## Web Appendix A

**Table WAA1: Levin, Lin and Chu Unit Root Test for Stationarity of Series**

| Dependent Variable in Column is Granger Caused by Variable in Row | Level (p-value) | Fourth Differenced (p-value) |
|---|---|---|
| *CCI* | ***-8.84*** | |
| *Log Demand (LCOGS)* | -1.76 | ***-4.36*** |
| *Log Purchases (LPURCH)* | -1.55 | ***-9.29*** |
| *Log Gross Margin (LGM)* | -1.26 | ***-89.16*** |
| *Abnormal Inventory Growth (ABIG)* | ***-9.49*** | |
| *Return on Assets (ROA)* | -1.67 | ***-53.49*** |

Note: ***p<.01 (Bold and Italicized)***; *p<.05 (Italicized)*

## Web Appendix B

**Table WAB1: Results of Granger Causality Test**

| Variable in Column is Granger Caused by Variable in Row | *CCI* | Log Demand (*ΔLCOGS*) | Log Purchases (*ΔLPURCH*) | Log Gross Margin (*ΔLGM*) | Abnormal Inventory Growth (*ABIG*) | Return on Assets (*ΔROA*) |
|---|---|---|---|---|---|---|
| *CCI* | | *5.79* | *6.48* | *6.52* | *8.82* | *6.65* |
| Log Demand (*ΔLCOGS*) | 1.56 | | ***318.56*** | ***20.93*** | ***54.65*** | .53 |
| Log Purchases (*ΔLPURCH)* | 1.51 | 3.42 | | ***98.19*** | ***122.54*** | 1.67 |
| Log Gross Margin (*ΔLGM*) | 2.72 | ***49.11*** | 2.33 | | ***11.40*** | 2.81 |
| Abnormal Inventory Growth (*ABIG*) | .95 | ***299.41*** | ***131.70*** | ***19.68*** | | ***24.09*** |
| Return on Assets (*ΔROA*) | ***9.14*** | 1.29 | ***11.81*** | 1.62 | 1.76 | |

Note: Chi Square; ***p<.01 (Bold and Italicized)***; *p<.05 (Italicized)*

## Web Appendix C

**Table WAC1: Results of Lag Order Selection Criteria**

| Lag Length | HIT Sample | LIT Sample |
|---|---|---|
| 0 | 4.1533 | 3.9819 |
| 1 | -1.2841 | -1.9390 |
| 2 | -1.2723 | -1.9125 |
| 3 | -1.3287 | -1.9344 |
| 4 | -1.3597* | -1.9465* |
| 5 | -1.2894 | -1.8617 |
| 6 | -1.2240 | -1.7651 |
| 7 | -1.1882 | -1.8141 |

Note: Schwarz Information Criterion

**Web Appendix D**

**Derivation of Impulse Response Function and their Standard Error**

Let us consider a simple VAR system with two variables A and S, both being endogenous to each other.

$$\begin{bmatrix} A_t \\ S_t \end{bmatrix} = \begin{bmatrix} \rho & \beta \\ \delta & \eta \end{bmatrix} \begin{bmatrix} A_{t-1} \\ S_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{A_t} \\ \varepsilon_{S_t} \end{bmatrix} \quad \text{(D1)}$$

To derive IRF let us set $\lfloor \varepsilon_{A_t} \quad \varepsilon_{S_t} \rfloor = [0 \quad 0]$ before t (D2)

$= [0 \quad 1]$ at t

$= [0 \quad 0]$ after t

At *t* the impact is

$$\begin{bmatrix} A_t \\ S_t \end{bmatrix} = \begin{bmatrix} \rho & \beta \\ \delta & \eta \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad \text{(D3)}$$

At *t+ 1* the impact is

$$\begin{bmatrix} A_{t+1} \\ S_{t+1} \end{bmatrix} = \begin{bmatrix} \rho & \beta \\ \delta & \eta \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} \beta \\ \eta \end{bmatrix} \quad \text{(D4)}$$

At *t+2* the impact is

$$\begin{bmatrix} A_{t+2} \\ S_{t+2} \end{bmatrix} = \begin{bmatrix} \rho & \beta \\ \delta & \eta \end{bmatrix} \begin{bmatrix} \beta \\ \eta \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} \rho\beta + \beta\eta \\ \delta\beta + \eta\eta \end{bmatrix} \quad \text{(D5)}$$

If S→A (S Granger Causes A) the structural equations in D1 can be specified as:

$$A_t = \gamma S_t + \rho A_{t-1} + \beta S_{t-1} + \varepsilon_{A_t} \quad \text{(D6a)}$$

$$S_t = \delta A_{t-1} + \eta S_{t-1} + \varepsilon_{S_t} \quad \text{(D6b)}$$

Where, γ captures the contemporaneous impact of S on A which recovered though the residual covariance matrix as follows.

Expanding the above system leads to the following reduced form specification:

$$A_t = \gamma S_t + \rho_1 A_{t-1} + \rho_2 A_{t-2} + \rho_3 A_{t-3} + .....\beta_1 S_{t-1} + \beta_2 S_{t-2} + \beta_3 S_{t-3} + .... + \varepsilon_{A_t} \quad \text{(D7a)}$$

$$S_t = \delta_1 A_{t-1} + \delta_2 A_{t-2} + \delta_1 A_{t-3} .... + \eta_1 S_{t-1} + \eta_2 S_{t-2} + \eta_3 S_{t-3} .... + \varepsilon_{S_t} \quad \text{(D7b)}$$

The above set of recursive equations can be specified in matrix form as:

$$T\begin{bmatrix} A_t \\ S_t \end{bmatrix} = \begin{bmatrix} \rho_1 & \beta_1 \\ \delta_1 & \eta_1 \end{bmatrix} \begin{bmatrix} A_{t-1} \\ S_{t-1} \end{bmatrix} + \begin{bmatrix} \rho_2 & \beta_2 \\ \delta_2 & \eta_2 \end{bmatrix} \begin{bmatrix} A_{t-2} \\ S_{t-2} \end{bmatrix} + \begin{bmatrix} \rho_3 & \beta_3 \\ \delta_3 & \eta_3 \end{bmatrix} \begin{bmatrix} A_{t-3} \\ S_{t-3} \end{bmatrix} + .... + \begin{bmatrix} \varepsilon_{A_t} \\ \varepsilon_{S_t} \end{bmatrix} \quad \text{(D8)}$$

Where, $T = \begin{bmatrix} 1 & -\gamma \\ 0 & 1 \end{bmatrix} \rightarrow T^{-1} = \begin{bmatrix} 1 & \gamma \\ 0 & 1 \end{bmatrix}$

Rearranging the above leads to

$$\begin{bmatrix} A_t \\ S_t \end{bmatrix} = T^{-1}\begin{bmatrix} \rho_1 & \beta_1 \\ \delta_1 & \eta_1 \end{bmatrix}\begin{bmatrix} A_{t-1} \\ S_{t-1} \end{bmatrix} + T^{-1}\begin{bmatrix} \rho_2 & \beta_2 \\ \delta_2 & \eta_2 \end{bmatrix}\begin{bmatrix} A_{t-2} \\ S_{t-2} \end{bmatrix} + T^{-1}\begin{bmatrix} \rho_3 & \beta_3 \\ \delta_3 & \eta_3 \end{bmatrix}\begin{bmatrix} A_{t-3} \\ S_{t-3} \end{bmatrix} + \ldots + T^{-1}\begin{bmatrix} \varepsilon_{A_t} \\ \varepsilon_{S_t} \end{bmatrix} \qquad \text{(D9)}$$

Where, $T^{-1}\begin{bmatrix} \rho_1 & \beta_1 \\ \delta_1 & \eta_1 \end{bmatrix} = \begin{bmatrix} 1 & \gamma \\ 0 & 1 \end{bmatrix}\begin{bmatrix} \rho_i & \beta_i \\ \delta_i & \eta_i \end{bmatrix} = \begin{bmatrix} \rho_i + \gamma\delta_i & \beta_i + \gamma\eta_i \\ \delta_i & \eta_i \end{bmatrix}$

and $T^{-1}\begin{bmatrix} \varepsilon_{A_t} \\ \varepsilon_{S_t} \end{bmatrix} = \begin{bmatrix} \varepsilon_{A_t} + \gamma\varepsilon_{S_t} \\ \varepsilon_{S_t} \end{bmatrix} = \begin{bmatrix} \omega_{A_t} \\ \omega_{S_t} \end{bmatrix}$

The variance covariance matrix of the impulses is given by:

$$\begin{aligned} \Sigma &= \begin{bmatrix} E(\omega_{A_t}^2) & E(\omega_{A_t}\omega_{S_t}) \\ E(\omega_{A_t}\omega_{S_t}) & E(\omega_{S_t}^2) \end{bmatrix} \\ &= \begin{bmatrix} \sigma_{\varepsilon_A}^2 + \gamma\sigma_{\varepsilon_S}^2 & \gamma\sigma_{\varepsilon_S}^2 \\ \gamma^2\sigma_{\varepsilon_S}^2 & \sigma_{\varepsilon_S}^2 \end{bmatrix} = \begin{bmatrix} 1 & \gamma \\ 0 & 1 \end{bmatrix}\begin{bmatrix} \sigma_{\varepsilon_A}^2 & 0 \\ 0 & \sigma_{\varepsilon_S}^2 \end{bmatrix} \\ &= T^{-1} VARCOVAR(\varepsilon_{A_t}, \varepsilon_{S_t}) T^{-1} \end{aligned} \qquad \text{(D10)}$$

## Web Appendix E

**Table WAE1: Coefficients from HIT Sample**

| | CCI | LCOGSQ_4FD | LPURCHQ_4FD | LGM_4FD | ABIG | ROA_4FD |
|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| | (S.E.) | (S.E.) | (S.E.) | (S.E.) | (S.E.) | (S.E.) |
| CCI(-1) | 1.1703 | 0.0008 | 0.0010 | -0.0000 | -0.0008 | 0.0009 |
| | (0.0176) | (0.0003) | (0.0004) | (0.0003) | (0.0008) | (0.0003) |
| CCI(-2) | -0.3693 | 0.0007 | 0.0006 | -0.0001 | -0.0010 | 0.0005 |
| | (0.0268) | (0.0005) | (0.0006) | (0.0005) | (0.0009) | (0.0002) |
| CCI(-3) | 0.3751 | 0.0007 | 0.0003 | -0.0003 | 0.0018 | 0.0001 |
| | (0.0273) | (0.0004) | (0.0006) | (0.0005) | (0.0010) | (0.0003) |
| CCI(-4) | -0.2532 | 0.0004 | 0.0007 | 0.0001 | -0.0009 | -0.0004 |
| | (0.0185) | (0.0003) | (0.0004) | (0.0003) | (0.0006) | (0.0002) |
| LCOGSQ_4FD(-1) | -1.5413 | 0.6686 | 0.7223 | -0.0423 | 0.2735 | -0.0255 |
| | (1.8459) | (0.0301) | (0.0410) | (0.0309) | (0.0594) | (0.0225) |
| LCOGSQ_4FD(-2) | -0.3637 | 0.0528 | -0.0611 | -0.0160 | -0.1692 | 0.0381 |
| | (1.9774) | (0.0322) | (0.0440) | (0.0331) | (0.0636) | (0.0241) |
| LCOGSQ_4FD(-3) | -0.0313 | 0.1000 | 0.2964 | -0.0679 | -0.3015 | 0.1148 |
| | (1.9635) | (0.0320) | (0.0437) | (0.0328) | (0.0632) | (0.0240) |
| LCOGSQ_4FD(-4) | -0.4202 | -0.1985 | 0.1543 | 0.0159 | 0.4851 | -0.0377 |
| | (1.4765) | (0.0241) | (0.0328) | (0.0247) | (0.0475) | (0.0180) |
| LPURCHQ_4FD(-1) | 2.0947 | 0.1371 | 0.0456 | 0.0244 | -0.1138 | 0.0011 |
| | (1.2304) | (0.0200) | (0.0274) | (0.0206) | (0.0396) | (0.0150) |
| LPURCHQ_4FD(-2) | -0.5397 | -0.0002 | 0.1066 | -0.0194 | 0.1565 | 0.0230 |
| | (1.2300) | (0.0200) | (0.0273) | (0.0206) | (0.0396) | (0.0150) |
| LPURCHQ_4FD(-3) | -0.4034 | -0.0272 | -0.0628 | 0.0761 | 0.1544 | -0.0664 |
| | (1.2364) | (0.0201) | (0.0275) | (0.0207) | (0.0398) | (0.0151) |
| LPURCHQ_4FD(-4) | 0.8888 | 0.0234 | -0.4595 | 0.0202 | -0.3367 | -0.0427 |
| | (1.1533) | (0.0188) | (0.0256) | (0.0193) | (0.0371) | (0.0141) |
| LGM_4FD(-1) | -0.0159 | 0.1157 | 0.1022 | 0.5186 | 0.0853 | 0.0063 |
| | (1.3518) | (0.0220) | (0.0301) | (0.0226) | (0.0435) | (0.0165) |
| LGM_4FD(-2) | -0.6047 | 0.1049 | 0.1321 | -0.1217 | -0.0893 | 0.0282 |
| | (1.4766) | (0.0241) | (0.0328) | (0.0247) | (0.0475) | (0.0180) |
| LGM_4FD(-3) | -0.1960 | -0.0030 | 0.0657 | 0.1820 | -0.0089 | 0.0645 |
| | (1.5346) | (0.0250) | (0.0341) | (0.0257) | (0.0494) | (0.0187) |
| LGM_4FD(-4) | -1.5411 | 0.0484 | 0.0276 | -0.3327 | 0.0595 | -0.1532 |
| | (1.2480) | (0.0203) | (0.0277) | (0.0209) | (0.0402) | (0.0152) |
| ABIG(-1) | 0.7037 | 0.0499 | 0.0232 | -0.0150 | 0.6857 | -0.0144 |
| | (0.6049) | (0.0099) | (0.0135) | (0.0101) | (0.0195) | (0.0064) |
| ABIG(-2) | -0.1449 | -0.0202 | -0.0598 | 0.0047 | -0.0384 | -0.0081 |
| | (0.6617) | (0.0108) | (0.0147) | (0.0111) | (0.0213) | (0.0085) |
| ABIG(-3) | 0.5391 | 0.0085 | 0.0353 | -0.0203 | -0.0582 | -0.0085 |
| | (0.6537) | (0.0107) | (0.0145) | (0.0109) | (0.0210) | (0.0080) |
| ABIG(-4) | -0.5012 | 0.0064 | -0.0051 | 0.0111 | -0.0162 | -0.0023 |
| | (0.4781) | (0.0078) | (0.0106) | (0.0080) | (0.0154) | (0.0058) |
| ROA_4FD(-1) | -0.9762 | 0.0236 | 0.1514 | -0.0184 | 0.1662 | -0.6507 |
| | (1.5264) | (0.0249) | (0.0339) | (0.0255) | (0.0491) | (0.0186) |
| ROA_4FD(-2) | -2.5154 | 0.0244 | 0.1746 | 0.0184 | -0.0618 | -0.4716 |
| | (1.8167) | (0.0296) | (0.0404) | (0.0304) | (0.0585) | (0.0222) |
| ROA_4FD(-3) | -4.4261 | 0.0596 | 0.2176 | 0.0320 | 0.0046 | -0.3445 |
| | (1.8361) | (0.0299) | (0.0408) | (0.0307) | (0.0591) | (0.0224) |
| ROA_4FD(-4) | -3.4479 | 0.0670 | 0.1258 | -0.0079 | -0.0646 | -0.0550 |
| | (1.6135) | (0.0263) | (0.0359) | (0.0270) | (0.0519) | (0.0197) |
| C | 7.6727 | 0.0089 | 0.0110 | 0.0153 | -0.0291 | 0.0041 |
| | (0.6889) | (0.0112) | (0.0153) | (0.0115) | (0.0222) | (0.0084) |
| Adj. R-squared | 0.8926 | 0.6772 | 0.5474 | 0.2732 | 0.4409 | 0.3344 |

**Table WAE2: Coefficients from LIT Sample**

| | CCI | LCOGSQ_4FD | LPURCHQ_4FD | LGM_4FD | ABIG | ROA_4FD |
|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| | (S.E.) | (S.E.) | (S.E.) | (S.E.) | (S.E.) | (S.E.) |
| CCI(-1) | 1.1871 | 0.0008 | 0.0004 | 0.0003 | 0.0004 | 0.0008 |
| | (0.0180) | (0.0003) | (0.0009) | (0.0001) | (0.0003) | (0.0003) |
| CCI(-2) | -0.4227 | 0.0006 | 0.0013 | 0.0001 | 0.0004 | 0.0004 |
| | (0.0278) | (0.0004) | (0.0006) | (0.0002) | (0.0005) | (0.0002) |
| CCI(-3) | 0.4442 | 0.0002 | 0.0011 | -0.0001 | 0.0010 | -0.0003 |
| | (0.0286) | (0.0004) | (0.0005) | (0.0004) | (0.0005) | (0.0003) |
| CCI(-4) | -0.2833 | 0.0002 | 0.0009 | -0.0002 | 0.0012 | -0.0001 |
| | (0.0192) | (0.0003) | (0.0004) | (0.0003) | (0.0004) | (0.0002) |
| LCOGSQ_4FD(-1) | -1.5181 | 0.7633 | 0.6982 | 0.0713 | -0.0615 | -0.0201 |
| | (2.6280) | (0.0351) | (0.0842) | (0.0349) | (0.0473) | (0.0289) |
| LCOGSQ_4FD(-2) | -1.8899 | 0.0434 | -0.1569 | -0.0247 | 0.0048 | -0.0537 |
| | (2.9794) | (0.0398) | (0.0954) | (0.0396) | (0.0536) | (0.0328) |
| LCOGSQ_4FD(-3) | 0.4545 | 0.0235 | 0.4258 | -0.0200 | 0.1569 | 0.0439 |
| | (2.9486) | (0.0394) | (0.0944) | (0.0392) | (0.0531) | (0.0324) |
| LCOGSQ_4FD(-4) | 1.6619 | -0.0669 | -0.0108 | -0.0306 | 0.0373 | -0.0065 |
| | (1.9728) | (0.0264) | (0.0632) | (0.0262) | (0.0355) | (0.0217) |
| LPURCHQ_4FD(-1) | 0.5003 | 0.0716 | 0.0975 | -0.0188 | -0.0112 | 0.0196 |
| | (0.9321) | (0.0125) | (0.0299) | (0.0124) | (0.0168) | (0.0102) |
| LPURCHQ_4FD(-2) | -0.3071 | 0.0125 | 0.0411 | -0.0051 | 0.0086 | 0.0076 |
| | (0.9365) | (0.0125) | (0.0300) | (0.0124) | (0.0169) | (0.0103) |
| LPURCHQ_4FD(-3) | 0.6963 | 0.0216 | -0.0365 | -0.0147 | -0.0158 | -0.0027 |
| | (0.9117) | (0.0122) | (0.0292) | (0.0121) | (0.0164) | (0.0100) |
| LPURCHQ_4FD(-4) | 0.0496 | -0.0688 | -0.4509 | 0.0160 | -0.0825 | 0.0112 |
| | (0.6818) | (0.0091) | (0.0218) | (0.0091) | (0.0123) | (0.0075) |
| LGM_4FD(-1) | -0.9463 | 0.1566 | 0.1589 | 0.5630 | -0.0639 | 0.0137 |
| | (1.5292) | (0.0205) | (0.0490) | (0.0203) | (0.0275) | (0.0168) |
| LGM_4FD(-2) | -0.5027 | -0.0378 | -0.0536 | 0.0453 | 0.0341 | -0.0096 |
| | (1.8665) | (0.0250) | (0.0598) | (0.0248) | (0.0336) | (0.0205) |
| LGM_4FD(-3) | 0.4801 | -0.0119 | -0.0181 | -0.0800 | 0.0225 | 0.0151 |
| | (1.9800) | (0.0265) | (0.0634) | (0.0263) | (0.0356) | (0.0218) |
| LGM_4FD(-4) | -1.0640 | 0.1363 | 0.1354 | -0.4030 | 0.0303 | 0.0132 |
| | (1.7500) | (0.0234) | (0.0561) | (0.0233) | (0.0315) | (0.0192) |
| ABIG(-1) | -1.2614 | 0.2814 | 0.1032 | -0.0060 | 0.3389 | -0.0354 |
| | (1.5684) | (0.0210) | (0.0502) | (0.0208) | (0.0282) | (0.0172) |
| ABIG(-2) | 0.3094 | -0.0454 | -0.2263 | -0.0365 | 0.0925 | -0.0305 |
| | (1.9082) | (0.0255) | (0.0611) | (0.0254) | (0.0343) | (0.0160) |
| ABIG(-3) | 1.5017 | -0.0122 | 0.1370 | 0.0252 | 0.0396 | -0.0321 |
| | (1.8734) | (0.0251) | (0.0600) | (0.0249) | (0.0337) | (0.0166) |
| ABIG(-4) | 0.2182 | 0.1113 | -0.1395 | -0.0309 | -0.3009 | -0.0320 |
| | (1.5306) | (0.0205) | (0.0490) | (0.0203) | (0.0275) | (0.0168) |
| ROA_4FD(-1) | 1.6902 | 0.1272 | 0.3869 | 0.0143 | 0.0064 | -0.7036 |
| | (1.9346) | (0.0259) | (0.0620) | (0.0257) | (0.0348) | (0.0213) |
| ROA_4FD(-2) | 3.4037 | 0.1749 | 0.4537 | 0.0229 | -0.0221 | -0.5263 |
| | (2.2743) | (0.0304) | (0.0728) | (0.0302) | (0.0409) | (0.0250) |
| ROA_4FD(-3) | 3.8101 | 0.1425 | 0.4603 | 0.0333 | 0.0160 | -0.3576 |
| | (2.2101) | (0.0296) | (0.0708) | (0.0294) | (0.0398) | (0.0243) |
| ROA_4FD(-4) | -1.5529 | 0.1188 | 0.3346 | -0.0143 | 0.0747 | -0.0325 |
| | (1.8733) | (0.0251) | (0.0600) | (0.0249) | (0.0337) | (0.0206) |
| C | 7.3916 | 0.0146 | 0.0125 | 0.0260 | -0.0209 | -0.0175 |
| | (0.7071) | (0.0095) | (0.0227) | (0.0094) | (0.0127) | (0.0078) |
| Adj. R-squared | 0.8975 | 0.6707 | 0.3080 | 0.4768 | 0.2860 | 0.3188 |

## Web Appendix F

### Alternate Methodology

In the main paper we used a VAR methodology to test Hypotheses H1-H4. In this Appendix, we use a reduced form methodology to test Hypotheses H1-H4. H1 and H2 are based on the impact of demand shocks on purchases, while H3 and H4 are based on the impact of demand shocks on abnormal inventory growth and gross margin, respectively.

### Calculation of demand shocks

Our methodology to measure demand shocks is based on the Martingale Model of Forecast Evolution (MMFE) (Hausman 1969, Heath and Jackson 1994), in which the difference in successive forecasts for a time period is used as a measure of demand shock. We generate demand signals of different quarterly lead times using these shocks and examine the signal(s) to which HIT and LIT retailers react. In other words we use the information lead time to gauge the physical lead time of high and low inventory turn retailers. In recent research, Bray and Mendelson (2012) use a similar MMFE methodology to decompose the bullwhip into a series of bullwhips based on information lead time of the demand signals.

Let $D_{i,q,r}$ denote the forecast made in quarter *q-l* for quantity demanded in quarter *q* for retailer *i*. Following the MMFE convention, $D_{i,q,0}$, represents the actual demand. Since the difference in forecasts from two successive periods capture the new information that arrived during this time period (Heath and Jackson 1994), we define the demand shock faced by retailer *i* in quarter *q-r* as the difference $D_{i,q,r} - D_{i,q,r+1}$. This shock represents the demand signal with lead time *r*.

Next we explain the model for forecasting quarterly demand for retailers. Since demand is typically not observed at the firm level, it is conventional to use cost-of-goods-sold (*COGS*) as a proxy for the size of demand at cost (example, Bray and Mendelson 2012). We estimate the following autoregressive demand forecast model of order four at five discrete lagged time periods with $l \in (1, 5)$ for each retailer *i*:

(Eq F1)
$$COGS_{i,q} = \alpha_{i0} + \sum_{t=0}^{3} \alpha_{i,t+1} COGS_{i,q-r-t} + \alpha_{i5} F_{q,r} + \zeta_{i,q,r}$$

where $F_{q,r}$ represents the macroeconomic forecast for personal consumption expenditure (PCE) for quarter *q* released in quarter *q-r*. We use a $4^{th}$-order autoregressive model because of considerations of seasonality in retail demand and model fit criteria.

The fitted values from above regressions are used to obtain $D_{i,q,r}$ Since we make comparisons across retailers, we compute the lead-*r* demand signals after normalizing i.e., $DS_{i,q,r} = \frac{D_{i,q,r} - D_{i,q,r+1}}{D_{i,q,r+1}}$. We measure five demand shocks corresponding to $l$ = 0...4, which are encountered by retailer *i* in quarters *q, q–1*, *q–2*, *q–3*, and *q-4,* respectively. Figure WAF1 illustrates the temporal sequencing of demand shocks and orders placed.

*--Insert Figure WAF1 about here--*

**Model Specification to test H1-2**

The model specification to estimate the impact of demand shocks on purchases is as follows:

(Eq F2) $$\Delta LP_{iq} = \beta_o + \beta_1 AS_{q,0} + \sum_{r=1}^{4} \beta_{r+1} DS_{i,q,r} + \beta_5 \Delta LGM_{iq} + W_{i,q-4}\Gamma + \rho_{j(i),q} + \Delta\xi_{iq}$$

where Δ represents year-over-year (YOY) change (i.e. $\Delta LP_q = LP_q - LP_{q-4}$), *L* indicates that the respective variables have been logged, $DS_{i,q,r}$ is demand shock in quarter *q-r* in the forecast for quarter *q*, *GM* denotes gross margin, *W* are a lagged set of control variables, $\beta_x$ are the response coefficients, Γ are the coefficients of control variables, $\rho_{j(i),q}$ are industry-quarter dummies for the industry *j*(*i*) that firm *i* is classified in, and ξ is a normally distributed random error. We avoid using $DS_{i,q,0}$ to capture the contemporaneous demand shock as it would cause the coefficients' estimates to be biased because both the demand shock and the dependent variable are functions of cost-of-goods-sold. Instead, we include the actual macroeconomic shock in that quarter, $AS_{q,0}$ (measured as the change in personal consumption expenditure), as it would be correlated with the demand shock experienced by retailers.

Since purchases in a given quarter are the result of orders placed earlier, we use actual macroeconomic shock from quarter *q* and demand shocks from quarters *q-1* to *q-4* to examine the lead times of orders for retailers. A significant coefficient for $DS_{i,q,r}$ would indicate that retailers placed orders in quarter *q-r* for quarter *q*. We expect purchases of long lead time retailers to be correlated with older shocks compared to those of short lead time retailers. This is the basis of our identification strategy.

The control variables include: $\Delta LCOGS_{q-4}$ as a proxy for the YOY change in demand, $\Delta LI_{q-4}$ is the YOY change in ending inventory to control for replenishment effects, $\Delta LAT_{q-4}$ represents YOY changes in assets, to control for such impacts on inventory purchases as new store openings and existing store closings, and $\Delta ICOST_{q-4}$ represents YOY change in inventory carrying cost, to control for the cost of financing inventories (Rumyantsev and Netessine 2007a).

Logarithms of variables are used in order to account for differences in scale across firms in the data set. YOY change in variables is used to account for seasonality and eliminate firm-wise fixed effects that would be present in a levels model. To account for industry- and time-specific unobserved heterogeneity, we include industry-quarter ($\rho_{j(i),q}$) dummies in the above equation. To account for state dependence, we include a lagged change in purchases ($\Delta LP_{i,q-4}$). Since quantity and pricing decisions are made jointly we include contemporaneous change in gross margin ($\Delta LGM_q$) as an explanatory variable in the above model. We resolve the endogeneity of contemporaneous change in gross margin using lagged value ($\Delta LGM_{q-4}$) as instrument.

In H1 we proposed that HIT retailers have a shorter lead time than LIT retailers. The statistical significance of different shock coefficients across the two samples would indicate the relative importance of lead time. For example, if $\beta_1$, the coefficient for the latest shock, is significant in the HIT sample but not in the LIT sample, that would suggest HIT retailers have a shorter lead time compared to LIT retailers. In H2, we proposed that the ordering behavior of HIT retailers is significantly less impacted by demand shocks compared to that of LIT retailers. The difference between the sum of coefficients $\beta_1$ through $\beta_5$ for the HIT and LIT subsamples provides a test of H2.

**Model Specification to test H3**

In H3 we proposed that LIT retailers are more susceptible to excesses and shortages of inventory vis-à-vis HIT retailers when faced with unexpected demand shocks. We use the following model specification to estimate the impact of actual demand shock on *ABIG* after controlling for all other variables that may drive *ABIG*:

(Eq F3) $$ABIG_{i,q} = \chi_0 + \chi_1 AS_{q,0} + \chi_2 \Delta LGM_{i,q} + Y_{i,q-1}\Omega + \delta_{j(i),q} + \xi_{i,q}$$

As explained earlier, we use actual macroeconomic shock as a proxy for actual demand shock in this regression. The control variables in $Y_{i,q\text{-}1}$ include $ABIG_{i,q-1}$, $\Delta LAT_{i,q-1}$, and $\Delta ICOST_{i,q-1}$. To account for simultaneity between abnormal inventory growth and pricing decisions, we include contemporaneous change in gross margin ($\Delta LGM_{i,q}$) in the model. We resolve this endogeneity using lagged value ($\Delta LGM_{iq-4}$). To account for industry- and time-specific unobserved heterogeneity, we include quarter-industry dummies ($\delta_{j(i),q}$) in the above equation. The difference between the estimates of $\chi_1$ for the HIT and LIT subsamples is a test of H3.

**Model Specification to test H4**

In H4, we proposed that LIT retailers are likely to be more price-responsive than HIT retailers when faced with demand shocks. The model specification to study the impact of actual demand shocks on gross margin, after controlling for all factors that might predict change in gross margin, is as follows:

(Eq F4) $$\Delta LGM_{i,q} = \gamma_0 + \gamma_1 AS_{q,0} + \gamma_2 \Delta LP_{i,q} + X_{i,q-1}\Theta + \eta_{j(i),q} + \Delta\psi_{i,q}.$$

Here, $\gamma$ are the response parameters, $X_{i,q\text{-}1}$ are the control variables, $\Theta$ are the coefficients of control variables, $\eta_{j(i),q}$ are the industry-quarter dummies, and $\psi_{i,q}$ is the normally distributed random-error term. The control variables include lagged change in (log) assets ($\Delta LAT_{i,q\text{-}1}$), (log) gross margin ($\Delta LGM_{i,q\text{-}1}$), inventory holding cost ($\Delta ICOST_{i,q\text{-}1}$), and contemporaneous change in purchases ($\Delta LP_{i,q}$). We include contemporaneous change in purchases to account for simultaneity in price and quantity decisions. We resolve the endogeneity of $\Delta LP_{i,q}$ using lagged value ($\Delta LP_{i,q\text{-}2}$) as instrument. We do not use demand shocks from prior quarters because the lead time associated with changing prices is usually negligible. The direct impact of macroeconomic demand shocks $AS_{q,0}$ on gross margin is captured by coefficient $\gamma_1$. The difference between the estimates of coefficient $\gamma_1$ for HIT and LIT subsamples is the test of H4.

**Results**

*Estimation of demand shocks of HIT and LIT retailers:* The summary statistics for demand shocks are provides in Tables AH1 and AH2. For the 100 quarters in our data window (1985–2009), the mean values of the forecasted demand shocks $DS_{i,q,1}$, $DS_{i,q,2}$, $DS_{i,q,3}$, and $DS_{i,q,4}$ for the entire sample are -0.59%, -0.29%, -0.17%, and -0.38%, respectively. Further the demand shocks across HIT and LIT retailers are comparable in magnitude, as shown in Table WAF1. Finally, we find that the correlation across forecasted demand shocks is low, as shown in Table WAF2, indicating that the shocks are independent of each other, i.e., they contain new information.

*--Insert Table WAF1 & WAF2 about here--*

Next we present the results of purchase, ABIG, and gross margin models in Table AH4-6, respectively.

**Results: Quantity Response**

From Table WAF3, we observe that HIT retailers react to only the current macroeconomic shock ($\beta_1$=.0023, $p<.10$) and to the last forecast update ($\beta_2$=.0037, $p<.05$). LIT retailers do not react to these two shocks ($\beta_1$=.0008, p>.10, and $\beta_2$=.0029, p>.10), showing that they have longer lead times. Instead, they react to older shocks that occur two quarters ($\beta_3$=.0185, $p<.01$), three quarters ($\beta_4$=.0110, $p<.01$), and four quarters ($\beta_5$=.0002, $p<.01$) ago. Since LIT retailers do not respond to demand shocks in the current and the preceding quarter, our estimates imply that their lead time is longer than three months. This evidence supports H1 and suggests that LIT retailers have longer lead times compared to HIT retailers.

*--Insert Table WAF3 about here--*

We find that the impact of shocks on purchases for LIT retailers is .0334 ($p<.01$), and for HIT retailers is .0088 ($p<.05$). The difference in magnitude of these coefficients across the two subsamples suggests that LIT retailers react more strongly to demand shocks compared to their HIT counterparts (diff = *.0246*, $p<.01$). The impact of 1% demand shock at the mean values on change in purchases amounts to increases of $1.68m and $6.61m in YOY purchases for HIT and LIT retailers respectively. Thus LIT retailers increase their purchases four times as much as their HIT counterparts. This result is interesting as it presents evidence that order variability of LIT retailers is significantly more sensitive to demand shocks than that of HIT retailers. Thus, we find support for H2.

We note that the coefficients' estimates of the control variables are in the expected direction: the greater the closing inventory, the lower is the inventory investment made in the current quarter; and the greater the change in sales and assets, the greater the inventory investment in the current quarter. Thus, retailers with a higher growth rate and greater increase in assets are likely to make more purchases.

*Abnormal Inventory Growth Model.* Next consider the impact of actual demand shocks on abnormal inventory growth for HIT and LIT retailers. The results of nested ABIG models are reported in Table WAF4. The coefficient $\chi_1$ measures the impact of actual macroeconomic shock encountered in quarter $q$ on ABIG during quarter $q$. The impact of actual demand shock on ABIG for LIT retailers is (.0003, p>.10), while that for HIT retailers is (.0008, p>.10). The difference between the sum of coefficients of the HIT and LIT subsamples (diff = .0005, p>.10) is not significant. Thus we do not find support for H3. This result is consistent with our VAR analysis where we found that demand shocks do not create excesses and shortages in the contemporaneous quarter. However, the VAR analysis showed that LIT retailers have abnormal inventory growth in the subsequent quarters as their orders get delivered with a delay.

*--Insert Table WAF4 about here--*

**Results: Price Response**

In H4, we argued that LIT retailers are likely to change their prices more than HIT retailers to manage demand shocks. Table WAF5 shows that the coefficient, $\gamma_1$, for LIT retailers is .0026 ($p<.01$), indicating that demand shocks are associated with significant price changes for LIT retailers. We find that HIT retailers also change their gross margin when faced with demand shocks (.0011, $p<.05$). A comparison of the magnitudes of coefficients across HIT and LIT retailers (diff = .0015, $p<.01$) emphasizes the significantly large impact of demand shock on the gross margin of LIT retailers compared to HIT retailers. Thus we find support for H4.

*--Insert Table WAF5 about here—*

In summary, our results are consistent with those reported in the VAR analysis in the main section of the paper. We find that with an alternate methodology that employs a different model specification and different measures of demand shocks, we obtain consistent results that support our contention that HIT and LIT retailers differ in their responses to demand shocks.

**Table WAF1: Summary Statistics: Forecasted Demand Shock**

| | Overall | | HIT Sample | | LIT Sample | |
|---|---|---|---|---|---|---|
| | Mean(%) | S.D. | Mean(%) | S.D. | Mean(%) | S.D. |
| $DS_{i,q,1}$ | -..587 | 7.501 | -.426 | 7.370 | .-.751 | 7.629 |
| $DS_{i,q,2}$ | -.292 | 6.424 | -.342 | 6.373 | -.242 | 6.474 |
| $DS_{i,q,3}$ | -.167 | 6.236 | -.333 | 6.137 | -.194 | 6.335 |
| $DS_{i,q,4}$ | -.384 | 9.646 | -.367 | 9.435 | -.536 | 9.856 |

Note: All bold coefficients have ***p<.05*** and italicized coefficients have *p<.10*. We remove 5% of outliers on both ends.

**Table WAF2: Correlation Between Forecasted Shocks**

| | $DS_{i,q,1}$ | $DS_{i,q,2}$ | $DS_{i,q,3}$ | $DS_{i,q,4}$ |
|---|---|---|---|---|
| $DS_{i,q,1}$ | 1.00 | | | |
| $DS_{i,q,2}$ | .03 | 1.00 | | |
| $DS_{i,q,3}$ | -.05 | .01 | 1.00 | |
| $DS_{i,q,4}$ | -.01 | -.03 | -.02 | 1.00 |

**Table WAF3: Results: Purchases Model**

| Dependent Variable - $\Delta LP_{iq}$ | Coefficient | HIT Full Model | | LIT Full Model | |
|---|---|---|---|---|---|
| | | Coeff. | S.E. | Coeff. | S.E. |
| $AS_{q,0}$ | $\beta_1$ | *.0023* | .0014 | .0008 | .0017 |
| $DS_{i,q,1}$ | $\beta_2$ | ***.0037*** | .0016 | .0029 | .0027 |
| $DS_{i,q,2}$ | $\beta_3$ | .0006 | .0014 | ***.0185*** | .0016 |
| $DS_{i,q,3}$ | $\beta_4$ | .0021 | .0016 | ***.0110*** | .0013 |
| $DS_{i,q,4}$ | $\beta_5$ | .0001 | .0012 | ***.0002*** | .0000 |
| $\Delta LGM_{iq}^{PRED}$ | $\beta_6$ | ***-.6291*** | .0813 | ***-1.2704*** | .1852 |
| $\Delta LCOGS_{iq-4}$ | $\beta_7$ | .0207 | .0307 | ***.2042*** | .0318 |
| $\Delta LI_{iq-4}$ | $\beta_8$ | -.0355 | .0205 | -*.0677* | .0389 |
| $\Delta LAT_{q-4}$ | $\beta_9$ | ***.1439*** | .0224 | ***.1843*** | .0375 |
| $\Delta ICOST_{iq-4}$ | $\beta_{10}$ | .0460 | .1526 | -.0788 | .1820 |
| $\Delta LP_{iq-4}$ | $\beta_{11}$ | *.0407* | .0263 | ***-.3314*** | .0204 |
| *Intercept* | $\beta_0$ | -.0236 | .0929 | -.0186 | .1281 |
| *QTR*SIC Dummies* | | Yes | | Yes | |
| Chi Square (d.f.) | | 246.01 (29) | | 326.85 (29) | |
| | | ***.0088*** | .0032 | ***.0334*** | .0038 |

Note: All bold coefficients have ***p<.05*** and italicized coefficients have *p<.10*. HIT and LIT classification based on *q-5*.

**Table WAF4: Results: Abnormal Inventory Growth Model**

| Dependent Variable - $ABIG_{iq}$ | Coefficient | HIT Full Model Coeff. | HIT Full Model S.E. | LIT Full Model Coeff. | LIT Full Model S.E. |
|---|---|---|---|---|---|
| $AS_{q,0}$ | $\chi_1$ | .0008 | .0011 | .0003 | .0009 |
| $\Delta LGM_{iq}^{PRED}$ | $\chi_2$ | ***-.5305*** | .0710 | ***-.6244*** | .1089 |
| $\Delta LAT_{iq-1}$ | $\chi_3$ | ***-.0348*** | .0139 | ***-.0553*** | .0135 |
| $\Delta ICOST_{iq-1}$ | $\chi_4$ | .1579 | .1265 | *.2099* | .1145 |
| $ABIG_{iq-1}$ | $\chi_5$ | ***.4927*** | .0132 | ***.5245*** | .0116 |
| *Intercept* | $\chi_0$ | -.0161 | .0691 | -.0468 | .0804 |
| *QTR*SIC Dummies* | | Yes | | Yes | |
| Chi Square (d.f.) | | 1256.63 (24) | | 1876.01 (24) | |

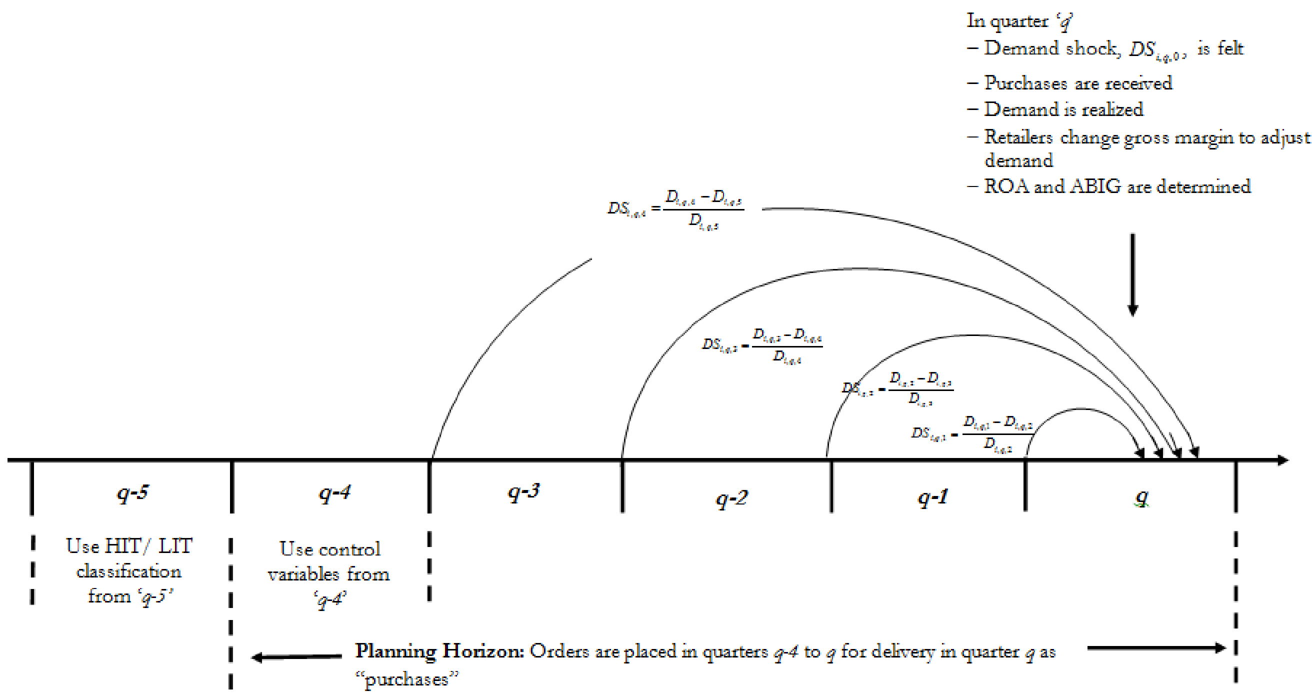
Note: All bold coefficients have ***p<.05*** and italicized coefficients have *p<.10*. HIT and LIT classification based on *q-2*.

**Table WAF5: Results: Gross Margin Model**

| Dependent Variable - $\Delta LGM_{iq}$ | Coefficient | HIT Full Model Coeff. | HIT Full Model S.E. | LIT Full Model Coeff. | LIT Full Model S.E. |
|---|---|---|---|---|---|
| $AS_{q,0}$ | $\gamma_1$ | ***.0011*** | .0005 | ***.0026*** | .0003 |
| $\Delta LP_{iq}^{PRED}$ | $\gamma_2$ | -.0048 | .0237 | ***-.0272*** | .0103 |
| $\Delta LAT_{iq-1}$ | $\gamma_3$ | .0023 | .0057 | -.0055 | .0035 |
| $\Delta ICOST_{iq-1}$ | $\gamma_4$ | .0786 | .0540 | .0367 | .0317 |
| $\Delta LGM_{iq-1}$ | $\gamma_5$ | ***.1244*** | .0075 | ***.1377*** | .0076 |
| *Intercept* | $\gamma_0$ | .0109 | .0326 | -.0167 | .0223 |
| *QTR*SIC Dummies* | | Yes | | Yes | |
| Chi Square (d.f.) | | 296.15 (24) | | 345.93 (24) | |

Note: All bold coefficients have ***p<.05*** and italicized coefficients have *p<.10*. HIT and LIT classification based on *q-2*.

**Figure WAF1: Temporal Sequencing of Events and Modeling Choices**



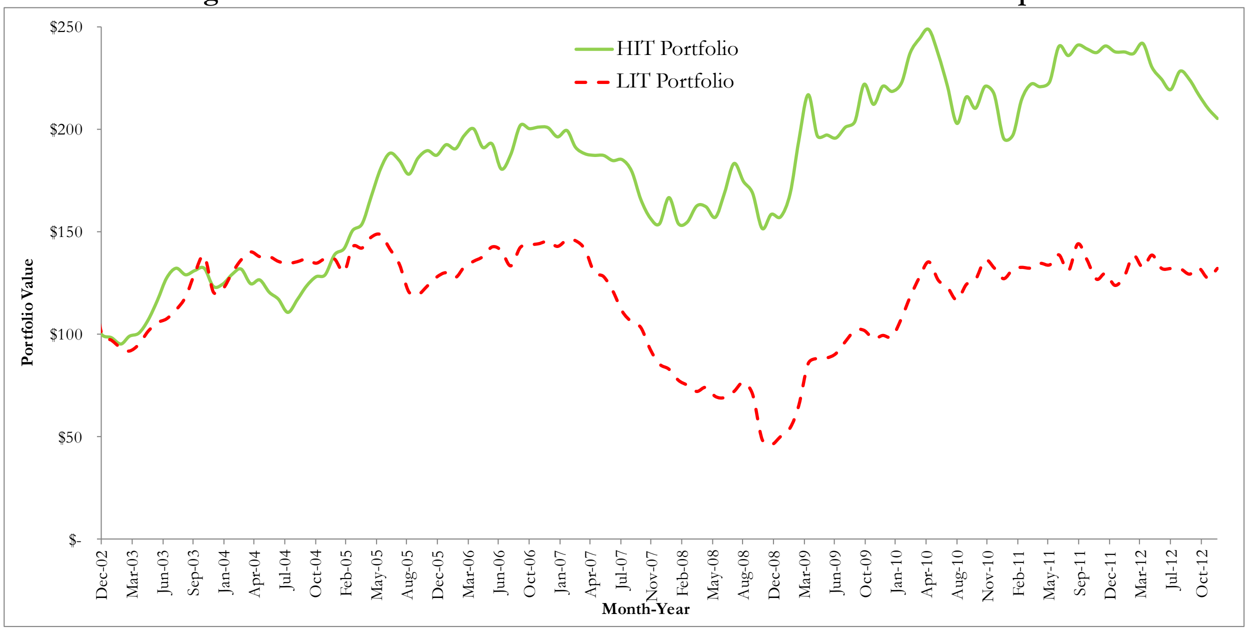
## Web Appendix G

**Table WAG1: Alternate Classification of Retailers in High and Low Group**

| Effect | HIT_ALT Sample | LIT_ALT Sample | Diff |
|---|---|---|---|
| Demand Shock → Demand | Immediate:.0059 (.0020); *p<.01*<br><br>Total: :.0059 (.0020); *p<.01* | Immediate: .0066 (.0020), *p<.01*<br><br>Total: .0066 (.0020), *p<.01* | Immediate: n.s.<br><br>Total: n.s. |
| Demand Shock → Purchases | Immediate: .0122 (.0029); *p<.01*<br><br>Total:.0212 (.0043); *p<.01*<br><br>Duration: 1Q to 2Q | Immediate: .0104 (.0063); n.s.<br><br>Total:.0422 (.0099); *p<.01*<br><br>Duration: 2Q to 4Q | Immediate: n.s.<br><br>Total:.0210 (.0107); *p<.05* |
| Demand Shock → Gross Margin | Immediate: .0016 (.0035); n.s.<br><br>Total: .0016 (.0035); n.s. | Immediate: .0055 (.0024); *p<.05*<br><br>Total: .0055 (.0024); *p<.05* | Immediate: n.s.<br><br>Total: n.s. |
| Demand Shock → ABIG | Immediate: -.0002 (.0050); n.s.<br><br>Total: -.0002 (.0050); n.s. | Immediate: .0009 (.0035); n.s.<br><br>Total:.0164 (.0084); *p<.05*<br><br>Duration: 2Q to 4Q | Immediate: n.s.<br><br>Total: .0166 (.0098); *p<.10* |
| Demand Shock → ROA | Immediate: .0038 (.0017); *p<.05*<br><br>Total: .0150 (.0034); *p<.01* | Immediate:.0037 (.0012); *p<.01*<br><br>Total: .0096 (.0024); *p<.01* | Immediate: n.s.<br><br>Total: n.s. |
| ABIG → ROA | Immediate: -.0080 (.0012); *p<.01*<br><br>Total: -.0080 (.0012); *p<.01* | Immediate: -.0115 (.0017); *p<.01*<br><br>Total: -.0179 (.0028); *p<.01* | Immediate: -.0035 (.0021); *p<.10*<br><br>Total: .0099 (.0030); *p<.01* |

## Web Appendix H

**Figure WAH1: Abnormal Portfolio Returns for HIT versus LIT Samples**




Note: We generate monthly equal-weighted portfolio returns of HIT and LIT retailers for a ten-year window from Jan 2003 to Dec 2012 with monthly re-balancing. The market index has been taken into account as the returns plotted in Figure H of the Web Appendix are abnormal returns of two portfolios: HIT firms and LIT firms, respectively. We compute abnormal monthly portfolio returns by regressing the excess portfolio returns on the market, size, and book-to-market factors. The figure shows the cumulative value of $100 invested in each portfolio on 01/01/2003 over the ten-year window.