Capacity Utilization and the Evolution of Manufacturing Output: A Closer Look at the "Bounce-Back Effect"

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ABSTRACT:

A simple error-correction model of output and utilization growth captures both the tendency for output growth to be especially rapid early in expansions and the tendency for deep recessions to be followed by strong recoveries. Estimates suggest that manufacturing capacity utilization typically peaks at around 83.5 percent. Once an expansion is underway, two thirds of the gap between actual utilization and normal peak utilization is closed each year. Output and utilization switch to a low-growth state during cyclical contractions. Capacity growth slows slightly during cyclical contractions and in response to weak output growth, but is independent of capacity utilization.

1. Introduction

This paper develops a simple econometric model of manufacturing output growth that ties together several different strands of the business-cycle literature. Consistent with results reported by Friedman (1969, 1993) and Wynne and Balke (1992, 1993), the model predicts that the rate of output growth in an expansion will be greater the deeper was the preceding recession. Consistent with results reported by Sichel (1992) and Emery and Koenig (1992), the model predicts that output growth is especially rapid in the early stages of expansions. Furthermore, estimates of the model reinforce Beaudry and Koop's point that "theories of recession that predict only temporary losses in output may be appropriate even if output is not trend-stationary" (Beaudry and Koop 1993, p. 150).

Like Beaudry and Koop, I allow output growth to be influenced by deviations of output from "capacity." In the Beaudry-Koop analysis, capacity equals the historical maximum of output. Here, in contrast, the measure of capacity is an index compiled and published by the Federal Reserve Board.

Estimation results confirm that, introduced separately, the Beaudry-Koop and Federal Reserve indexes of capacity utilization are both useful in predicting changes in manufacturing output. However, when they are introduced together, the Federal Reserve utilization index unambiguously dominates that of Beaudry and Koop. Nevertheless, the evidence points to significant non-linearity in the behavior of output over the business cycle. In particular, a contraction dummy based on Hamilton's Markov-switching model (Hamilton 1989) has marginal explanatory power for output even in regressions that include the Federal Reserve's utilization index as a right-hand-side variable.

An implication of the empirical results is that output growth tends to be especially strong in the early stages of expansions. Furthermore, the deeper is a recession, the stronger is the subsequent recovery. Normal peak utilization is found to be approximately 83.5 percent of measured capacity. Once an expansion begins, nearly two thirds of the gap between actual utilization and normal peak utilization is closed each year.

Capacity growth--unlike output growth--is independent of the rate of utilization. The effects of lagged output growth and a contraction dummy on capacity growth are statistically significant but quantitatively small.

II. The Model

Wynne and Balke estimate a relationship of the form

$$(1) \qquad \Delta y_T = \alpha_0 + \alpha_1(y_T - y_P),$$

where y_T and y_P are the logarithms of some measure of output at a business-cycle trough and at the preceding business-cycle peak, respectively, and where Δy_T denotes the percentage change in output from the business-cycle trough to one year after the trough. For industrial production and several subcomponents of industrial production (including manufacturing), Wynne and Balke obtain estimates of α_1 that are negative and statistically significant, indicating that deep recessions are typically followed by strong recoveries.

A disadvantage of the Wynne-Balke approach to modeling output growth is that it yields only one observation per recession. This characteristic limits the usefulness of the Wynne-Balke approach to businessmen and policymakers, who are generally interested in predicting movments in output over the entire course of the business cycle, not just at cyclical troughs. From the viewpoint of the econometrician, the approach has the disadvantage that it requires long time series for statistical inference.

To get around these limitations, one might estimate a relationship of the form

$$(2) \qquad \Delta y_t = \alpha_0 + \alpha_1 (y - c)_t + \gamma_1(L)\Delta y_{t-1} + \gamma_2(L)\Delta c_{t-1},$$

where y_t is the logarithm of output at date t, c_t is some measure of "capacity" at date t, and Δy_t and Δc_t denote percentage changes in output and capacity, respectively, from time t to time t + 1.

Using post-WWII quarterly real GNP data, Beaudry and Koop (1993) estimate a version of equation 2 in which $\gamma_2(L) = 0$ and $c_t = \max\{y_{t-j}\}_{j\geq 0}$.[1] They find that α_1 is negative and statistically significant. Similar results are obtained for manufacturing output. Estimating equation 2 using fourth-quarter manufacturing output data from 1948 through 1992, one obtains:[2]

$$\Delta y_t = \underset{(.0153)}{.0197} - \underset{(.495)}{1.043}(y - c)_t + \underset{(.195)}{.136}\Delta y_{t-1}.$$

The estimate of α_1 is negative and statistically significant. It follows not only that deep recessions tend to be followed by strong recoveries, but also that output growth is stronger in the early stages of expansions (while output remains below its historical maximum) than in the latter stages of expansions.

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[1] The Beaudry-Koop and Wynne-Balke measures of capacity coincide at cyclical troughs provided that at each new cyclical peak the level of output exceeds the level of output at the previous cyclical peak. For a generalization of the Beaudry-Koop measure of capacity, see equation 17 in De Long and Summers (1988, p. 459).

[2] Standard errors appear in parentheses. The Akaike criterion was used to determine the number of lagged output-growth terms.

As emphasized by Beaudry and Koop, negative output shocks are less persistent than are positive output shocks.

For the manufacturing sector of the economy, an alternative to the Beaudry-Koop capacity measure is the index of capacity compiled by the Federal Reserve Board. In the following section, I review the construction and some of the properties of the Board index. Then, I compare the marginal explanatory power of the Beaudry-Koop measure of capacity utilization to that of the Board measure.

III. The Federal Reserve Indices of Capacity and Utilization

Every month, the Federal Reserve publishes indices of manufacturing capacity and capacity utilization. Data extend back to 1948. Great pains are taken to ensure that the capacity index is consistent across time and with the corresponding output index. A number of studies have found a relationship between the Federal Reserve's utilization index and inflation, suggesting that movements in the index accurately reflect changes in capacity pressures (Kan, Krieger, and Tinsley 1989; Bauer 1990; Franz and Gordon 1993; Steindel 1993).

The Federal Reserve bases its capacity estimates on end-of-year capital stock data and on a fourth-quarter survey of large manufacturers. Monthly estimates of capacity are obtained by interpolating between the end-of-year figures. It follows that within-year variation in capacity utilization largely reflects month-to-month movements in output (Raddock 1985, 1990). Accordingly, this paper uses only output, capacity, and utilization data reported for the fourth quarter of each year.

When Phillips-Perron and augmented Dickey-Fuller unit-root tests are applied to the logarithms of the Federal Reserve indices of manufacturing output and capacity, test results strongly suggest that deviations of output and capacity away from a linear time trend are non-stationary. (In no case can the hypothesis of a unit root be rejected at even the ten-percent level.) When similar tests are applied to the logarithm of the Federal Reserve index of capacity utilization (without a time trend) the unit-root hypothesis is rejected.[3] It follows that the Federal Reserve's capacity and output indices are cointegrated.

IV. Error-Correction Models of Output Growth and Utilization Growth

The stationarity-test results reported above suggest that it is appropriate to estimate error-correction models of output growth and utilization growth. For output growth, the relevant model is given by equation 2, with c_t set equal to the logarithm of the Board's capacity index. The error-correction model for utilization growth takes a similar form:

$$\Delta(y - c)_t = a_0 + a_1(y - c)_t + c_1(L)\Delta y_{t-1} + c_2(L)\Delta c_{t-1}. \tag{3}$$

Estimates of equations 2 and 3 are presented in the second columns of Tables 1A and 1B, respectively. The Akaike criterion was used to determine lag lengths. In each regression, the estimated value of the error-correction coefficient (α_1 in equation 1, a_1 in equation 2) is highly significant and of the expected sign.

The stationarity of the Federal Reserve Board's capacity utilization index implies that the long-run growth rates of output and capacity must be

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[3] According to the Dickey-Fuller test, a unit root is rejected at the ten percent significance level. According to the Phillips-Perron test, a unit root is rejected at the one percent significance level.

equal. This restriction will be satisfied for an arbitrary long-run capacity growth rate only if the coefficients of the lagged output growth and lagged capacity growth variables sum to one in equation 2 and sum to zero in equation 3. Restricted estimates of the output and utilization equations are reported in the third columns of Tables 1A and 1B. Formal tests of the parameter restrictions indicate that they cannot be rejected. (See the F statistics reported at the bottom of the columns.) The coefficients of the error-correction term and the contraction dummy remain significant and of the expected sign.

Note that, in Table 1A, lagged output growth appears to be of relatively little use in predicting fourth-quarter-to-fourth-quarter growth in output once one controls for the lagged effects of capacity utilization and capacity growth. In Table 1B, neither lagged output growth nor lagged capacity growth aids in predicting changes in capacity utilization. The point estimates of the error correction coefficient in the utilization equation indicate that two thirds of any gap between output and normal peak capacity is typically eliminated after one year.

The fourth columns of Tables 1A and 1B report estimates of versions of equations 2 and 3 in which both the Federal Reserve and Beaudry-Koop measures of manufacturing capacity utilization appear as right-hand-side variables. The results are unambiguous. Coefficients attached to the Federal Reserve Board utilization index are highly significant and of the expected sign. Coefficients attached to the Beaudry-Koop utilization measure, although of the expected sign, are smaller in magnitude than those attached to the Board index, and are statistically insignificant. Thus, in predicting growth in manufacturing output, the information contained in the Beaudry-Koop measure of utilization is negligible in comparison to the information in the Federal Reserve measure of utilization. A simple bivariate linear model of output growth clearly outperforms Beaudry and Koop's univarite non-linear model.

Hamilton (1989) has proposed a Markov-switching model of output growth that is similar to the model of Beaudry and Koop in that it is univariate and non-linear.[4] In Hamilton's model, the economy is sometimes in a high-growth state and sometimes in a low-growth state. To test whether Hamilton's state variable contains information about future growth in manufacturing output beyond that contained in the Federal Reserve Board's measure of capacity utilization, I estimated versions of equations 2 and 3 in which a dummy variable was included as an additional right-hand-side variable. The dummy variable was defined to equal one in years in which, according to Hamilton, the probability that the economy was in its low-growth state during the fourth quarter exceeded one half. Otherwise, the dummy variable was defined to equal zero.[5] Results are presented in the fifth columns of Tables 1A and 1B.

The regression results indicate that the Hamilton contraction dummy and the Board's utilization index both contain useful information about future growth in manufacturing output and capacity utilization. Apparently, the dynamics of output and utilization are qualitatively different during expansions than during contractions. In particular, if the economy is in cyclical decline in the fourth quarter of a given year, then one should expect

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[4] In a sense, there are actually two variables in the Hamilton model (output and the state variable). However, only one of the variables is observable.

[5] Hamilton's methodology can be used to estimate either real-time or full-sample recession probabilities. However, the recession dummy variables corresponding to the alternative probability estimates are identical. They equal one in 1949, 1953, 1957, 1960, 1969, 1970, 1974, 1979, 1981, 1982, and 1990, and are zero otherwise.

rates of output and utilization growth over the next four quarters that are substantially lower than rates that would have prevailed had the economy been in its expansion phase.

V. Simultaneous Estimation of the Output and Utilization Equations

Consistent with empirical results obtained in the preceding section, I modified equations 2 and 3 by imposing long-run cointegration restrictions, allowing for an intercept shift in contraction periods, and dropping lagged output growth and lagged capacity growth variables from the right-hand side of the utilization growth equation. The modified error-correction model takes the form:

$$(2') \qquad \Delta y_t = \alpha[(y - c)_t - \beta] + \gamma\Delta c_{t-1} + (1 - \gamma)\Delta y_{t-1} + \delta h_t$$

$$(3') \qquad \Delta(y - c)_t = a[(y - c)_t - \beta] + dh_t,$$

where h is the contraction dummy. In the modified model, the parameter β represents the (log of the) measured rate of capacity utilization towards which the economy tends to converge in expansion periods.

Table 2 reports parameter estimates obtained from simultaneous estimation of equations 2′ and 3′.[6] Note, first, that both error-correction coefficients (α and a) are significant and of the expected sign. Gaps between actual and potential output are eliminated fairly quickly: over two thirds of the output gap is eliminated each year.

[6] A chi-square test indicates that one cannot reject the hypothesis that the limiting utilization rate, β, is the same in equations 2′ and 3′. The test statistic is $\chi^2(1)$ = .021, with marginal significance level .885.

Second, it remains the case, in these regressions, that lagged capacity growth is a much more important determinant of current output growth than is lagged output growth. The weight (γ) placed on lagged capacity growth is over 96 percent. The weight is estimated quite precisely: its standard error is only 1.8 percentage points.

Third, as before, if the economy has entered its contraction phase, then both output growth and utilization growth can be expected to be depressed over the coming year, relative to what they would have been had the economy been in its expansion phase. That is, the coefficients (δ and d) of the lagged contraction dummy are always negative and always statistically significant. The phase effects are also <u>quantitatively</u> significant: annualized output and utilization growth slow by about 4.5 percentage points during cyclical contractions.

Finally, the logarithm of the limiting utilization rate is -.180, which corresponds to a measured utilization rate of 83.5 percent.

VI. What Variables Affect Growth in Capacity?

Together, equations 2′ and 3′ imply that

$$(4) \quad \Delta c_t = (\alpha - a)[(y - c)_t - \beta] + \gamma \Delta c_{t-1} + (1 - \gamma)\Delta y_{-1} + (\delta - d)h_t .$$

In general, capacity growth is a function of capacity utilization, lagged capacity growth, lagged output growth, and the stage of the business cycle. However, the point estimates of α and a reported in column 2 of Table 2 are quite close, suggesting that changes in utilization have a negligible effect upon capacity growth. The chi-square statistic at the bottom of Column 3 of

Table 2 confirms that the difference between α and a is statistically insignificant. When--as in column 3--equations 2′ and 3′ are re-estimated subject to $\alpha = a$, parameter estimates change little. In particular, it remains the case that about two thirds of the output gap is eliminated each year. The estimated normal peak utilization drops from 83.5 percent to 83.4 percent of measured capacity.

According the the chi-square statistics reported at the bottom of columns 4 and 5 of Table 2, one also cannot reject the hypothesis that capacity growth is independent of the stage of the business cycle and the hypothesis that capacity growth is independent of lagged output growth. However, when one tries to impose these two hypotheses simultaneously--as in column 6--one obtains a very strong rejection. Similarly, the hypothesis that $\alpha = a$ is compatible with either the hypothesis that $\delta = d$ or the hypothesis that $\gamma = 1$, but not both of these hypotheses at the same time. See the results reported in columns 7, 8, and 9 of Table 2.

Apparently, capacity growth is independent of utilization. Furthermore, either capacity growth is depressed when the economy is in its contraction phase or capacity growth is depressed when output growth has been weak. The data are insufficient to distinguish between the latter alternatives.

In an effort to shed further light on the determinants of capacity growth, and as a robustness check, equations 2′ and 3′ were reestimated with an NBER contraction dummy in place of the Hamilton contraction dummy.[7]

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[7] The NBER contraction dummy, n_t, is defined to equal one in a given year if the economy was in the contraction phase of the business cycle in the fourth quarter of that year, where business cycle dates are as determined by the National Bureau of Economic Research. Thus, the NBER dummy equals one in 1949, 1953, 1957, 1960, 1969, 1970, 1973, 1974, 1981, 1982, and 1990, and is zero otherwise. For a nice discussion of the relative merits of alternative business-cycle dating methods, see Boldin (1994).

Results are displayed in Table 3, which has the same format as Table 2.

Measures of fit are generally somewhat improved using the NBER dummy, but parameter estimates are very similar to those obtained using the Hamilton dummy.[8] As in Table 2, one cannot reject the hypothesis that capacity growth is independent of capacity utilization. (See the chi-square statistic at the bottom of column 3 of Table 3.) Now, however, both the hypothesis that capacity growth is independent of the stage of the business cycle and the hypothesis that capacity growth is independent of lagged output growth are unambiguously rejected by the data. (See the chi-square statistics at the bottom of columns 4 and 5 of Table 3.)

In summary, capacity growth slows during business-cycle contractions and in response to slow output growth, but is independent of the rate of capacity utilization. The impact of contractions is quite small, as is the impact of slow output growth. Annualized capacity growth falls by only .3-to-.4 percentage points during cyclical contractions, and the elasticity of capacity growth with respect to lagged output growth is only .028.

VI. Concluding Remarks

One explanation of the "bounce-back effect" and the tendency for output growth to be especially rapid in the early stages of recoveries is that output growth is responsive to some measure of capacity utilization. Beaudry and Koop (1993) suggest using the historical maximum of output as a capacity measure. The resultant model is non-linear: it predicts that negative growth shocks are less persistent than are positive growth shocks.

[8] As before, one cannot reject the hypothesis that the limiting rate of capacity utilization, β, is the same in equations 2′ and 3′. The test statistic is $\chi^2(1) = .038$, with marginal significance level .845.

Results presented here indicate that, in predicting movements in manufacturing output, the Beaudry-Koop capacity measure is dominated by the capacity index published by the Federal Reserve Board. The Board's output and capacity indices are cointegrated, suggesting that estimating error-correction equations for output growth and utilization growth is appropriate. The estimated equations reveal that output growth is strongly influenced by capacity growth, while capacity growth is largely exogenous with respect to output growth. Shocks to capacity growth are persistent. In contrast, shocks to output growth are short-lived, given capacity growth.

Output growth is influenced not only by lagged capacity growth and the rate of capacity utilization, but also by the stage of the business cycle. That is, even after conditioning on lagged capacity growth and the utilization rate, the dynamics of output growth remain non-linear to a significant degree. This result obtains regardless of whether the dating of cyclical peaks and troughs is determined using Hamilton's real-time Markov switching model of GNP growth or NBER business-cycle dates. In expansions, the estimated limiting rate of capacity utilization is 83.5 percent.

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TABLE 1A. An Error-Correction Model of Output Growth

Sample Period: 1948-1992

Variable	Estimated Coefficients			
Constant	$-.2097^{**}$	$-.1266^{**}$	$-.1184^{**}$	$-.1253^{**}$
	(.0677)	(.0331)	(.0354)	(.0315)
(y - c)	$-.8228^{**}$	$-.6456^{**}$	$-.5809^{**}$	$-.7032^{**}$
	(.2037)	(.1618)	(.1884)	(.1563)
Δc_{-1}	2.0146^{*}	$.8149^{**}$	$.7567^{**}$	1.0105^{**}
	(.8692)	(.1555)	(.1782)	(.1720)
Δy_{-1}	.2786	.1851	.2433	-.0105
	(.1675)	(.1555)	(.1782)	(.1720)
Beaudry-Koop	---	---	-.3488	---
			(.5103)	
Hamilton Dummy	---	---	---	$-.0502^{*}$
				(.0224)
$\bar{R}^2$	.2571	.2392	.2289	.3087
SE	.0516	.0522	.0525	.0498
Q(11)	2.7280	2.4723	2.1710	5.3204
Restriction		$F_{1,39} = 1.966$	$F_{1,38} = 1.736$	$F_{1,38} = 2.907$

* Significant at the five-percent level
** Significant at the one-percent level
Standard errors appear in parentheses.

TABLE 1B. An Error-Correction Model of Utilization Growth

Sample Period: 1948-1992

Variable	Estimated Coefficients			
Constant	$-.2166^{**}$	$-.1226^{**}$	$-.1147^{**}$	$-.1215^{**}$
	(.0638)	(.0315)	(.0337)	(.0302)
(y - c)	$-.8287^{**}$	$-.6284^{**}$	$-.5663^{**}$	$-.6807^{**}$
	(.1921)	(.1541)	(.1794)	(.1498)
Δc_{-1}	1.2217	-.1344	-.1903	.0431
	(.8195)	(.1481)	(.1697)	(.1648)
Δy_{-1}	.2401	.1344	.1903	-.0431
	(.1579)	(.1481)	(.1697)	(.1648)
Beaudry-Koop	---	---	-.3349	---
			(.4861)	
Hamilton Dummy	---	---	---	$-.0456^{*}$
				(.0215)
$\bar{R}^2$	.3165	.2853	.2758	.3428
SE	.0486	.0497	.0501	.0477
Q(11)	3.3378	3.3206	3.0814	6.2743
Restriction		$F_{1,39} = 2.827$	$F_{1,38} = 2.541$	$F_{1,38} = 3.949$

* Significant at the five-percent level
** Significant at the one-percent level
Standard errors appear in parentheses.

TABLE 2. Non-Linear Estimates of the Error-Correction Model: Hamilton Contraction Dummy

(2′) $$\Delta y_t = \alpha[(y - c)_t - \beta] + \gamma\Delta c_{t-1} + (1 - \gamma)\Delta y_{t-1} + \delta h_t$$

(3′) $$\Delta(y - c)_t = a[(y - c)_t - \beta] + dh_t$$

Parameter	none	$\alpha = a$	$\delta = d$	$\gamma = 1$	$\delta = d$, $\gamma = 1$	$\alpha = a$, $\delta = d$	$\alpha = a$, $\gamma = 1$	$\alpha = a$, $\delta = d$, $\gamma = 1$
				Restrictions				
α	-.719** (.139)	-.651** (.128)	-.673** (.138)	-.708** (.139)	-.636** (.138)	-.640** (.128)	-.672** (.129)	-.672** (.129)
a	-.695** (.133)	$\equiv \alpha$	-.662** (.132)	-.696** (.133)	-.648** (.132)	$\equiv \alpha$	$\equiv \alpha$	$\equiv \alpha$
β	-.180** (.012)	-.181** (.012)	-.181** (.012)	-.181** (.011)	-.182** (.011)	-.180** (.012)	-.183** (.012)	-.183** (.012)
γ	.965** (.018)	.972** (.018)	.952** (.018)	≡1.000	≡1.000	.957** (.015)	≡1.000	≡1.000
δ	-.047* (.018)	-.043* (.018)	-.034* (.017)	-.048** (.018)	-.030 (.017)	-.034* (.017)	-.045* (.018)	-.030 (.017)
d	-.043* (.018)	-.039* (.017)	$\equiv \delta$	-.042* (.018)	$\equiv \delta$	$\equiv \delta$	-.040* (.017)	$\equiv \delta$
Eq. 2′:								
$\bar{R}^2$	.372	.369	.364	.372	.356	.362	.370	.354
SE	.0474	.0475	.0477	.0474	.0480	.0478	.0475	.0481
DW	1.460	1.524	1.465	1.414	1.412	1.509	1.447	1.351
Eq. 3′:								
$\bar{R}^2$	.403	.401	.399	.403	.395	.399	.402	.394
SE	.0454	.0455	.0456	.0455	.0457	.0456	.0455	.0458
DW	1.453	1.503	1.444	1.445	1.440	1.482	1.466	1.395
χ^2	---	1.68	3.75	3.81	11.86**	4.21	4.36	12.52**
d.f.		1	1	1	2	2	2	3

* Significant at the five-percent level
** Significant at the one-percent level
Standard errors appear in parentheses.

TABLE 3. Non-Linear Estimates of the Error-Correction Model: NBER Contraction Dummy

(2′) $\Delta y_t = \alpha[(y - c)_t - \beta] + \gamma \Delta c_{t-1} + (1 - \gamma)\Delta y_{t-1} + \delta n_t$

(3′) $\Delta(y - c)_t = a[(y - c)_t - \beta] + d n_t$

		Restrictions						
Parameter	none	$\alpha = a$	$\delta = d$	$\gamma = 1$	$\delta = d$, $\gamma = 1$	$\alpha = a$, $\delta = d$	$\alpha = a$, $\gamma = 1$	$\alpha = a$, $\delta = d$, $\gamma = 1$
α	-.708**	-.644**	-.665**	-.696**	-.631**	-.633**	-.667**	-.667**
	(.135)	(.125)	(.134)	(.135)	(.134)	(.125)	(.125)	(.125)
a	-.684**	-.644**	-.653**	-.686**	-.643**	-.633**	-.667**	-.667**
	(.129)	(.125)	(.129)	(.129)	(.129)	(.125)	(.125)	(.125)
β	-.179**	-.180**	-.180**	-.181**	-.181**	-.179**	-.182**	-.182**
	(.012)	(.012)	(.012)	(.012)	(.012)	(.012)	(.012)	(.012)
γ	.964**	.972**	.952**	≡1.000	≡1.000	.958**	≡1.000	≡1.000
	(.018)	(.017)	(.018)			(.015)		
δ	-.048**	-.044*	-.035*	-.049**	-.032	-.035*	-.046**	-.031
	(.018)	(.017)	(.017)	(.018)	(.017)	(.017)	(.017)	(.017)
d	-.044*	-.041*	-.035*	-.043*	-.032	-.035*	-.041*	-.031
	(.017)	(.017)	(.017)	(.017)	(.017)	(.017)	(.017)	(.017)
Eq. 2′:								
$\bar{R}^2$	.381	.378	.373	.381	.365	.371	.380	.364
SE	.0471	.0472	.0474	.0471	.0477	.0474	.0471	.0477
DW	1.405	1.471	1.433	1.356	1.384	1.474	1.389	1.326
Eq. 3′:								
$\bar{R}^2$	.411	.409	.407	.410	.403	.406	.410	.403
SE	.0452	.0452	.0453	.0452	.0454	.0453	.0452	.0455
DW	1.396	1.449	1.404	1.389	1.406	1.439	1.410	1.363
χ^2	---	1.68	4.39*	4.05*	12.50**	4.83	4.49	13.18**
d.f.		1	1	1	2	2	2	3

* Significant at the five-percent level
** Significant at the one-percent level
Standard errors appear in parentheses.

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