

## Internet Appendix for RQ Innovative Efficiency and Firm Value

### Appendix D: Robustness Tables

**Table D.1 2SLS using Industry Median of RQ**

This table reports two-stage, least squared regression results using the industry median of RQ (excluding a firm's own RQ) as the instrumental variable. The sample period is from 1981 to 2015. Column (1) and (2) repeat the OLS regressions that regress Market-to-Book ratio on RQ from table 3 and 4. Column (3) is the first-stage regression. Column (4) and (5) are the second-stage regression. Standard errors are clustered at the firm level. In all models, we include industry- (Fama-French 48) and year-fixed effects. Detailed variable definitions can found in Appendix B.

|                   | OLS Regressions     |                         | 2SLS                 |                     |                         |
|-------------------|---------------------|-------------------------|----------------------|---------------------|-------------------------|
|                   | 1                   | 2                       | 1st Stage            | 2nd Stage           | 2nd Stage               |
| Dep. Var.         | $\ln(\text{MTB}_t)$ | $\ln(\text{MTB}_{t+1})$ | $\text{RQ}_t$        | $\ln(\text{MTB}_t)$ | $\ln(\text{MTB}_{t+1})$ |
| RQ                | 0.764***<br>(7.398) | 0.764***<br>(6.987)     |                      | 1.291***<br>(2.824) | 1.075**<br>(2.198)      |
| RQ_MEDIAN         |                     |                         | 0.751***<br>(15.090) |                     |                         |
| ABNORMAL_EARNINGS | -0.005***           | -0.001                  | -0.000               | -0.005***           | -0.001*                 |

|                               |           |           |                |           |           |
|-------------------------------|-----------|-----------|----------------|-----------|-----------|
|                               | (-4.018)  | (-1.620)  | (-1.058)       | (-4.092)  | (-1.664)  |
| ADVERTISING/ME                | -2.093*** | -1.357*** | 0.023          | -2.075*** | -1.366*** |
|                               | (-8.658)  | (-5.853)  | (1.255)        | (-8.065)  | (-5.318)  |
| R&D_TAX_SHIELD                | 0.005***  | 0.001     | 0.000          | 0.005***  | 0.001     |
|                               | (3.464)   | (1.416)   | (1.239)        | (3.464)   | (1.122)   |
| ln(1+CAPEX/ASSETS)            | 1.341***  | 0.893***  | -0.104***      | 0.229     | -0.098    |
|                               | (5.842)   | (3.854)   | (-4.190)       | (0.932)   | (-0.388)  |
| RD/BE                         | 0.005***  | 0.002**   | 0.000          | 0.006**   | 0.002**   |
|                               | (2.594)   | (2.12)    | (1.056)        | (2.550)   | (2.084)   |
| ln(ME)                        | 0.145***  | 0.109***  | 0.002***       | 0.139***  | 0.108***  |
|                               | (29.307)  | (21.685)  | (4.509)        | (26.134)  | (19.320)  |
| Constant                      | -0.169*** | 0.043     | 0.036***       | -0.160**  | 0.043     |
|                               | (-4.945)  | (1.207)   | (5.377)        | (-2.216)  | (0.554)   |
| Cragg-Donald Wald F statistic |           |           | <b>1065.87</b> |           |           |
| Observations                  | 30,316    | 27,286    | 30,223         | 30,165    | 26,666    |
| Adj. R-sqr                    | 0.274     | 0.191     | 0.034          | 0.180     | 0.105     |

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**Table D.2. Fama-MacBeth Regression Version of Table 3**

This table reports Fama-MacBeth regressions of contemporaneous MTB on Research Quotient (RQ), Innovation Efficiency based on patents (IE\_PATENTS), and Innovation Efficiency based on citations (IE\_CITATIONS), patent measures (ln(1+PAT) and ln(1+CIT/PAT)), and control variables. The sample period is from 1982 to 2015 for model (1) and 1982 to 2006 for all other models due to data availability of the patent-based measures. All independent variables are contemporaneous to MTB. T-statistics are reported in parenthesis. Standard errors are estimated using Newey-West method with 3 lags. Detailed variable definitions can be found in Appendix B.

|                   | 1       | 2        | 3         | 4         | 5         | 6         | 7        | 8        | 9         | 10        | 11        | 12        |
|-------------------|---------|----------|-----------|-----------|-----------|-----------|----------|----------|-----------|-----------|-----------|-----------|
|                   | 0.905** |          |           |           |           |           |          |          |           |           |           |           |
| RQ                | *       | 0.916*** |           |           |           |           | 0.919*** | 0.921*** | 0.938***  | 0.934***  | 0.954***  | 0.946***  |
|                   | (4.092) | (3.048)  |           |           |           |           | (3.070)  | (3.061)  | (3.166)   | (3.036)   | (3.273)   | (3.089)   |
| IE_PATENTS        |         |          | 0.155***  |           |           |           | 0.008    |          |           |           | 0.099***  | -0.014    |
|                   |         |          | (3.639)   |           |           |           | (0.270)  |          |           |           | (2.856)   | (-0.377)  |
| IE_CITATIONS      |         |          |           | 0.141***  |           |           |          | 0.092*** |           |           | 0.185***  | 0.155***  |
|                   |         |          |           | (3.129)   |           |           |          | (4.229)  |           |           | (8.532)   | (6.782)   |
| ln(1+PAT)         |         |          |           |           | -0.066*** |           |          |          | -0.132*** |           | -0.151*** |           |
|                   |         |          |           |           | (-3.419)  |           |          |          | (-14.129) |           | (-15.975) |           |
| ln(1+CIT/PAT)     |         |          |           |           |           | -0.008    |          |          |           | -0.056*** |           | -0.066*** |
|                   |         |          |           |           |           | (-0.520)  |          |          |           | (-6.902)  |           | (-7.554)  |
| ABNORMAL_EARNINGS | 0.015   | 0.017    | -0.009*** | -0.009*** | -0.009*** | -0.009*** | 0.017    | 0.017    | 0.016     | 0.017     | 0.017     | 0.017     |
|                   | (1.275) | (1.080)  | (-3.119)  | (-3.117)  | (-3.101)  | (-3.121)  | (1.082)  | (1.102)  | (1.059)   | (1.084)   | (1.092)   | (1.099)   |

|                    |          |           |           |           |           |           |           |           |           |           |           |           |
|--------------------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                    | -        |           |           |           |           |           |           |           |           |           |           |           |
|                    | 1.870**  |           |           |           |           |           |           |           |           |           |           |           |
| ADVERTISING/ME     | *        | -2.184*** | -1.613*** | -1.608*** | -1.614*** | -1.619*** | -2.184*** | -2.166*** | -2.065*** | -2.176*** | -1.996*** | -2.135*** |
|                    | (-5.413) | (-5.470)  | (-11.608) | (-11.769) | (-11.431) | (-11.483) | (-5.468)  | (-5.497)  | (-5.490)  | (-5.540)  | (-5.475)  | (-5.589)  |
| R&D_TAX_SHIELD     |          | -0.002    | 0.002     | 0.024     | 0.024     | 0.026     | 0.024     | 0.002     | 0.002     | 0.004     | 0.003     | 0.004     |
|                    | (-0.175) | (0.115)   | (1.634)   | (1.637)   | (1.652)   | (1.621)   | (0.128)   | (0.107)   | (0.230)   | (0.176)   | (0.204)   | (0.176)   |
|                    | 0.868**  |           |           |           |           |           |           |           |           |           |           |           |
| ln(1+CAPEX/ASSETS) | *        | 1.019***  | 0.794***  | 0.797***  | 0.735***  | 0.777***  | 1.010***  | 0.975***  | 1.121***  | 1.082***  | 1.019***  | 1.021***  |
|                    | (3.716)  | (4.134)   | (5.444)   | (5.449)   | (5.341)   | (5.659)   | (4.151)   | (3.946)   | (5.222)   | (4.649)   | (4.666)   | (4.353)   |
|                    | 0.491**  |           |           |           |           |           |           |           |           |           |           |           |
| RD/BE              | *        | 0.544***  | 0.287***  | 0.287***  | 0.292***  | 0.288***  | 0.545***  | 0.545***  | 0.563***  | 0.550***  | 0.570***  | 0.552***  |
|                    | (5.431)  | (4.591)   | (5.922)   | (5.934)   | (5.854)   | (5.849)   | (4.591)   | (4.605)   | (4.416)   | (4.511)   | (4.415)   | (4.525)   |
|                    | 0.125**  |           |           |           |           |           |           |           |           |           |           |           |
| ln(ME)             | *        | 0.116***  | 0.118***  | 0.117***  | 0.130***  | 0.119***  | 0.116***  | 0.116***  | 0.171***  | 0.129***  | 0.179***  | 0.131***  |
|                    | (8.443)  | (5.958)   | (6.570)   | (6.580)   | (8.854)   | (7.410)   | (5.971)   | (5.965)   | (8.174)   | (6.480)   | (8.635)   | (6.617)   |
|                    | -        |           |           |           |           |           |           |           |           |           |           |           |
|                    | 0.210**  |           |           |           |           |           |           |           |           |           |           |           |
| Constant           | *        | -0.169    | 0.004     | 0.003     | -0.013    | 0.012     | -0.171    | -0.182*   | -0.324*** | -0.184*   | -0.386*** | -0.208*   |
|                    | (-2.757) | (-1.683)  | (0.043)   | (0.035)   | (-0.151)  | (0.131)   | (-1.697)  | (-1.813)  | (-3.044)  | (-1.799)  | (-3.608)  | (-2.026)  |
| Obs.               | 35,707   | 26,546    | 97,441    | 97,441    | 97,441    | 97,441    | 26,546    | 26,546    | 26,546    | 26,546    | 26,546    | 26,546    |
| Adj. Rsq           | 0.274    | 0.269     | 0.186     | 0.187     | 0.190     | 0.186     | 0.270     | 0.271     | 0.298     | 0.275     | 0.307     | 0.280     |

**Table D.3. Fama-MacBeth Regression Version of Table 4**

This table reports Fama-MacBeth regressions of MTB on the one-year lagged Research Quotient (RQ), Innovation Efficiency based on patents (IE\_PATENTS), and Innovation Efficiency based on citations (IE\_CITATIONS), patent measures (ln(1+PAT) and ln(1+CIT/PAT)), and control variables. The sample period is from 1982 to 2015 for model (1) and 1982 to 2006 for all other models due to data availability of the patent-based measures. All independent variables are lagged one year to MTB. T-statistics are reported in parenthesis. Standard errors are estimated using Newey-West method with 3 lags. Detailed variable definitions can be found in Appendix B.

|                   | 1                     | 2                     | 3                     | 4                     | 5                     | 6                     | 7                     | 8                     | 9                     | 10                    | 11                    | 12                    |
|-------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| RQ                | 0.987***<br>(4.709)   | 1.015***<br>(3.680)   |                       |                       |                       |                       | 1.019***<br>(3.705)   | 1.018***<br>(3.702)   | 1.030***<br>(3.751)   | 1.024***<br>(3.641)   | 1.046***<br>(3.882)   | 1.036***<br>(3.718)   |
| IE_PATENTS        |                       |                       | 0.201***<br>(4.271)   |                       |                       |                       | 0.015<br>(0.447)      |                       |                       |                       | 0.077*<br>(1.931)     | -0.003<br>(-0.066)    |
| IE_CITATIONS      |                       |                       |                       | 0.158***<br>(3.462)   |                       |                       |                       | 0.060**<br>(2.599)    |                       |                       | 0.117***<br>(5.339)   | 0.091***<br>(3.910)   |
| ln(1+PAT)         |                       |                       |                       |                       | -0.010<br>(-0.470)    |                       |                       |                       | -0.088***<br>(-8.863) |                       | -0.103***<br>(-9.429) |                       |
| ln(1+CIT/PAT)     |                       |                       |                       |                       |                       | 0.025<br>(1.391)      |                       |                       |                       | -0.032***<br>(-4.027) |                       | -0.039***<br>(-4.672) |
| ABNORMAL_EARNINGS | 0.015<br>(1.395)      | 0.020<br>(1.485)      | -0.004**<br>(-2.229)  | -0.004**<br>(-2.216)  | -0.004**<br>(-2.215)  | -0.004**<br>(-2.204)  | 0.020<br>(1.488)      | 0.020<br>(1.534)      | 0.020<br>(1.479)      | 0.020<br>(1.501)      | 0.020<br>(1.536)      | 0.020<br>(1.540)      |
| ADVERTISING/ME    | -1.174***<br>(-3.650) | -1.521***<br>(-4.173) | -1.390***<br>(-5.948) | -1.386***<br>(-5.973) | -1.397***<br>(-5.890) | -1.391***<br>(-5.856) | -1.522***<br>(-4.174) | -1.508***<br>(-4.192) | -1.436***<br>(-4.147) | -1.511***<br>(-4.202) | -1.383***<br>(-4.105) | -1.482***<br>(-4.209) |

|                    |          |          |          |          |          |          |          |          |          |          |          |          |
|--------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| R&D_TAX_SHIELD     | -0.022   | -0.014   | -0.000   | -0.000   | -0.000   | -0.001   | -0.014   | -0.014   | -0.013   | -0.014   | -0.012   | -0.013   |
|                    | (-1.229) | (-0.633) | (-0.018) | (-0.057) | (-0.004) | (-0.206) | (-0.616) | (-0.633) | (-0.572) | (-0.597) | (-0.553) | (-0.574) |
| ln(1+CAPEX/ASSETS) | 0.423*   | 0.533**  | 0.430*** | 0.429*** | 0.413*** | 0.444*** | 0.524**  | 0.497*   | 0.603**  | 0.568**  | 0.534**  | 0.529**  |
|                    | (1.725)  | (2.166)  | (3.602)  | (3.585)  | (3.822)  | (4.139)  | (2.112)  | (2.050)  | (2.606)  | (2.327)  | (2.318)  | (2.180)  |
| RD/BE              | 0.366*** | 0.401*** | 0.267*** | 0.268*** | 0.276*** | 0.270*** | 0.403*** | 0.402*** | 0.415*** | 0.405*** | 0.422*** | 0.408*** |
|                    | (5.352)  | (4.628)  | (3.831)  | (3.827)  | (3.633)  | (3.676)  | (4.611)  | (4.640)  | (4.492)  | (4.577)  | (4.481)  | (4.566)  |
| ln(ME)             | 0.099*** | 0.091*** | 0.083*** | 0.083*** | 0.085*** | 0.079*** | 0.091*** | 0.091*** | 0.127*** | 0.097*** | 0.133*** | 0.099*** |
|                    | (8.273)  | (6.145)  | (7.010)  | (7.040)  | (10.904) | (8.371)  | (6.152)  | (6.145)  | (8.714)  | (6.710)  | (9.380)  | (6.891)  |
| Constant           | -0.035   | 0.002    | 0.167**  | 0.168**  | 0.178**  | 0.182**  | -0.002   | -0.006   | -0.102   | -0.007   | -0.147   | -0.023   |
|                    | (-0.478) | (0.022)  | (2.299)  | (2.321)  | (2.642)  | (2.577)  | (-0.017) | (-0.069) | (-1.105) | (-0.072) | (-1.620) | (-0.255) |
| Obs.               | 32,373   | 24,752   | 88,527   | 88,527   | 88,527   | 88,527   | 24,752   | 24,752   | 24,752   | 24,752   | 24,752   | 24,752   |
| Adj. Rsq           | 0.148    | 0.142    | 0.088    | 0.088    | 0.089    | 0.090    | 0.144    | 0.144    | 0.155    | 0.144    | 0.162    | 0.148    |

**Table D.4. Fama-MacBeth Regression Version of Table 7 Panels A and B**

This table reports the results from reestimating the tests in Tables 3 and 4 using Fama-MacBeth regressions and an alternative sample where we do not insert zeros into missing firm-year values of patent-based measures. The sample period is from 1981 to 2006. Panel A and B replicate the regressions in table 3 and 4 respectively using the alternative sample. All the control variables are included but not tabulated. In all three panels, the regressions use the same controls the previous tables, but we suppress the control variable output. T-statistics are reported in parenthesis. The standard errors are estimated using Newey-West method with 3 lags. Detailed variable definitions can be found in Appendix B.

**Panel A. Robustness test for Table 3 using Fama-MacBeth Regression and Alternative Samples**

|               | 1                   | 2                   | 3                   | 4                      | 5                   | 6                   | 7                   | 8                      | 9                   | 10                     | 11                  |
|---------------|---------------------|---------------------|---------------------|------------------------|---------------------|---------------------|---------------------|------------------------|---------------------|------------------------|---------------------|
| RQ            | 0.916***<br>(3.048) |                     |                     |                        |                     | 1.068***<br>(3.131) | 0.941***<br>(3.042) | 1.085***<br>(2.861)    | 0.964**<br>(2.368)  | 1.099***<br>(3.057)    | 0.999**<br>(2.191)  |
| IE_PATENTS    |                     | 0.281***<br>(7.578) |                     |                        |                     | 0.384***<br>(8.547) |                     |                        |                     | 0.444***<br>(5.130)    | 0.282***<br>(4.714) |
| IE_CITATIOINS |                     |                     | 0.307***<br>(8.698) |                        |                     |                     | 0.342***<br>(9.859) |                        |                     | 0.308***<br>(8.197)    | 0.199***<br>(4.916) |
| ln(1+PAT)     |                     |                     |                     | -0.137***<br>(-10.718) |                     |                     |                     | -0.167***<br>(-12.672) |                     | -0.225***<br>(-12.523) |                     |
| ln(1+CIT/PAT) |                     |                     |                     |                        | 0.134***<br>(9.781) |                     |                     |                        | 0.107***<br>(7.650) |                        | 0.101***<br>(6.185) |

|          |        |        |        |        |        |        |        |        |        |       |       |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|-------|
| Controls | Y      | Y      | Y      | Y      | Y      | Y      | Y      | Y      | Y      | Y     | Y     |
| Obs.     | 26,546 | 19,572 | 19,521 | 21,573 | 19,255 | 14,151 | 15,064 | 12,286 | 10,938 | 9,554 | 8,570 |
| Adj. Rsq | 0.269  | 0.267  | 0.285  | 0.291  | 0.281  | 0.322  | 0.328  | 0.361  | 0.334  | 0.446 | 0.379 |

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**Panel B. Panel A. Robustness test for Table 4 using Fama-MacBeth Regression and Alternative Samples**

|               | 1                   | 2                   | 3                   | 4                     | 5                   | 6                   | 7                   | 8                     | 9                   | 10                    | 11                  |
|---------------|---------------------|---------------------|---------------------|-----------------------|---------------------|---------------------|---------------------|-----------------------|---------------------|-----------------------|---------------------|
| RQ            | 1.015***<br>(3.680) |                     |                     |                       |                     | 1.026***<br>(3.262) | 0.921***<br>(3.144) | 1.102***<br>(2.930)   | 0.888**<br>(2.336)  | 1.091***<br>(3.349)   | 0.918**<br>(2.313)  |
| IE_PATENTS    |                     | 0.209***<br>(5.669) |                     |                       |                     | 0.268***<br>(6.440) |                     |                       |                     | 0.305***<br>(3.441)   | 0.164**<br>(2.137)  |
| IE_CITATIONS  |                     |                     | 0.227***<br>(6.028) |                       |                     |                     | 0.239***<br>(8.485) |                       |                     | 0.216***<br>(5.834)   | 0.170***<br>(3.007) |
| ln(1+PAT)     |                     |                     |                     | -0.086***<br>(-4.902) |                     |                     |                     | -0.117***<br>(-9.789) |                     | -0.165***<br>(-9.265) |                     |
| ln(1+CIT/PAT) |                     |                     |                     |                       | 0.133***<br>(6.601) |                     |                     |                       | 0.105***<br>(5.569) |                       | 0.100***<br>(4.471) |
| Controls      | Y                   | Y                   | Y                   | Y                     | Y                   | Y                   | Y                   | Y                     | Y                   | Y                     | Y                   |
| Obs.          | 24,752              | 18,383              | 18,281              | 21,244                | 18,965              | 13,411              | 14,196              | 12,137                | 10,807              | 9,444                 | 8,474               |
| Adj. Rsq      | 0.142               | 0.147               | 0.157               | 0.156                 | 0.174               | 0.205               | 0.190               | 0.221                 | 0.224               | 0.284                 | 0.267               |