct 2010	30 jun 2012	27 oct 1995	–	40	1
Scana Industrier	27 may 2009		4 dec 1995	–	10	3
Scandinavian Clinical Nutrition	5 jun 2008	5 may 2009	22 nov 2007	17 sep 2009	30	1
Siem Offshore	13 nov 2009		12 aug 2005	–	10	3
Simrad Optronics	9 jan 2009	7 jun 2010	7 jul 2005	5 jul 2010	20	2
Simtronics	8 jan 2007	30 nov 2010	5 jan 2007	–	20	1
Vestfold Sparebank	1 jun 2012		27 may 1994	–	40	2
Nøtterø Sparebank	28 jan 2013		29 oct 2007	–	40	1
Sparebanken Vest	8 jul 2010		4 jan 1995	–	40	1
Sparebanken Vest	8 jul 2010		4 jan 1995	–	40	1
Spits	21 nov 2006		12 dec 2006	5 jul 2007	25	1
SuperOffice	28 feb 2007	16 sep 2008	10 mar 1997	14 oct 2008	45	2
Synnøve Finden	9 sep 2005	30 nov 2006	6 jul 1998	13 aug 2009	30	2
Synnøve Finden	18 mar 2005	3 jan 2006	6 jul 1998	13 aug 2009	30	2
Synnøve Finden	25 sep 2006	9 oct 2008	6 jul 1998	13 aug 2009	30	2
Storm Real Estate	6 jul 2010		6 jul 2010	–	40	2
SÃ¸lvtrans Holding	29 sep 2010	30 jan 2012	30 mar 2010	–	20	2
Teco Maritime	18 apr 2005	31 dec 2011	22 jun 2004	–	20	2
Toten Sparebank	1 feb 2010		18 dec 1995	–	40	1
Trefoil	5 dec 2005	14 jul 2008	20 dec 2005	8 aug 2008	10	3
Trolltech	12 jan 2007	7 apr 2008	5 jul 2006	6 jun 2008	45	3
TTS Technology	20 sep 2004	9 oct 2008	2 may 1995	–	20	1
VIA Travel Group	7 jul 2005	11 oct 2005	9 jun 2005	12 oct 2005	30	2
Vizrt	13 sep 2006		12 may 2005	–	45	3
Zoncolan	18 jun 2007		15 jun 2007	–	40	1

IV. Abnormal returns around DMM hirings

To examine whether the market response to the hiring of DMMs is similar in the Norwegian market to what has been documented for other markets, we perform an event study of the market reaction at the date when the firm announces a DMM. The event study is illustrated in figure IA.3.[1] and detailed in Table IA.XII. To test for significance we start 5 trading days before the event date and calculate the aggregate CAR for the next ten trading days. In aggregate there is a significantly positive reaction of about 1% just around the announcement date.

This positive market reaction is consistent with other research. For example, Anand, Tanggaard, and Weaver (2009) find a CAR around liquidity provider introduction of about 7% in their Swedish sample, and Menkveld and Wang (2013) find a CAR of 3.5% at Euronext. We thus confirm the effects on the market found in other studies, liquidity improves, and the market reacts positively to DMM introductions.

To further investigate these results we look at whether the size of the CAR is related to properties of the firms hiring DMM's. In panel B of Table IA.XII we regress the magnitude of the CAR on the liquidity, measured by the spread, of the stock before the DMM start, also controlling for the firm size. The regression shows a positive relationship between the spread and CAR. This means that the larger the spread before the DMM start, the bigger the reaction. The positive market reaction is thus largest for the least liquid stocks.

[1] We exclude stocks that started trading simultaneously with the DMM initiation. There are quite a few cases where the firm hires a DMM at the same time as the firm's IPO. In several cases the DMM agreement is likely to be part of the IPO "package," where the underwriter also acts as a market maker to keep a liquidity market for the stock after the IPO. We also remove cases where we can not identify with certainty the announcement date.

Figure IA.3
Event study, announcement date of DMM

The figure shows the results of an event study centered around the date when a DMM contract is announced. The figure plots the average cumulative abnormal return (CAR), where CAR is calculated relative to the market model. The event study is done using the standard methods, as for example exposited in Campbell, Lo, and MacKinlay (1997). Specifically, for each stock i and date t we calculate $AR_t = r_{it} - (\widehat{\alpha}_i + \widehat{\beta}_i(r_{mt} - r_{ft}))$, where AR is the abnormal return, r_{mt} the market return, and $\widehat{\alpha}_i$ and $\widehat{\beta}_i$ the estimated parameters. We use an equally weighted stock market index for the market. The figure shows the cumulative abnormal return (CAR) from 5 days before the DMM announcement (at t=0) to 5 days after the DMM announcement. We only use stocks for which we can identify the announcement date from the OSE news feed. See internet appendix section VI. for detailed definitions of the variables.

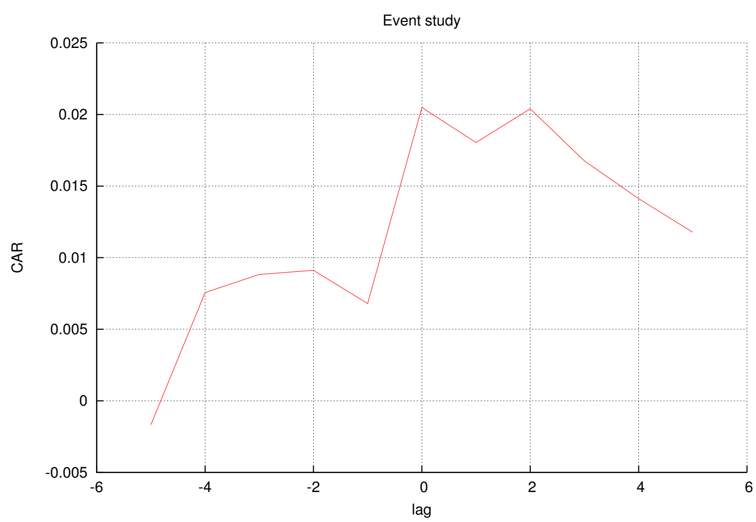


Table IA.XII
Event study

The tables provide further information about the event study illustrated in figure IA.3. In Panel A we test the significance of the CAR's for the event study. The second column lists the average cumulative abnormal return (CAR) for the given lag, where CAR is calculated relative to the market model. Specifically, for each stock i and date t we calculate $AR_t = r_{it} - (\widehat{\alpha}_i + \widehat{\beta}_i(r_{mt} - r_{ft}))$, where AR is the abnormal return, r_{mt} the market return, and $\widehat{\alpha}_i$ and $\widehat{\beta}_i$ the estimated parameters. We use an equally weighted stock market index for the market. For each stock, CAR_i is the sum of abnormal returns, and the table lists the average of CAR_i for each lag. The next two columns provides the two standard tests for significance of the average CAR being different from zero, J_1 and J_2, as exposited in Campbell et al. (1997). These test statistics follow a t-distribution. In Panel B we show results of a regression where the CAR at a 10 day horizon is the dependent variable. In these regressions we look at two explanatory variables: Liquidity, measured by relative spread one year before the DMM initialization, and firm size, proxied by the log of operating income (OI). The regression is specified as $CAR_i = a + b_1 \text{Liquidity}_i + b_2 \ln(OI_i) + \varepsilon_i$. See appendix VI. for detailed definitions of the variables.

Panel A: Significance test of CAR's in event study

lag	$C\bar{A}R$	J_1	J_2
0	0.0205	7.337	8.310
1	0.0180	5.982	6.669
2	0.0204	6.324	6.631
3	0.0168	4.899	4.527
4	0.0141	3.917	3.650
5	0.0118	3.115	2.791

Panel B: Determinants of CAR

	coeff	(serr)	[pvalue]
Constant	-0.1637	(0.1163)	[0.16]
liqudity(rel spread)	1.5662	(0.9221)	[0.09]
ln(operating income)	0.0086	(0.0088)	[0.33]
n	62		
$\bar{R}^2$	0.06		

V. Does hiring a DMM affect the firm's cost of capital?

Let us now look at the second potential channel through which the hiring of a DMM may affect firm value, cost of capital. We do this with an asset pricing approach. We estimate an asset pricing model that also include liquidity risk as a priced risk factor. In this setting we first ask whether the hiring of a DMM affect the loading on the liquidity risk factor, which we confirm. We then use a measure of the (per unit) risk premium associated with liquidity risk to estimate the magnitude of the effect on the cost of capital.

A. Liquidity as a risk factor at the OSE

To investigate liquidity risk we consider the following two-factor asset pricing model,

$$er_{it} = a_i + \beta_i^m er_{mt} + \beta_i^{liq} LIQ_t + e_t \tag{1}$$

where er_{it} is the excess return of stock i on day t. In this formulation the first terms: a_i a constant term, er_{mt}, the excess return on the market on day t, and β_i^m, stock i's loading on the market factor corresponds to the formulation of a standard CAPM single factor model. To measure liquidity risk we use a domestic liquidity factor, constructed in a similar way as the Fama and French size and book/market factors. The liquidity factor (LIQ) is constructed as a difference between the returns of a liquid portfolio (low spread) and a illiquid portfolio (high spread). This particular specification was shown in Næs, Skjeltorp, and Ødegaard (2009) to do a good job in pricing the cross-section of Norwegian stocks. In fact the model using the market and liquidity factor (LIQ) did as well as the the more standard Fama-French three factor model in pricing the Norwegian cross-section. The domestic pricing factors (er_m) and (LIQ) are downloaded from the homepage of Bernt Arne Ødegaard.[2]

For our purposes, the interesting coefficient is β_i^{liq}, stock i's loading on the liquidity risk factor. In general, a large positive β_i^{liq} coefficient means that the stock has high liquidity risk, while a low (or negative) coefficient means that the stock has low liquidity risk. To illustrate the typical values for these loadings, in panel A of table IA.XIII we show results for estimating the factor model (1) for liquidity-sorted portfolios for the whole exchange. Looking the liquidity beta estimates at the right of the table, we see that for these portfolios the liquidity risk loadings (β_i^{liq}) range from -0.63 to $+0.54$.

In addition to coefficients on the LIQ factor, we need to look at the *liquidity risk premium* of the market as a whole. To estimate this we add the cross-sectional pricing restriction (2) to the set of asset by asset equations (1)

$$E[er_i] = \lambda_0 + \lambda_m \beta_i^m + \lambda_{liq} \beta_i^{liq} \tag{2}$$

For a set of assets/portfolios, estimating a system where one imposes both equations (1) and (2) jointly provides an estimate of the (per unit) price of liquidity risk, namely the coefficient λ_{liq}. In panel B of Table IA.XIII we present the risk premia estimates for this two factor model. The estimate of the liquidity risk premium, $\widehat{\lambda}_{liq}$, equals 0.012.

B. Changes in liquidity risk

Let us now turn to investigating what happens as a firm hires a DMM. In our asset pricing setting, if the presence of a DMM reduces the liquidity risk, we would expect the liquidity risk in the stocks of firms

[2] This is a data library similar to that of Ken French, but for the Norwegian Crossection. See the discussion of variables in appendix VI..

Table IA.XIII
Liquidity risk at the Oslo Stock Exchange (1980-2011)

The tables shows results from factor model estimations on ten portfolios sorted by liquidity (relative spread). The estimation uses monthly data for the period 1980-2011. Panel A shows the factor loading estimates from a Black, Jensen, and Scholes (1972) analysis where we estimate the two-factor model

$$er_{it} = a_i + \beta_i^m er_{mt} + \beta_i^{liq} LIQ_t + e_t$$

Panel B shows the factor loading estimates from a GMM analysis where we estimate factor models jointly with a cross-sectional pricing restriction. The first model, the single factor case, is specified as:

$$E[er_{it}] = a_i + \beta_i^m er_{mt}$$

$$E[er_i] = \lambda_0 + \lambda_m \beta_i^m$$

The two factor model is specified as

$$E[er_{it}] = a_i + \beta_i^m er_{mt} + \beta_i^{liq} LIQ_t$$

$$E[er_i] = \lambda_0 + \lambda_m \beta_i^m + \lambda_{liq} \beta_i^{liq}$$

Here er_{it} is the excess return of portfolio i, a_i is a constant term, er_{mt} is the excess return on the market portfolio, β_i^m is portfolio i's loading on the market factor, LIQ_t is the liquidity factor, and β_i^{liq} is portfolio i's loading on the liquidity risk factor. The risk premia are λ_m and λ_{liq}. numbers in parenthesis are p-values associated with the coefficients. The (monthly) factor premia in Panel B are estimated by GMM. Numbers in parenthesis are p-values. The last row reports the χ^2 and the associated p-value from a J-test for over-identifying restrictions for the two factor model. See appendix VI. for detailed definitions of the variables.

Panel A: Market and liquidity risk loadings

	a		er_m		LIQ		R^2	n
1 (low spread)	-0.0003	(0.89)	0.9080	(0.00)	-0.6307	(0.00)	0.77	372
2	-0.0033	(0.04)	1.0040	(0.00)	-0.3412	(0.00)	0.83	372
3	-0.0007	(0.71)	1.0759	(0.00)	-0.2657	(0.00)	0.79	372
4	-0.0017	(0.31)	0.9118	(0.00)	-0.1651	(0.00)	0.76	372
5	-0.0018	(0.36)	0.9899	(0.00)	-0.0344	(0.37)	0.71	372
6	-0.0025	(0.16)	0.9660	(0.00)	0.0296	(0.40)	0.74	372
7	-0.0018	(0.37)	1.0099	(0.00)	0.2359	(0.00)	0.71	372
8	0.0004	(0.84)	1.0032	(0.00)	0.4235	(0.00)	0.68	372
9	0.0049	(0.03)	0.9744	(0.00)	0.4031	(0.00)	0.65	372
10 (high spread)	0.0077	(0.01)	0.9671	(0.00)	0.5379	(0.00)	0.54	372

Panel B: Risk premia estimates

$\lambda_1(er_m)$	0.0066	(0.04)
λ_2(LIQ)	0.0120	(0.00)
J	15.29	(0.64)

that hire a DMM to decrease after the DMM starts market making. If the presence of a DMM reduces the liquidity risk this would result in changes of the estimates of β^{liq}.

Panel A in Table IA.XIV shows the average and median liquidity beta (β^{liq}) estimated using data one year before the firm hires a DMM ("Pre DMM"), and one year after the hiring ("post DMM"). Both the mean and median liquidity beta before the DMM contract is positive and is reduced after the DMM hiring. This drop in liquidity beta is highly significant both with respect to the mean as well as the median. Thus, in support of our conjecture, the stocks of firms that hire a DMM experience a significant reduction in liquidity risk.[3]

To further investigate how the liquidity risk changes, in panel B of Table IA.XIV we split the DMM stocks into 10 portfolios of stocks based on their pre-DMM liquidity beta, with P1 being the portfolio with the lowest pre-DMM liquidity beta and P10 containing stocks with the highest pre-DMM liquidity beta. The table shows that liquidity betas of these portfolios vary in magnitude between -0.43 for P1 to $+1.34$ for P10. After the DMM hire we observe liquidity betas much more similar across portfolios, both with respect to sign and size. Interestingly, we also find that stocks that had the lowest (most negative) pre-DMM liquidity beta (stocks in P1), experience a significant increase in liquidity risk loading. With respect to the portfolios with higher pre-DMM liquidity risk, we see that these stocks generally experience a significant decline in the liquidity risk loading.

To show that the results are robust also for the median firm, Figure IA.4 plots the pre-DMM (grey and white bars) average and median liquidity beta across stock groups and the post-DMM liquidity betas (solid and dotted lines). Overall, there seems to be strong support for the conjecture that hiring a designated market maker with a contractual obligation to keep the spread at or below a maximum level reduces the liquidity risk for these stocks.

C. Liquidity risk premium

Comparing the liquidity risk loadings for all stocks in Panel A of Table IA.XIII with the loadings on the liquidity factor before and after the DMM hiring in Table IA.XIV, we see that the average pre-DMM liquidity beta (0.16) is similar to the loading for stocks in the upper range of liquidity portfolios (portfolios 7 and 8) in Table IA.XIII. However, after the firm has hired the DMM, the liquidity beta becomes negative and closer to what we find for the more liquid stocks on the exchange (portfolios 4 and 5), indicating a reduction in the liquidity risk of these firms. However, looking only at the risk loadings does not let us evaluate the economic significance associated with the reduction in liquidity risk for DMM stocks. To measure this significance we look at the pricing implications of the reduction in liquidity risk.

To get a measure of the economic magnitude of the liquidity effect, we can use the estimated liquidity risk premium $\hat{\lambda}_{liq} = 0.012$ to calculate the annual reduction in expected returns due to the hiring of a DMM. Combining the premium with the reduction of 0.21 in the loading on liquidity risk found in Table IA.XIV, we would calculate the change in required return as $(1+(0.012\cdot 0.21))^{12}-1 \approx 3\%$. In other words, on average the required return for firms that hire a DMM is reduced by about 3% in annualized terms. If we look at the median change, which would be more robust to outliers in our estimates, we would infer the drop in required return to be about 2% per year. This suggest that the hiring of a DMM has a significant impact on the firm's cost of raising equity capital which is large enough to justify the fee that the firm pays to the DMM.

[3] As a robustness check of this result we have also performed the analysis using a Fama/French model augmented with the liquidity risk factor. We find a similar change in liquidity risk in that more comprehensive model.

Table IA.XIV
DMM impact on liquidity risk

Panel A of the table shows the average and median of estimated liquidity beta (β^{liq}) across DMM stocks before (pre) and after (post) the DMM agreement. The liquidity beta is estimated using 1 year of daily data before and after the DMM contract is established using the following regression specification,

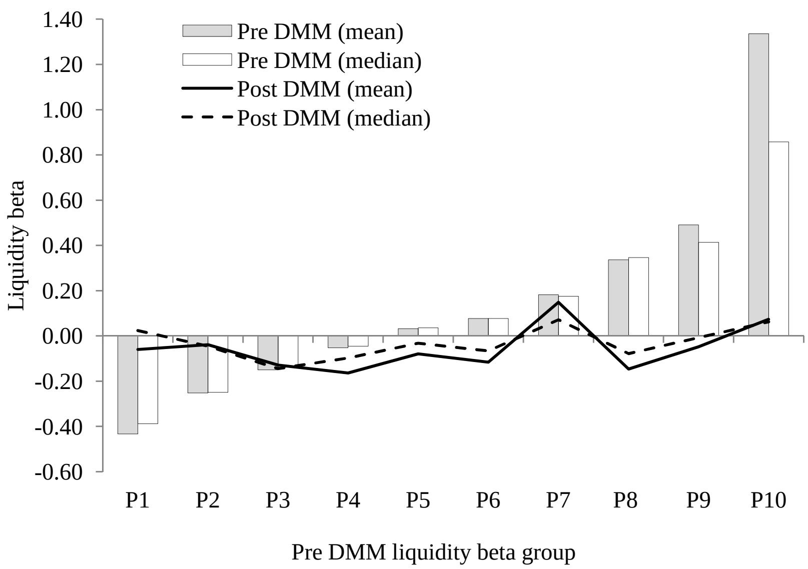
$$er_{it} = a_i + \beta_i^m er_{mt} + \beta_i^{liq} LIQ_t + e_t$$

where er_{it} denotes the excess return on day t for stock i, er_{mt} denotes the excess return on the market, and LIQ is the liquidity risk factor. The difference in liquidity beta is the difference between the post- and pre estimates of β_i^{liq}. The last two columns show the change in β_i^{liq} with the associated p-value from a t-test for the difference being significant. In the second row of Panel A, we report the medians of the distribution of liquidity betas estimated for the pre-DMM and post-DMM periods. We perform a Wilcoxon/Mann-Whitney test for the equality of medians between the pre-DMM and post-DMM distributions. ***, ** and * indicate a significant difference between the post- and pre-DMM liquidity beta at the 1%, 5% and 10% level, respectively. The last column provides the p-values from a test of whether the change in the average (median) liquidity beta is significantly different from zero. Panel B of the table shows the average liquidity beta for 10 subgroups of the sample firms grouped based on their pre-DMM liquidity beta. See appendix VI. for detailed definitions of the variables.

		Liquidity beta (β^{liq})		Test for difference	
	n	Pre DMM	Post DMM	Post-Pre	p-value
Panel A: All stocks					
All stocks, mean	100	0.16	-0.06	-0.21***	0.00
All stocks, median	100	0.06	-0.02	-0.15***	0.00
Panel B: Groups of stocks based on pre-DMM β^{liq}					
P1 (Low β^{liq})	10	-0.43	-0.06	0.37**	0.02
P2	10	-0.25	-0.04	0.21*	0.07
P3	10	-0.15	-0.13	0.02	0.80
P4	10	-0.05	-0.16	-0.11	0.29
P5	10	0.03	-0.08	-0.11**	0.05
P6	10	0.08	-0.12	-0.19***	0.00
P7	10	0.18	0.15	-0.03	0.72
P8	10	0.34	-0.15	-0.48***	0.00
P9	10	0.49	-0.05	-0.54***	0.00
P10 (High β^{liq})	10	1.34	0.07	-1.26***	0.00

Figure IA.4
Pre- versus post-DMM liquidity beta

The figure shows the average and median of estimated liquidity beta before and after the firm having a DMM. We group stocks into ten portfolios based on their pre-DMM liquidity beta. The average pre-DMM betas are shown by the grey bars and the pre-DMM median liquidity betas are the white bars. The lines show the mean (solid) and median (dotted) post-DMM liquidity betas for the same groups of stocks.



D. Redoing the analysis also including Fama French factors

Table IA.XV
DMM impact on liquidity risk - Fama/French factors

Panel A of the table shows the average and median of estimated liquidity beta (β^{liq}) across DMM stocks before (pre) and after (post) the DMM agreement. The liquidity beta is estimated using 1 year of daily data before and after the DMM contract is established using the following Fama-French specification augmented with the liquidity risk factor,

$$er_{it} = a_i + \beta_i^m er_{mt} + \beta_i^{liq} LIQ_t + \beta_i^{smb} SMB_t + \beta_i^{hml} HML_t + e_t$$

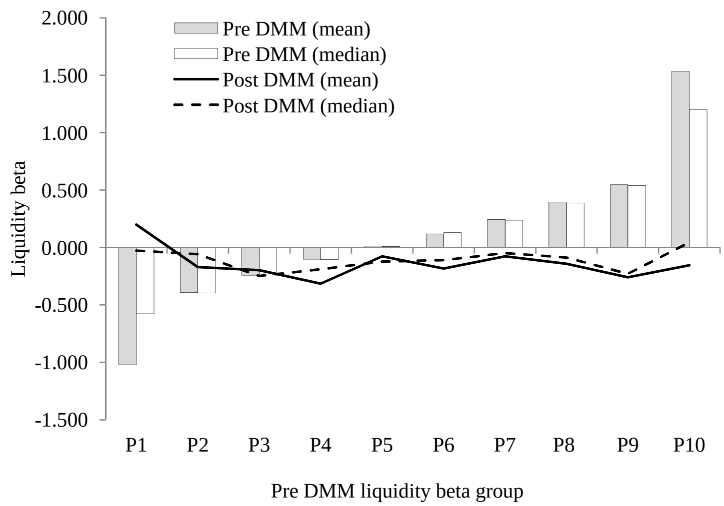
where SMB denotes the size factor and HML denotes the high minus low book-to-market factor. The difference in liquidity beta is the difference between the post- and pre DMM estimates of β_i^{liq}. The last two columns show the change in β_i^{liq} with the associated p-value from a t-test for the difference being significant. In the second row of Panel A, we report the medians of the distribution of liquidity betas estimated for the pre-DMM and post-DMM periods. We perform a Wilcoxon/Mann-Whitney test for the equality of medians between the pre-DMM and post-DMM distributions. *** and ** indicate a significant difference between the post- and pre-DMM liquidity beta at the 1% and 5% level, respectively. The last column provides the p-values from a test of whether the change in the average (median) liquidity beta is significantly different from zero.
Panel B of the table shows the average liquidity beta for subgroups of firms grouped on their pre-DMM liquidity beta.

		Liquidity beta (β^{liq})		t-test for difference	
	n	Pre DMM	Post DMM	Diff.	p-value
Panel A: All stocks					
All stocks, mean	100	0.11	-0.14	-0.25***	0.01
All stocks, median	100	0.05	-0.09	-0.19***	0.00
Panel B: Groups based on pre-DMM β^{liq}					
P1 (Low β^{liq})	10	-1.02	0.20	1.22***	0.01
P2	10	-0.39	-0.17	0.22	0.18
P3	10	-0.24	-0.20	0.04	0.52
P4	10	-0.10	-0.31	-0.21	0.16
P5	10	0.01	-0.08	-0.09	0.31
P6	10	0.12	-0.18	-0.30***	0.01
P7	10	0.24	-0.08	-0.32**	0.05
P8	10	0.40	-0.14	-0.54***	0.00
P9	10	0.55	-0.26	-0.81***	0.00
P10 (High β^{liq})	10	1.54	-0.15	-1.69***	0.00

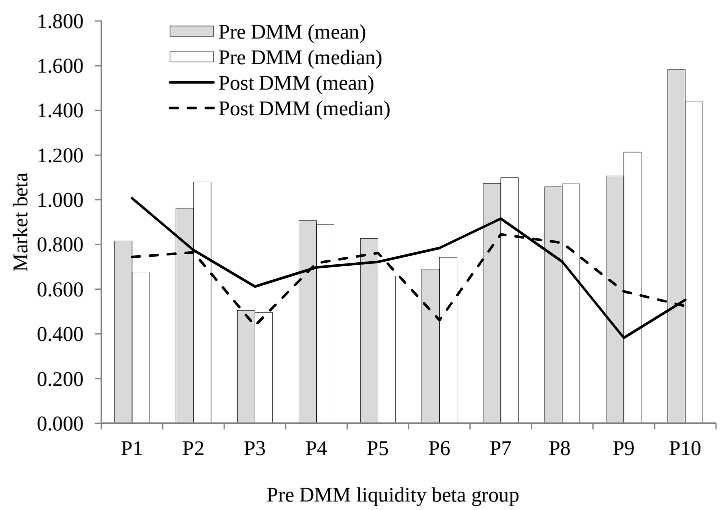
Figure IA.5
Pre- versus post-DMM liquidity beta

The figure shows the average and median of estimated liquidity beta before and after the firm having a DMM. We group stocks into eight portfolios based on their pre-DMM liquidity beta. The average pre-DMM betas are shown by the grey bars and the pre-DMM median liquidity betas are the white bars. The lines show the mean (solid) and median (dotted) post-DMM liquidity betas for the same groups of stocks.

(a) Liquidity factor loading pre-/post DMM



(b) Market factor loading pre-/post DMM



VI. Variable definitions

In this section we provide full definitions and descriptions of the variables employed in the analysis.

- β - Risk measure, sensitivity of asset returns to changes in pervasive risk factor.
  - β_i^m - Sensitivity of stock return to changes in asset returns, coefficient in regression $er_i = \alpha_i + \beta_i^m er_m + \cdots + \varepsilon_i$.
  - β_i^{LIQ} - Sensitivity of stock return to changes in asset returns, coefficient in regression $er_{i,t} = \alpha_i + \cdots + \beta_i^{LIQ} LIQ_t + \cdots + \varepsilon_{it}$.
- λ - Risk measure
  - λ_m - Estimated from crossectional restriction $E[er_i] = \lambda_m \beta_i^m + \cdots$
  - λ_{LIQ} - Estimated from crossectional restriction $E[er_i] = \cdots + \lambda_{LIQ} \beta_i^{LIQ}$
- **Amihud** is the Amihud (2002) illiquidity measure, estimating the *elasticity* of stock prices to volume. It is estimated as
$$Amihud = \frac{Vol}{|r|}$$
- **Equity issue** - Ask whether a company has made a Seasoned Equity Offering, raising new capital, within some given time period.
- $\mathbf{er_m}$ is the excess return on the market portfolio. The returns are available from the homepage of Bernt Arne Ødegaard at `http:///www1.uis.no/ansatt/odegaard`.
- **Firm size** is total value of the firm's assets at year-end.
- **Fraction of year traded** is the fraction of the trading year with trades in the stock. We count the number of days during a year when there was trading in the stock, and measure this relative to the maximal possible days this stock could have traded (If it e.g. was listed during the year, we only count the days the stock potentially could have traded).
- **GICS** - Classification system for industry, see S&P web pages for definitions.
- **Have DMM**. Dummy variable equal to one if a firm has had a DMM at some point during a given calendar year.
- **Hire DMM**. Dummy variable equal to one if a firm hires a DMM during a given calendar year.
- **Inside trades** - Equity trades made by the firm's legal insiders. These insiders include the CEO, members of the firm's top administration and members of the Company's Board. All such trades must be reported to the exchange. All these reports are collected and aggregated to find the trading by the firm's insiders. In some cases we only sum the *sales* by insiders.
- **LIQ** - Asset pricing factor constructed to measure exposure to liquidity risk. The factor is constructed similarly to the Fama and French factors, but as a difference between a high liquidity and a low liquidity portfolio. The factor is downloaded from the data library of Bernt Arne Ødegaard, available from his homepage.

- **Listing Period**. Time a stock has been listed on the Oslo Stock Exchange.
- **LOT** - The Lesmond et al. (1999) estimate of transaction costs. It estimates the implicit transaction cost consistent with the (lack of) price movement in a stock when the market moves. We estimate this using stock returns and an equally weighted market index for the OSE, using asset prices for a given time interval, such as a half year or a year.
- **Operating income** is the accounting income for the company.
- **Q** is an estimate of Tobins' Q, estimated as the market value of the firm's asset over the book value.
- **Relative Spread**: The Relative spread is measured as the difference between the best bid and best offer price, divided by the midpoint price (the average of the bid and offer price). The relative spread is measured every day at the closing of the Oslo Stock Exchange. In the paper we use averages of this spread over varying horizons, such as quarterly, biannually and annually.
- **Repurchase** - Measure repurchase activity during a given period. Two specifications:
  - *Planned Repurchasers* is the fraction of companies that have an active repurchasing plan at yearend,
  - *Actual repurchasers* is the fraction of companies that repurchases stock during the year
- **Sales growth** is the percentage change in the firm's operating income.
- **Size quartile**. We calculate the total value of the firm's equity at yearend. This is used as a ranking measure to group the firm's into four "size quartiles," where quartile 1 contains the smallest firms on the exchange, and quartile 4 the largest firms.
- **Spread**: The spread is measured as the difference between the best bid and best offer price (in Norwegian kroner, NOK) using the closing bid and ask price at the exchange.
- **Turnover** is the average fraction of the firms outstanding stock that is traded over the year. It is calculated as the daily turnover (trading volume/no shares outstanding that day) summed over all trading days of the year.

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