Internet Appendix for
"Does Stock Liquidity Enhance or Impede Firm Innovation?"*

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This appendix provides supplemental analyses and robustness tests to accompany the main article. In Section I we discuss and report robustness tests using alternative measures of stock liquidity. In Section II we discuss and report several additional robustness tests which supplement the tests in the main article. In Section III we show additional decimalization pilot firm robustness results in tables that did not fit in the main article. In Section IV we show the results of supplemental tests of possible mechanisms through which liquidity may impede innovation.

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Section I. Robustness Checks Using Alternative Measures of Stock Liquidity

In this section we check to see if the results shown in Table II of the main article are robust to the use of alternative measures of stock liquidity. We obtain intraday trades and quotes from the *Trade and Quote (TAQ)* database and daily trading information (price and volume) from *CRSP* daily stock files to construct two alternative measures of liquidity: the natural logarithm of the annual relative quoted spread, *RQSPRD*, and the natural logarithm of the annual Amihud (2002) illiquidity measure, *AMIHUD*. Relative quoted spread is the quoted spread standardized by the midpoint of the prevailing bid-ask quote, based on the same sample we use to calculate relative effective spread. The Amihud measure is calculated as the daily price response associated with $1 of trading volume and averaged over fiscal year *t* for firm *i*. To build the sample using the Amihud measure, we require that a stock be listed at the end of its fiscal year *t*, have at least 200 days of return and volume data available in the *CRSP* daily files during fiscal year *t*, and have a price of $5 or more at the end of fiscal year *t*. Both liquidity measures are highly correlated with our main measure of liquidity *ILLIQ*: *RQSPRD* has a 0.99 correlation (both Pearson and Spearman) with *ILLIQ*, and *AMIHUD* has a Pearson (Spearman) correlation of 0.90 (0.91) with *ILLIQ*, all significant at the 1% level.

We report the results using the relative quoted spread measure and the Amihud (2002) illiquidity measure in Tables IA.I and IA.II, respectively. As shown, the coefficient estimates on the relative quoted spread are all positive and significant at the 1% level. For example, the coefficient is 0.130 (p-value < 0.001) in model (1) of Table IA.I Panel A when one-year-ahead *INNOV_PAT* is the dependent variable. Increasing relative quoted spread from its median (0.014) to the 90th percentile (0.060) is associated with a 42.7% increase in the number of patents filed in one year. The coefficient estimates on the Amihud illiquidity measure are also significantly positive.[1] For example, the coefficient is 0.012 (*p*-value = 0.075) in model (1) of Table IA.II Panel A when one-year-ahead *INNOV_PAT* is the dependent variable. Increasing the Amihud illiquidity measure from its median (0.023) to the 90th percentile (0.431) is associated with a 21.3% increase in the number of patents filed in one year. Thus, our results are robust to using both relative quoted spread and the Amihud illiquidity measure.

Microstructure literature posits that the bid-ask spread can be decomposed into inventory holding, order processing, and adverse selection components (e.g., Huang and Stoll (1997)). Of the three components, the adverse selection component captures information asymmetry between informed and uninformed traders. Since both streams of theories underpinning our hypotheses concern information, (i.e., Stein (1988) on information asymmetry and Maug (1998) as well as Edmans (2009) on collection and/or trading of private information), our baseline results should remain robust to using a proxy for the information-related component of the bid-ask spread (i.e., adverse selection component). We repeat equation (1) using Easley, Kiefer, and O'Hara’s (1997) *PIN* (probability of informed trading) measure, a measure used in prior research to capture the degree of information asymmetry among traders in the secondary market.[2] We report the results in Table IA.III. The coefficient estimates on *PIN* are positive and significant at the 1% level in both panels. Increasing *PIN* from its median (0.205) to the 90th percentile (0.328) is associated with approximately a 3.71% increase in the number of patents filed and a 1.99% increase in the number of citations received by each patent in one year.

Section II. Robustness Checks and Various Sub-Samples of Firms

In this section we run several tests to examine if the causal effect of liquidity on innovation is being driven by a particular subsample of firms. First, we examine if the results are being driven by the subsample of firms that have relied on acquisitions to achieve innovation. We begin by identifying firms in our sample that have acquired at least 50% ownership or assets of another firm in a year. We then calculate the aggregate value of all mergers and acquisitions (M&As) undertaken by these firms normalized by their book value of assets at the end of the year, *DEALVAL*, which we set to zero if no majority acquisition is undertaken. In column (1) of Panels A and B in Table IA.IV, we augment equation (1) in the main article by including *DEALVAL*. The coefficient estimates on *ILLIQ* continue to be of the same magnitude as in Table II in the main article and continue to be significant at the 1% level, while the coefficient estimates on *DEALVAL* are positive and statistically insignificant. Increasing the relative effective spread from its median (0.013) to the 90^{th} percentile (0.052) continues to be associated with a 42.3% increase in the number of patents filed in one year and a 31.2% increase in the number of citations received by each patent in one year. Second, instead of controlling for *DEALVAL*, we focus on a subsample of firms that either make no acquisitions or acquire a minor share of target firms (< 50% ownership) in a given year and reestimate equation (1) in the main article. We report the results in column (2) of Panels A and B in Table IA.IV. The coefficient estimates on *ILLIQ* continue to be positive and significant at the 1% level, although the magnitudes of the coefficient estimates decrease marginally from 0.141 to 0.134 in Panel A and from 0.104 to 0.098 in Panel B. Finally, based on the sample used in column (2), we further exclude firm-year observations for which more than 50% of the firm's ownership or assets are acquired by another firm in a given year and reestimate equation (1) in the main article. The results are shown in column (3) of Panels A and B in Table IA.IV. The coefficient estimates on *ILLIQ* continue to be positive and significant at the 1% level, with the magnitudes of the coefficient estimates almost identical to those in column (2). Overall, these tests suggest that while our sample period covers a M&A wave in the 1990s, the findings are not driven by M&As that change the ownership of patenting firms.

Next we partition our sample into size quartiles to see if the results are being driven by small firms that are typically more innovative but usually have low stock liquidity. The coefficient estimates on *ILLIQ* are shown in Panels A and B of Table IA.V and are positive across all four quartiles in all regressions. The negative relation between liquidity and innovation appears to be weakest for the bottom size quartile. For example, increasing relative spread from the sample median (0.013) to the 90th percentile (0.052) is associated with a 47.1% increase in the number of patents filed in one year (significant at 1%) for firms in the largest size quartile and a 0.90% increase in the number of patents filed in one year (insignificant) for firms in the smallest size quartile. The results are very similar if we partition our sample based on firm age, as shown in Table IA.VI. Overall, the subsample tests suggest that the causal relation between liquidity and innovation is not being driven by small, young firms.

To rule out the possibility that our results are driven by a large number of firm-year observations with zero patents and citations, we focus on a subsample of firms that have at least one patent in the pooled sample. In Table IA.VII, we continue to observe positive and significant coefficient estimates on *ILLIQ*.

Lastly, we examine if a particular year or set of years drive the results. To do so, in addition to controlling for year fixed effects, we add interaction terms between *ILLIQ* and year dummies to equation (1) in the main article and report the results in Table IA.VIII. The coefficient estimates on *ILLIQ* are positive and significant, suggesting that the negative relation between liquidity and firm innovation is present in 1994 (the base year). The economic effect of liquidity on innovation is smaller but still economically significant in 1994 (the base year). For example, increasing relative spread from the sample median (0.013) to the 90^{th} percentile (0.052) is associated with a 19.8% increase in the number of patents filed in one year for firms in 1994 and a 19.2% increase in the number of citations received for each patent in one year in 1994. Depending on the specification, the coefficient estimates of the interaction terms become positive and significant as early as 1997 in one specification and as late as 2002 in another specification, suggesting that the negative relation between liquidity and innovation is unchanged (compared to 1994) in earlier years but becomes stronger in later years. One possible explanation for why significance begins appearing in 1997 is that the shift in the minimum tick size in 1997 from the eighth regime to the sixteenth regime enhanced stock liquidity. Also, an interesting observation is that once the interaction term becomes significant, the magnitude of the interaction term increases monotonically suggesting that the negative relation between liquidity and innovation has strengthened as liquidity increased in the past decade.

In summary, in this section we show that the negative relation between stock liquidity and firm innovation is not being driven by firms acquiring or merging with other firms, is not being driven by small cap firms, is not being driven by firms with zero R&D or patents, and is increasing over time.

Section III. Additional Decimalization Pilot Firm Robustness Results

In this section we show we show additional difference-in-difference regression results surrounding the phase-in of decimalization. The treatment firms are NYSE pilot firms and control firms are NYSE nonpilot firms. The results are discussed in Section II of the main article but the tables that did not fit in the main text.

In Table IA.IX Panel A we show the difference-in-difference regression results after dropping pilot firms in the business equipment industry.

In Table IA.IX Panel B we show the difference-in-difference regression results after dropping pilot firms in the bottom decile of our sample based on relative effective spreads.

In Table IA.IX Panel C we show the difference-in-difference regression results after dropping the three automobile manufacturing pilot firms, based on them being identified as potential outliers using Cook's distance.

In Table IA.IX Panel D we show the difference-in-difference regression results after dropping the phase three pilot stocks.

Section IV. Possible Mechanism Supplemental Results

In Table IA.X we compute changes in sensitivity of pay to stock price, scaled wealth-performance sensitivity, and the incidence of proxy fights surrounding decimalization of treatment and control firms. The results are discussed in Section III of the main article but the tables that did not fit in the main text.

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Table IA.I
Robustness Check Using Relative Quoted Spread to Measure Liquidity

Panel A (B) reports pooled regression results of the model $INNOV\_PAT_{i,t+\mathrm{n}}$ ($INNOV\_CITE_{i,t+\mathrm{n}}$) = a + $bRQSPRD_{i,t}$ + $c'CONTROLS_{i,t}$ +YR_t +$FIRM_i$ + $error_{i,t}$. The dependent variable is $INNOV\_PAT_{i,t+1}$ ($INNOV\_CITE_{i,t+1}$) in column (1) and is replaced with $INNOV\_PAT_{i,t+2}$ ($INNOV\_CITE_{i,t+2}$) and $INNOV\_PAT_{i,t+3}$ ($INNOV\_CITE_{i,t+3}$) in columns (2) and (3), respectively. *RQSPRD* is the natural logarithm of relative quoted spread, calculated as the quoted spread standardized by the midpoint of the prevailing bid-ask quote and averaged over fiscal year *t* for firm *i*. Definitions of other variables are listed in Table I Panel A of the main article. Year fixed effects YR_t and firm fixed effects $FIRM_i$ are included in all regressions. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents			
	(1)	(2)	(3)
Dependent Variable	$\mathrm{INNOV\_PAT}_{t+1}$	$\mathrm{INNOV\_PAT}_{t+2}$	$\mathrm{INNOV\_PAT}_{t+3}$
$RQSPRD_t$	0.130^{***}	0.181^{***}	0.208^{***}
	(0.021)	(0.023)	(0.027)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	39,469	33,098	27,363
Adjusted R^2	0.839	0.844	0.849

Panel B: Innovation Measured by Patent Citations			
	(1)	(2)	(3)
Dependent Variable	$\mathrm{INNOV\_CITE}_{t+1}$	$\mathrm{INNOV\_CITE}_{t+2}$	$\mathrm{INNOV\_CITE}_{t+3}$
$RQSPRD_t$	0.105^{***}	0.124^{***}	0.134^{***}
	(0.015)	(0.016)	(0.019)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	39,469	33,098	27,363
Adjusted R^2	0.652	0.653	0.653

Table IA.II
Robustness Check Using Amihud Illiquidity Ratio to Measure Liquidity

Panel A (B) reports pooled regression results of the model $INNOV\_PAT_{i,t+\mathrm{n}}$ ($INNOV\_CITE_{i,t+\mathrm{n}}$) = a + $bAMIHUD_{i,t}$ + $c'CONTROLS_{i,t}$ $+YR_t$ $+FIRM_i$ + $error_{i,t}$. The dependent variable is $INNOV\_PAT_{i,t+1}$ ($INNOV\_CITE_{i,t+1}$) in column (1) and replaced with $INNOV\_PAT_{i,t+2}$ ($INNOV\_CITE_{i,t+2}$) and $INNOV\_PAT_{i,t+3}$ ($INNOV\_CITE_{i,t+3}$) in columns (2) and (3), respectively. *AMIHUD* is the natural logarithm of Amihud (2002) illiquidity ratio, calculated as the daily price response associated with $1 of trading volume and averaged over fiscal year *t* for firm *i*. Definitions of other variables are listed in Table I Panel A of the main article. Year fixed effects YR_t and firm fixed effects $FIRM_i$ are included in all regressions. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents			
	(1)	(2)	(3)
Dependent Variable	$\mathrm{INNOV\_PAT}_{t+1}$	$\mathrm{INNOV\_PAT}_{t+2}$	$\mathrm{INNOV\_PAT}_{t+3}$
$AMIHUD_t$	0.012^{*}	0.026^{***}	0.027^{***}
	(0.006)	(0.008)	(0.009)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	37,421	31,410	25,992
Adjusted R^2	0.842	0.847	0.852

Panel B: Innovation Measured by Patent Citations			
	(1)	(2)	(3)
Dependent Variable	$\mathrm{INNOV\_CITE}_{t+1}$	$\mathrm{INNOV\_CITE}_{t+2}$	$\mathrm{INNOV\_CITE}_{t+3}$
$AMIHUD_t$	0.005	0.014^{**}	0.017^{**}
	(0.006)	(0.007)	(0.007)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	37,421	31,410	25,992
Adjusted R^2	0.653	0.654	0.654

Table IA.III
Robustness Check using PIN to Capture Adverse Selection Component of Liquidity

Panel A (B) reports pooled regression results of the model $INNOV\_PAT_{i,t+n}$ ($INNOV\_CITE_{i,t+n}$) = a + $bPIN_{i,t}$ + $c'CONTROLS_{i,t}$ $+YR_t$ + $FIRM_i$ + $error_{i,t}$. The dependent variable is $INNOV\_PAT_{i,t+1}$ ($INNOV\_CITE_{i,t+1}$) in column (1) and replaced with $INNOV\_PAT_{i,t+2}$ ($INNOV\_CITE_{i,t+2}$) and $INNOV\_PAT_{i,t+3}$ ($INNOV\_CITE_{i,t+3}$) in columns (2) and (3), respectively. *PIN* is the probability of informed trade measure of Easley, Kiefer, and O'Hara (1997), averaged over four quarters of fiscal year *t* for firm *i*. Definitions of other variables are listed in Table I Panel A of the main article. Year fixed effects YR_t and firm fixed effects $FIRM_i$ are included in all regressions. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents			
	(1)	(2)	(3)
Dependent Variable	$INNOV\_PAT_{t+1}$	$INNOV\_PAT_{t+2}$	$INNOV\_PAT_{t+3}$
PIN_t	0.296^{***}	0.547^{***}	0.458^{***}
	(0.082)	(0.096)	(0.106)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	37,929	31,811	26,295
Adjusted R^2	0.840	0.845	0.854

Panel B: Innovation Measured by Patent Citations			
	(1)	(2)	(3)
Dependent Variable	$INNOV\_CITE_{t+1}$	$INNOV\_CITE_{t+2}$	$INNOV\_CITE_{t+3}$
PIN_t	0.160^{**}	0.351^{***}	0.247^{***}
	(0.076)	(0.082)	(0.093)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	37,929	31,811	26,295
Adjusted R^2	0.652	0.654	0.655

Table IA.IV
Robustness Checks Controlling for M&A, Deal Size, or Removing M&A Firms

The dependent variable is $INNOV\_PAT_{i,t+1}$ in all three columns. In column (1), *DEALVAL* is the deal value (in millions) of the M&A deflated by end-of-year book value of assets. *DEALVAL* is included as an additional control variable if there is an acquisition that involves 50% or more in another firm for a firm-year and set to zero otherwise. In column (2), we delete a firm-year if the firm acquires 50% or more in another firm. In column (3), we delete a firm-year if the firm acquires 50% or more in another firm or 50% or more of the firm is acquired by another firm. Definitions of other variables are listed in Table I Panel A of the main article. Year fixed effects YR_t and firm fixed effects $FIRM_i$ are included in all regressions. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents

Dependent Variable	(1) $INNOV\_PAT_{t+1}$	(2) $INNOV\_PAT_{t+1}$	(3) $INNOV\_PAT_{t+1}$
$ILLIQ_t$	0.141***	0.134***	0.133***
	(0.020)	(0.022)	(0.022)
LN_MV_t	0.158***	0.146***	0.146***
	(0.018)	(0.018)	(0.018)
$RDTA_t$	0.278***	0.237**	0.236**
	(0.089)	(0.092)	(0.094)
ROA_t	-0.030	-0.037	-0.038
	(0.068)	(0.070)	(0.070)
$PPETA_t$	0.290***	0.300***	0.294***
	(0.094)	(0.098)	(0.099)
LEV_t	-0.259***	-0.294***	-0.300***
	(0.075)	(0.081)	(0.081)
$CAPEXTA_t$	0.176	0.164	0.169
	(0.119)	(0.125)	(0.125)
$HINDEX_t$	0.107	0.117	0.112
	(0.086)	(0.092)	(0.093)
$HINDEX^2_t$	-0.113	-0.108	-0.104
	(0.150)	(0.155)	(0.156)
Q_t	-0.006	-0.014*	-0.015*
	(0.007)	(0.008)	(0.007)
$KZINDEX_t$	-0.000*	-0.000*	-0.000**
	(0.000)	(0.000)	(0.000)
LN_AGE_t	0.168***	0.155***	0.162***
	(0.035)	(0.035)	(0.036)
$DEALVAL_t$	0.044		
	(0.032)		
INTERCEPT	0.276***	0.315***	0.304***
	(0.106)	(0.109)	(0.110)
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	39,469	32,466	32,349
Adjusted R^2	0.839	0.833	0.833

(*Continued*)

Table IA.IV – *Continued*

Panel B: Innovation Measured by Patent Citations			
Dependent Variable	(1) $INNOV\_CITE_{t+1}$	(2) $INNOV\_CITE_{t+1}$	(3) $INNOV\_CITE_{t+1}$
$ILLIQ_t$	0.104***	0.098***	0.098***
	(0.015)	(0.016)	(0.016)
LN_MV_t	0.060***	0.054***	0.053***
	(0.013)	(0.014)	(0.014)
$RDTA_t$	0.169**	0.115	0.104
	(0.080)	(0.081)	(0.082)
ROA_t	0.137**	0.113*	0.108*
	(0.061)	(0.065)	(0.065)
$PPETA_t$	0.168**	0.100	0.093
	(0.077)	(0.083)	(0.083)
LEV_t	-0.197***	-0.209***	-0.214***
	(0.052)	(0.058)	(0.059)
$CAPEXTA_t$	0.240**	0.295**	0.305**
	(0.113)	(0.118)	(0.119)
$HINDEX_t$	0.129*	0.112	0.106
	(0.077)	(0.081)	(0.081)
$HINDEX^2_t$	-0.167	-0.121	-0.115
	(0.126)	(0.124)	(0.124)
Q_t	0.004	-0.001	-0.001
	(0.006)	(0.006)	(0.006)
$KZINDEX_t$	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
LN_AGE_t	0.091***	0.078***	0.083***
	(0.025)	(0.027)	(0.027)
$DEALVAL_t$	0.006		
	(0.032)		
INTERCEPT	0.662***	0.713***	0.707***
	(0.080)	(0.084)	(0.085)
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	39,469	32,466	32,349
Adjusted R^2	0.652	0.656	0.656

Table IA.V
Robustness Checks Partitioning Sample into Size Quartiles

Panel A (B) reports pooled regression results of the model $INNOV\_PAT_{i,t+\mathrm{n}}$ ($INNOV\_CITE_{i,t+\mathrm{n}}$) = a + b $ILLIQ_{i,t}$ + $c'CONTROLS_{i,t}$ +YR_t +$FIRM_i$ + $error_{i,t}$ for four subsamples, created by partitioning the pooled sample into size quartiles, with quartile 1 indicating the subsample of the smallest firms. Control variables, year fixed effects YR_t, and firm fixed effects $FIRM_i$ are included in all regressions. Definitions of variables are listed in Table I Panel A of the main article. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents

Dependent Variable	$INNOV\_PAT_{t+1}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.003	0.069**	0.128***	0.157**
	(0.026)	(0.031)	(0.042)	(0.075)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	10,525	10,097	9,623	9,224
Adjusted R^2	0.672	0.803	0.830	0.891
Dependent Variable	$INNOV\_PAT_{t+2}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.044*	0.089***	0.155***	0.170*
	(0.024)	(0.033)	(0.047)	(0.087)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	9,023	8,350	7,975	7,750
Adjusted R^2	0.688	0.817	0.843	0.891
Dependent Variable	$INNOV\_PAT_{t+3}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.039	0.078**	0.225***	0.194*
	(0.026)	(0.034)	(0.059)	(0.101)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	7,612	6,811	6,514	6,426
Adjusted R^2	0.713	0.831	0.858	0.892

(*Continued*)

Table IA.V – *Continued*

Panel B: Innovation Measured by Patent Citations				
Dependent Variable	$INNOV\_CITE_{t+1}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.013	0.091***	0.102***	0.050*
	(0.028)	(0.030)	(0.028)	(0.030)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	10,525	10,097	9,623	9,224
Adjusted R^2	0.588	0.694	0.721	0.764
Dependent Variable	$INNOV\_CITE_{t+2}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.042	0.079**	0.114***	0.049**
	(0.030)	(0.031)	(0.033)	(0.019)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	9,023	8,350	7,975	7,750
Adjusted R^2	0.593	0.695	0.727	0.755
Dependent Variable	$INNOV\_CITE_{t+3}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.078**	0.073**	0.093**	0.064***
	(0.033)	(0.035)	(0.039)	(0.022)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	7,612	6,811	6,514	6,426
Adjusted R^2	0.609	0.691	0.739	0.751

Table IA.VI
Robustness Checks Partitioning Sample into Age Quartiles

Panel A (B) reports pooled regression results of the model $INNOV\_PAT_{i,t+\text{n}}$ ($INNOV\_CITE_{i,t+\text{n}}$) = a + b $ILLIQ_{i,t}$ + $c'CONTROLS_{i,t}$ + YR_t + $FIRM_i$ + $error_{i,t}$ for four subsamples, created by partitioning the pooled sample into age quartiles, with quartile 1 indicating the subsample of the youngest firms. Control variables, year fixed effects YR_t, and firm fixed effects $FIRM_i$ are included in all regressions. Definitions of variables are listed in Table I Panel A of the main article. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents				
Dependent Variable	$INNOV\_PAT_{t+1}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.004	0.097***	0.043	0.120**
	(0.035)	(0.035)	(0.038)	(0.050)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	9,086	10,154	9,960	10,269
Adjusted R^2	0.883	0.867	0.850	0.885
Dependent Variable	$INNOV\_PAT_{t+2}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.128***	0.154***	0.069	0.128**
	(0.043)	(0.039)	(0.047)	(0.056)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	7,906	8,206	8,514	8,472
Adjusted R^2	0.878	0.871	0.851	0.885
Dependent Variable	$INNOV\_PAT_{t+3}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.135***	0.178***	0.056	0.208***
	(0.044)	(0.043)	(0.056)	(0.064)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	6,645	6,598	7,166	6,954
Adjusted R^2	0.889	0.884	0.854	0.886

(*Continued*)

Table IA.VI – *Continued*

Panel B: Innovation Measured by Patent Citations				
Dependent Variable	$INNOV\_CITE_{t+1}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.018	0.086***	0.020	0.082**
	(0.034)	(0.028)	(0.029)	(0.033)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	9,086	10,154	9,960	10,269
Adjusted R^2	0.769	0.723	0.665	0.721
Dependent Variable	$INNOV\_CITE_{t+2}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.065*	0.093***	0.061*	0.077**
	(0.038)	(0.030)	(0.033)	(0.038)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	7,906	8,206	8,514	8,472
Adjusted R^2	0.761	0.731	0.676	0.718
Dependent Variable	$INNOV\_CITE_{t+3}$			
	(1) Quartile 1	(2) Quartile 2	(3) Quartile 3	(4) Quartile 4
$ILLIQ_t$	0.103***	0.107***	0.042	0.099**
	(0.039)	(0.037)	(0.036)	(0.046)
Control Variables	*Included*	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*	*Included*
Number of Obs. Used	6,645	6,598	7,166	6,954
Adjusted R^2	0.761	0.737	0.675	0.719

Table IA.VII
Robustness Check Restricting the Sample to Firms with At Least One Patent

Panel A (B) reports pooled regression results of the model $INNOV\_PAT_{i,t+n}$ ($INNOV\_CITE_{i,t+n}$) = a + $bRQSPRD_{i,t}$ + $c'CONTROLS_{i,t}$ $+YR_t$ $+FIRM_i$ + $error_{i,t}$. The dependent variable is $INNOV\_PAT_{i,t+1}$ ($INNOV\_CITE_{i,t+1}$) in column (1) and is replaced with $INNOV\_PAT_{i,t+2}$ ($INNOV\_CITE_{i,t+2}$) and $INNOV\_PAT_{i,t+3}$ ($INNOV\_CITE_{i,t+3}$) in columns (2) and (3), respectively. We restrict the sample to firms with at least one patent in year 1. Definitions of other variables are listed in Table I Panel A of the main article. Year fixed effects YR_t and firm fixed effects $FIRM_i$ are included in all regressions. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents

Dependent Variable	(1) INNOV_PAT$_{t+1}$	(2) INNOV_PAT$_{t+2}$	(3) INNOV_PAT$_{t+3}$
ILLIQ$_t$	0.251***	0.306***	0.323***
	(0.087)	(0.099)	(0.108)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	8,734	8,215	7,335
Adjusted R^2	0.401	0.388	0.402

Panel B: Innovation Measured by Patent Citations

Dependent Variable	(1) INNOV_CITE$_{t+1}$	(2) INNOV_CITE$_{t+2}$	(3) INNOV_CITE$_{t+3}$
ILLIQ$_t$	0.072**	0.064*	0.073*
	(0.029)	(0.036)	(0.039)
Control Variables	*Included*	*Included*	*Included*
Year and Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	8,734	8,215	7,335
Adjusted R^2	0.292	0.306	0.353

Table IA.VIII
Robustness Checks Interacting Liquidity with Time Effects

Panel A (B) report pooled regression results of the model $INNOV\_PAT_{i,t+\mathrm{n}}$ = a + b $ILLIQ_{i,t}$ + $c'CONTROLS_{i,t}$ $+YR_t$ + $ILLIQ_{i,t}{\times}YR_t$ $+FIRM_i$ + $error_{i,t}$. The dependent variable is $INNOV\_PAT_{i,t+1}$ ($INNOV\_CITE_{i,t+1}$) in column (1) and replaced with $INNOV\_PAT_{i,t+2}$ ($INNOV\_CITE_{i,t+2}$) and $INNOV\_PAT_{i,t+3}$ ($INNOV\_CITE_{i,t+3}$) in columns (2) and (3), respectively. Definitions of variables are listed in Table I Panel A of the main article. Firm fixed effects, $FIRM_{i,}$ are included in all regressions. Coefficient estimates are shown, and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Innovation Measured by Patents			
	(1)	(2)	(3)
Dependent Variable	$\mathrm{INNOV\_PAT}_{t+1}$	$\mathrm{INNOV\_PAT}_{t+2}$	$\mathrm{INNOV\_PAT}_{t+3}$
$ILLIQ_t$	0.066^{**}	0.066^{**}	0.078^{**}
	(0.031)	(0.033)	(0.034)
$ILLIQ_t{\times}YR\_1995$	0.014	-0.010	-0.028^{**}
	(0.014)	(0.016)	(0.014)
$ILLIQ_t{\times}YR\_1996$	-0.005	-0.052^{***}	0.004
	(0.017)	(0.018)	(0.019)
$ILLIQ_t{\times}YR\_1997$	-0.058^{***}	-0.013	0.039
	(0.019)	(0.023)	(0.024)
$ILLIQ_t{\times}YR\_1998$	-0.010	0.020	0.046^{*}
	(0.023)	(0.027)	(0.026)
$ILLIQ_t{\times}YR\_1999$	0.007	0.021	0.064^{**}
	(0.026)	(0.028)	(0.028)
$ILLIQ_t{\times}YR\_2000$	-0.005	0.029	0.107^{***}
	(0.027)	(0.030)	(0.030)
$ILLIQ_t{\times}YR\_2001$	0.005	0.062^{**}	0.246^{***}
	(0.029)	(0.031)	(0.034)
$ILLIQ_t{\times}YR\_2002$	0.055^{**}	0.179^{***}	0.387^{***}
	(0.028)	(0.032)	(0.035)
$ILLIQ_t{\times}YR\_2003$	0.152^{***}	0.312^{***}	0.654^{***}
	(0.029)	(0.033)	(0.070)
$ILLIQ_t{\times}YR\_2004$	0.288^{***}	0.551^{***}	
	(0.031)	(0.064)	
$ILLIQ_t{\times}YR\_2005$	0.541^{***}		
	(0.060)		
LN_MV_t	0.106^{***}	0.057^{***}	0.025
	(0.018)	(0.019)	(0.021)
$RDTA_t$	0.280^{***}	0.237^{**}	0.191^{**}
	(0.090)	(0.096)	(0.095)
ROA_t	-0.123^{*}	0.112^{*}	0.245^{***}
	(0.068)	(0.068)	(0.078)
$PPETA_t$	0.277^{***}	0.310^{***}	0.386^{***}
	(0.092)	(0.106)	(0.126)

LEV_t	-0.202***	-0.281***	-0.372***
	(0.073)	(0.083)	(0.090)
$CAPEXTA_t$	-0.014	0.170	0.018
	(0.119)	(0.134)	(0.146)
$HINDEX_t$	0.108	0.111	0.153
	(0.086)	(0.098)	(0.106)
$HINDEX^2_t$	-0.116	-0.077	-0.202
	(0.149)	(0.165)	(0.176)
Q_t	-0.008	0.008	-0.005
	(0.007)	(0.008)	(0.008)
$KZINDEX_t$	-0.000**	-0.000	0.000
	(0.000)	(0.000)	(0.000)
LN_AGE_t	0.068**	0.053	0.032
	(0.031)	(0.034)	(0.037)
YR_1995	0.127**	-0.115*	-0.044
	(0.056)	(0.066)	(0.061)
YR_1996	-0.040	-0.234***	0.012
	(0.067)	(0.073)	(0.079)
YR_1997	-0.205***	-0.129	0.147
	(0.075)	(0.092)	(0.096)
YR_1998	-0.062	-0.016	0.119
	(0.090)	(0.106)	(0.103)
YR_1999	-0.001	-0.051	0.131
	(0.103)	(0.111)	(0.111)
YR_2000	-0.115	-0.098	0.170
	(0.109)	(0.119)	(0.120)
YR_2001	-0.105	-0.068	0.573***
	(0.114)	(0.123)	(0.133)
YR_2002	-0.047	0.238*	0.995***
	(0.112)	(0.127)	(0.140)
YR_2003	0.201*	0.639***	1.952***
	(0.117)	(0.133)	(0.277)
YR_2004	0.590***	1.458***	
	(0.126)	(0.260)	
YR_2005	1.629***		
	(0.259)		
INTERCEPT	-0.081	0.269*	0.439***
	(0.133)	(0.148)	(0.153)
Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	39,469	33,098	27,363
Adjusted R^2	0.843	0.848	0.855

(*Continued*)

Table IA.VIII – *Continued*

Panel B: Innovation Measured by Patent Citations			
Dependent Variables	(1) $INNOV\_CITE_{t+1}$	(2) $INNOV\_CITE_{t+2}$	(3) $INNOV\_CITE_{t+3}$
$ILLIQ_t$	0.064***	0.054**	0.052*
	(0.023)	(0.025)	(0.027)
$ILLIQ_t \times YR\_1995$	0.018	-0.009	0.010
	(0.016)	(0.017)	(0.017)
$ILLIQ_t \times YR\_1996$	0.006	0.001	0.022
	(0.017)	(0.018)	(0.018)
$ILLIQ_t \times YR\_1997$	0.004	0.031	0.053***
	(0.018)	(0.019)	(0.020)
$ILLIQ_t \times YR\_1998$	0.038**	0.050**	0.066***
	(0.018)	(0.020)	(0.020)
$ILLIQ_t \times YR\_1999$	0.051***	0.059***	0.086***
	(0.020)	(0.020)	(0.022)
$ILLIQ_t \times YR\_2000$	0.057***	0.088***	0.133***
	(0.020)	(0.022)	(0.023)
$ILLIQ_t \times YR\_2001$	0.097***	0.121***	0.210***
	(0.021)	(0.023)	(0.024)
$ILLIQ_t \times YR\_2002$	0.123***	0.167***	0.249***
	(0.021)	(0.023)	(0.024)
$ILLIQ_t \times YR\_2003$	0.161***	0.211***	0.298***
	(0.021)	(0.023)	(0.033)
$ILLIQ_t \times YR\_2004$	0.212***	0.268***	
	(0.022)	(0.032)	
$ILLIQ_t \times YR\_2005$	0.287***		
	(0.031)		
LN_MV_t	0.036***	0.006	-0.005
	(0.013)	(0.014)	(0.016)
$RDTA_t$	0.169**	0.139	0.182*
	(0.080)	(0.092)	(0.101)
ROA_t	0.074	0.218***	0.160**
	(0.061)	(0.063)	(0.073)
$PPETA_t$	0.136*	0.093	0.091
	(0.076)	(0.086)	(0.093)
LEV_t	-0.152***	-0.211***	-0.252***
	(0.051)	(0.059)	(0.063)
$CAPEXTA_t$	0.125	0.136	0.167
	(0.112)	(0.120)	(0.126)
$HINDEX_t$	0.136*	0.113	0.107
	(0.077)	(0.082)	(0.086)
$HINDEX^2_t$	-0.179	-0.046	-0.103
	(0.124)	(0.130)	(0.135)
Q_t	0.003	0.005	0.002

	(0.006)	(0.006)	(0.006)
KZINDEX$_t$	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
LN_AGE$_t$	0.008	-0.034	-0.031
	(0.025)	(0.028)	(0.031)
YR_1995	0.092	-0.088	0.065
	(0.072)	(0.077)	(0.076)
YR_1996	-0.005	-0.016	0.058
	(0.076)	(0.079)	(0.082)
YR_1997	0.009	0.059	0.143
	(0.079)	(0.086)	(0.089)
YR_1998	0.091	0.087	0.108
	(0.083)	(0.093)	(0.092)
YR_1999	0.096	0.035	0.074
	(0.089)	(0.092)	(0.097)
YR_2000	0.030	0.041	0.143
	(0.090)	(0.098)	(0.099)
YR_2001	0.098	0.060	0.350***
	(0.092)	(0.100)	(0.105)
YR_2002	0.083	0.148	0.436***
	(0.092)	(0.103)	(0.108)
YR_2003	0.134	0.251**	0.545***
	(0.095)	(0.106)	(0.145)
YR_2004	0.258**	0.382***	
	(0.101)	(0.148)	
YR_2005	0.525***		
	(0.145)		
INTERCEPT	0.273***	0.604***	0.656***
	(0.101)	(0.110)	(0.118)
Firm Fixed Effects	*Included*	*Included*	*Included*
Number of Obs. Used	39,469	33,098	27,363
Adjusted R^2	0.656	0.657	0.659

Table IA.IX
Difference-in-Differences Analysis Comparing Pilot and Nonpilot Stocks Dropping Outliers

This table reports the pooled regression results of the model $INNOV\_PAT_{i,t+1}(INNOV\_CITE_{i,t+1}) = a + bPILOT_i \times YR\_2000 + cPILOT_i + dYR\_2000 + e'CONTROLS_{i,t} + IND_j + error_{i,}$. *PILOT* is a dummy variable equal to one if a firm's stock is in NYSE's decimalization pilot program and zero otherwise. *YR_2000* is a dummy variable equal to one for year 2000 and zero for year 1999. *PILOT× YR_2000* is an interaction term between these two variables. Definitions of all other variables are listed in Table 1 Panel A of the main article. Fama-French 12 industry fixed effects are included in all regressions but the coefficients are not reported. Coefficient estimates are shown in bold and their standard errors are clustered by firm and displayed in parentheses below. *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

Panel A: Dropping Pilot Firms in the Business Equipment Industry		
	(1)	(2)
Dependent Variables	$INNOV\_PAT_{t+1}$	$INNOV\_CITE_{t+1}$
$PILOT_i \times YR\_2000$	-0.407*	-0.288*
	(0.236)	(0.173)
$PILOT_i$	0.295	0.321*
	(0.320)	(0.176)
YR_2000	-0.152	0.087
	(0.170)	(0.097)
Control Variables	*Included*	*Included*
Industry Fixed Effects	*Included*	*Included*
Number of Obs. Used	2,144	2,144
Adjusted R^2	0.442	0.477
Panel B: Dropping Pilot Firms with Relative Effective Spreads in Bottom Decile		
	(1)	(2)
Dependent Variables	$INNOV\_PAT_{t+1}$	$INNOV\_CITE_{t+1}$
$PILOT_i \times YR\_2000$	-0.408*	-0.274
	(0.209)	(0.179)
$PILOT_i$	0.020	0.265
	(0.198)	(0.182)
YR_2000	-0.006	0.093
	(0.165)	(0.097)
Control Variables	*Included*	*Included*
Industry Fixed Effects	*Included*	*Included*
Number of Obs. Used	2,146	2,146
Adjusted R^2	0.544	0.475

(*Continued*)

Table IA.IX – *Continued*

Panel C: Dropping Three Auto Manufacturing Pilot Firms as Potential Outliers Using Cook's Distance		
Dependent Variables	(1) $INNOV\_PAT_{t+1}$	(2) $INNOV\_CITE_{t+1}$
$PILOT_i \times YR\_2000$	-0.330*	-0.248
	(0.197)	(0.166)
$PILOT_i$	0.118	0.268
	(0.220)	(0.170)
YR_2000	0.024	0.109
	(0.163)	(0.096)
Control Variables	*Included*	*Included*
Industry Fixed Effects	*Included*	*Included*
Number of Obs. Used	2,154	2,154
Adjusted R^2	0.550	0.481

Panel D: Dropping Phase Three Pilot Stocks		
Dependent Variables	(1) $INNOV\_PAT_{t+1}$	(2) $INNOV\_CITE_{t+1}$
$PILOT_i \times YR\_2000$	-0.702*	-0.526**
	(0.365)	(0.248)
$PILOT_i$	0.669	0.495*
	(0.481)	(0.275)
YR_2000	-0.022	0.100
	(0.169)	(0.099)
Control Variables	*Included*	*Included*
Industry Fixed Effects	*Included*	*Included*
Number of Obs. Used	2,086	2,086
Adjusted R^2	0.558	0.482

Table IA.X
Difference-in-Differences Analysis Using PPS, WPS, and Probability of Proxy Fights

This table reports DiD tests examining how the sensitivity of pay to stock price (*PPS*) measure of Core and Guay (2002), the scaled wealth-performance sensitivity (*WPS*) measure of Edmans, Gabaix, and Landier (2009), and the incidence of proxy fights (*PF*) of Fos (2011) change surrounding decimalization. Firms are sorted into terciles based on their change in the annual relative effective spread from the pre-decimalization year to the post-decimalization year. The top (bottom) tercile is the treatment (control) group. We match firms using one-to-one nearest neighbor propensity score matching, without replacement. We then merge treatment and control firms with *PPS*, *WPS*, and *PF* whenever data is available. In all panels *** (**) (*) indicates significance at the 1% (5%) (10%) two-tailed level.

	Mean Treatment Difference (after - before)	Mean Control Difference (after - before)	Mean DiD Estimator (treat - control)	*t*-statistic for DiD Estimator
PPS	-19.33	1.195	-20.53	-1.514
	(9.875)	(7.963)	(13.56)	
WPS	-27.00	4.906	-31.90	-1.007
	(35.93)	(10.70)	(31.69)	
PF	0.002	-0.003	0.005	1.300
	(0.002)	(0.003)	(0.004)	

[1] One exception is that when one-year-ahead *INNOV_CITE* is the dependent variable, the coefficient estimate on the annual Amihud illiquidity measure is positive but not statistically significant.

[2] Huang and Stoll (1997) conclude "The spread components differ significantly according to trade size and are also sensitive to assumptions about the relation between orders and trades." Lacking consensus in the methodologies to compute the components of the bid-ask spread, we rely on *PIN* to capture information asymmetry rather than decomposing the spread.