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PHOENIX CENTER POLICY BULLETIN NO. 6

17 September 2003

UNE-P DRIVES BELL INVESTMENT: A SYNTHESIS MODEL

Abstract: The purpose of this POLICY BULLETIN is to evaluate the robustness of the empirical results presented in PHOENIX CENTER POLICY BULLETIN NO. 5, *Competition and Bell Company Investment in Telecommunications Plant: The Effects of UNE-P.* To accomplish this goal, this POLICY BULLETIN incorporates the constructive comments made by Drs. Thomas Hazlett, Arthur Havenner and Coleman Bazelon ("HHB") and by Dr. Carter Hill about POLICY BULLETIN NO. 5 and, accordingly, estimates twenty new specifications models of the Bell Company investment equation. While these new specifications represent a synthesis of the modeling preferences of the Phoenix Center and the aforementioned economists, they nonetheless remain true to the neoclassical model of investment and valid econometric practice. These new specifications vary by estimation technique, explanatory variables included, and the measure of investment. Despite wide variations in model specification, all our new empirical specifications, especially those based on the suggestions of Drs. Hazlett *et al.*, confirm that UNE-P competition increases Bell Company investment in local telecommunications plant. *In all twenty models, the effect of UNE-P competition is positive and statistically significant.* Despite the changes to specification, the new models continue to perform well in specification tests, which is, of course, encouraging. As such, the models set forth in this *Policy Bulletin* affirm both the results and specification of the empirical models in POLICY BULLETIN NO. 5.

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I. Preface and Introduction

Since its inception, the Phoenix Center has sought to create a forum where rigorous debate about the complex policy issues facing our society can find fertile ground. For this reason, consistent with our mandate under Section 501(c)(3) of the U.S. Internal Revenue Code, the Phoenix Center does not seek to influence the political process by participating as a party in any regulatory proceeding or engaging in lobbying of legislatures. To the contrary, the Phoenix Center attempts to provide and disseminate freely through its web page thorough analytical research and analysis for the public dialectic.

We are very pleased to report that our recently-released POLICY BULLETIN NO. 5, *Competition and Bell Company Investment in Telecommunications Plant: The Effects of UNE-P* (July 2003)[1] has fostered our desired Socratic debate. As a bit of recap, POLICY BULLETIN NO. 5 evaluated, using a simple economic and econometric model, the relationship between UNE-P and Bell Company investment in telecommunications plant at the state level. For the analysis, data from the Automated Reporting and Management Information System ("ARMIS") and other publicly-available data were used. This state-level data provides sufficient variation and sample size to estimate econometrically the parameters of an investment model. From the results of an econometric analysis, we concluded that UNE-P had a positive and sizeable effect on BOC investment in telecommunications plant, with each UNE-P line increasing on average BOC net investment by about $759.00.

Subsequently, two formal responses to the analysis set forth in POLICY BULLETIN NO. 5 were released. On one hand, in a document filed in Verizon's Forbearance Petition (WC Docket No. 03-157), Verizon employed Drs. Thomas Hazlett (the Manhattan Institute), Arthur Havenner (Univ. California – Davis), and Coleman Bazelon (Analysis Group) to comment on the empirical analysis contained in the BULLETIN.[2] Verizon's advocates propose several modifications to our model, and present a few alternate specifications.[3] On the other hand, Z-Tel Communications,

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[1] http://www.phoenix-center.org/PolicyBulletin/PolicyBulletin5.pdf.

[2] Declaration of Thomas W. Hazlett, Ph.D., Arthur M. Havenner, Ph.D., and Coleman Bazelon, Ph.D., on Behalf of Verizon Communications, Inc., Reply Comments of Verizon Telephone Companies in Support of Petition for Expedited Forbearance from the Current Pricing Rules for the Unbundled Network Element Platform, WC Docket No. 03-157 (filed Sept. 2, 2003) (available at: http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6514783810 and is also posted on the Phoenix Center's web page).

[3] The declaration of HHB also includes an anecdotal discussion of investment and UNE-P, but we do not dwell on that discussion here. Because HHB's anecdotes include little more than quotes from investment analysts and the observation that investment is falling while UNE-P is rising. This *post hoc* fallacy line of reasoning is standard Bell Company argument, and brings nothing new to the debate. Further, investment analysts, for the most part, report to investors what they hear from corporate executives. Consequently, the analysts' claim that there is a link between UNE-P and investment often is based on little more than the fact a Bell executive told them that such a
(Footnote Continued….)

Inc. asked Dr. Carter Hill (Louisiana State University) to review the declaration of Hazlett, Havenner, and Bazelon as well as provide comments on the econometric model in POLICY BULLETIN NO. 5.[4]

In response both to the comments of Hazlett, Havenner and Bazelon ("HHB") and to Carter Hill ("Hill"), this POLICY BULLETIN summarizes an extensive effort to evaluate the robustness of the empirical results reported in POLICY BULLETIN NO. 5. While these new specifications represent a synthesis of the modeling preferences of the Phoenix Center and the aforementioned economists, they nonetheless remain true to the neoclassical model of investment and valid econometric practice. These new specifications vary by estimation technique, explanatory variables included, and the measure of investment. Despite wide variations in model specification, all our new empirical models, especially those based on the suggestions of HHB, confirm that UNE-P competition increases Bell Company investment in local telecommunications plant. *In all twenty specifications, the effect of UNE-P competition is positive and statistically significant*. Despite the changes to specification, the new models continue to perform well in specification tests, which is, of course, encouraging. As such, our new models affirm both the results and specification of the empirical models in POLICY BULLETIN NO. 5.

This POLICY BULLETIN proceeds as follows. In Section II, we describe our investment models and define the variables included in the analysis. Section III includes a discussion of the results and related topics. Conclusions are then provided in Section IV.

II. The Phoenix-Investment Empirical Model

In specifying our empirical models, the primary objective is consistency with economic and econometric theory, and the neo-classical model of investment, developed by Dale Jorgenson (1963), serves as our theoretical foundation.[5] While this body of work is rather technical, the empirical relationship of interest can be summarized generally as follows:

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link existed. Analysts rarely, if ever, conduct their own, independent econometric analysis of causality. The other problem with a heavy reliance on investment analysts is that they are not known generally for their accuracy. As Martin Weiss pointed out in a recent editorial, at one time "nine out of 10 or more … brokerages [had] 'buy' or 'hold' ratings on bankrupt companies." *Analyzing the analysts: A conversation with Martin Weiss, of Weiss Ratings*. WALL STREET WEEK (Jan. 31, 2003).

[4] Declaration of R. Carter Hill, Ph.D., on Behalf of Z-Tel Communications, Inc., *In the Matter of Petition for Forbearance From the Current Pricing Rules for the Unbundled Network Element Platform*, WC Docket No. 03-157 (September 18, 2003). Dr. Hill generously provided us a draft copy of his comments prior to the filing date and the final version will be posted on the Phoenix Center's web page.

[5] D. W. Jorgenson, *Capital Theory and Investment Behavior*, AMERICAN ECONOMIC REVIEW, Vol. 53, Issue 2, (May 1963) at 247-259.

$$I = \Delta K = f(\Delta R, \Delta C, \Delta X) + \delta K, \quad (1)$$

where investment (I) equals the change in capital stock (ΔK) and is a function of changes in the monetary value of output (ΔR), changes in the cost of capital (ΔC), changes in other relevant factors (ΔX), and the existing capital stock *K* (δ is the replacement portion of capital).[6] Particular assumptions about functional forms and lag structures offer a wide variety of empirical specifications for the neo-classical model of investment.[7]

In POLICY BULLETIN NO. 5, we presented two models generally consistent with Equation (1). The monetary value of output (ΔR) was measured by changes in total operating revenues, and changes in the cost of capital (ΔC) were subsumed into a period dummy variable under the assumption that the cost of capital was constant across the Bell Companies. Existing capital stock (K) was not included in the regression, but as we discuss later, this exclusion did not bias our earlier results. Model 2 from the BULLETIN estimated that Bell Company investment rose an average of $759.^{00} per UNE-P line in the state. Despite Model 2's parsimonious specification, statistical tests of model specification indicated that the results of that model were unbiased estimates of the true parameters of interest (the goal of regression analysis), confirmation of which is provided by our new model specifications.

In their review of BULLETIN NO. 5, HHB recommend three major changes to our empirical model. First, HHB suggest making the empirical model dynamic by including the existing capital stock in the regression and lagged values of some explanatory variables.[8] Second, they recommend letting the cost of capital vary by Bell Company.[9] Third, they propose estimating the models using weighted least squares where all variables are weighted by (the inverse of) access lines.[10] Many of our new empirical models incorporate these suggestions, and in some cases adopt more dynamic specifications than proposed by HHB.[11] In every instance, these changes *affirm and, in many cases, strengthen* the conclusion that Bell Company investment is positively related to UNE-P competition.

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6 *See, e.g.*, D. W. Jorgenson and J. A. Stephenson, *Investment Behavior in U.S. Manufacturing*, 1947-1960, ECONOMETRICA, Vol. 35, No. 2 (April 1967) at 169-220.

7 Typically, academic research uses time series data when analyzing investment. We do not, however, have long data series on either investment or UNE-P lines. Nevertheless, it is important to use theory as our guide to specification.

8 HHB Appendix at ¶15 and n. 7.

9 HHB Appendix at ¶17.

10 HHB Appendix at ¶3. The inverse of access lines is used as the weight.

11 HHB specify a dynamic structure by including initial (or lagged) capital stock. We include this variable, as well as lagged investment and lagged market size in some of our models.

Z-Tel's expert Dr. Carter Hill recommends altering the symbolic discussion of the empirical models, and his recommendations are now incorporated into the latest version of Policy Bulletin No. 5 (released September 19, 2003). Dr. Hill also points to a potential problem with the econometric error terms in our regression, and suggests basing our t-statistics on Newey-West robust standard errors. We incorporate this suggestion into our analysis, and update Policy Bulletin No. 5 accordingly. Hill also recommends assessing the robustness of our earlier estimates through alternate specifications. To comply, this document summarizes twenty different specifications of the investment equation.

A. *General Empirical Framework*

For the twenty empirical models estimated here, the general framework is as follows. The change in capital stock, or net investment, is taken to be a function of the annual change in revenue (ΔR), the annual change in UNE-P lines (ΔU), the annual change in the cost of capital (ΔC), the existing (or "lagged" or "beginning" capital stock) capital stock (K), a dummy variable that equals (1) for the period 2001 to 2002, (0) otherwise, and a constant term. We do deviate from this general framework in some cases in order to employ different measures of relevant variables and to illustrate that the estimated coefficients are not very sensitive to specification. Most of the models are estimated using weighted least squares ("WLS") as recommended by HHB. The data is measured at the state level, unless otherwise indicated. All models are estimated using 52 observations as before.[12] States included are from the BellSouth, SBC, and Verizon (excluding GTE) regions only. Qwest data for year 2002 is not available.

The variables used in the analysis include:

I = Annual change in Average Net Investment, Subject to Separations, from ARMIS Form 43-01;

I′ = Annual change in Total Plant in Service less Accumulated Depreciation and Accumulated Amortization, Subject to Separations, from ARMIS Form 43-01;

ΔR = Annual change in Total Operating Revenue, Subject to Separations, from ARMIS Form 43-01;

[12] We do not, as suggested by HHB, unnecessarily reduce variation and sample size by aggregating data up to the Bell Company level (HHB Appendix at ¶10).

ΔU = Annual change in UNE-P lines measured from June of each year as reported in the FCC's Form 477 data;[13]

ΔC = Annual change in the weighted average cost of capital for the relevant Bell Company;

K_{t-1} = The prior year's Average Net Investment, Subject to Separations, from ARMIS Form 43-01 (i.e., lagged net investment);

K'_{t-1} = The prior year's Total Plant in Service less Accumulated Depreciation and Accumulated Amortization, Subject to Separations, from ARMIS Form 43-01 (i.e., lagged net investment);

Period = A dummy variable that equals 1 for investment in year 2002, 0 otherwise;

$\Delta(R/c)$ = Annual change in Total Operating Revenue, Subject to Separations, divided by the user cost of capital;[14]

$\Delta(R/c)_{t-1}$ = The prior year's value of $\Delta(R/c)$;

I_{t-1} = The prior year's value of I;

I'_{t-1} = The prior year's value of I'.

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[13] The weighted-average cost of capital is computed using the following: (i) debt costs are assumed to equal the Aa corporate bond yields for June 2000, 2001, and 2002, (ii) the cost of equity is computed using the Capital Asset Pricing Model, where the 10-year Treasury Bond yield (June) is the risk-free rate, the risk-premium is 5%, and the Betas are computed as 5-year Betas (using weekly data) ending in December for the relevant year for Bellsouth, SBC, and Verizon. The risk premium is from Tom Copeland, Tim Koller, and Jack Murrin, VALUATION: MEASURING AND MANAGING THE VALUE OF COMPANIES, 3rd Ed., McKinsey & Company, Inc. (2000), at 216 ("In early 2000, we were recommending using a 4½ percent to 5 percent historically estimated market risk premium for U.S. companies."). Stock prices provided by Yahoo finance. Bond yields provided by the St. Louis Federal Reserve Bank (http://research.stlouisfed.org/fred2/) and the U.S. Treasury (http://www.ustreas.gov/offices/domestic-finance/debt-management/interest-rate/index.html). Capital structure is assumed to be 40% debt, 60% equity. The variable is expressed in percentage points.

[14] The user cost of capital is estimated as the producer price index for telephone communications multiplied by the sum of the weighted average cost of capital and the depreciation rate. The depreciation rate is measured as the average annual difference in Accumulated Depreciation divided by Average Net Investment for years 2000 and 2002. *See* Larry Neal, *Investment Behavior by American Railroads: 1987-1914*, REVIEW OF ECONOMICS AND STATISTICS, Vol. 51, No. 2 (May 1969) at 126-135. The price index is provided by the Bureau of Labor Statistics (http://www.bls.gov).

We employ Δ(R/c) as a substitute for both variables ΔR and ΔC, since Δ(R/c) is computed using revenue (R) and the user cost of capital (c).[15] Lagged values of Δ(R/c) appear in a few of the alternate specifications, as recommended by HHB.[16] Two different versions of the capital stock and investment are available in ARMIS (K, K′ and I, I′). Models 1 through 10 use the variables K and I, whereas Models 11 through 20 use the variables K′ and I′. Models 11 through 20 are comparable to Models 1 through 10, with the only difference being the substitution of these two variables.

B. *Model Specification Issues*

If a regression equation is not specified correctly, the estimated coefficients may be biased estimates of the true population parameters.[17] In a policy context, it is important, therefore, to subject empirical models to specification tests in an effort to determine whether (and what type of) specification errors are present. Specification tests are important when somewhat parsimonious specifications are employed.[18]

Ramsey's RESET is a very general test of specification error, capable of detecting omitted variables bias, incorrect functional form, and the consequences of simultaneity bias.[19] While the test is desirable in that it is relatively powerful and is easy to implement, it only indicates that some type of specification error is present, providing no guidance as to how to remedy the problem.[20] The null hypothesis of RESET is "no specification error." If the RESET F statistic does not exceed the critical value, the null is not rejected. The null of RESET is not rejected for

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15 This specification of the revenue/cost of capital variable is frequently used in the empirical analysis of investment. *See, e.g.,* Jorgenson and Stephenson, *supra* n. 6.

16 HHB Appendix at n. 7.

17 D. N. Gujarati, BASIC ECONOMETRICS (1995) at 454-459.

18 Parsimony is not a flaw, as explained by Gujarati:

> A model can never be a completely accurate description of reality; to describe reality one may have to develop such a complex model that it will be of little practical use. Some amount of abstraction or simplification is inevitable in any model building. The Occam's razor [], or the principle of parsimony, states that a model be kept as simple as possible or, as Milton Friedman would say, "A hypothesis [model] is important if it 'explains' much by little …" What this means is that one should introduce in the model a few key variables that capture the essence of the phenomenon under study and relegate all minor and random influences to the error term u_t.

Although parsimony is desirable, it is important to subject a parsimonious specification to careful scrutiny, to ensure that specification errors, which often have severe statistical consequences, are not present. Gujarati, *supra* n. 17 at 453-4 (emphasis in original).

19 *Id.* at 464-466; *see also* J.B. Ramsey, *Tests for Specification Errors in Classical Linear Least Squares Regression Analysis*, JOURNAL OF THE ROYAL STATISTICAL SOCIETY, SERIES B, VOL. 31 (1969) at pp. 350-371.

20 Gujarati, *supra* n. 17 at 466.

18 of the 20 models, and the 2 rejections were expected (given the results from POLICY BULLETIN NO. 5).

Another common problem with regression is heteroscedasticity, which is an undesirable property of the random disturbance term of the regression.[21] The presence of heteroscedasticity implies the estimated standard errors of the estimated coefficients are inefficient, meaning they are either too large or too small.[22] The estimated coefficients themselves, however, are unbiased.[23] If heteroscedasticity is of a known form, then the equation can be weighted accordingly to render efficient standard errors (*i.e.,* weighted least squares or WLS).[24] If unknown, then other methods are available to compute asymptotically valid standard errors such as the White and Newey-West procedures.[25] Based on the comments of Hill, whose recommendations are based on the properties of error terms in first-difference models, all reported t-statistics in the table are computed using Newey-West robust standard errors.[26] The White test statistic is reported for all models.

C. *Summary of Results*

The estimates from our twenty models are summarized in Tables 1 and 2. Because the standard R^2 (a measure of goodness of fit) is not valid for WLS, for those regressions estimated by WLS we provide a Pseudo-R^2 computed as the squared correlation coefficient between the actual and fitted value of the weighted regression.[27] We are encouraged that the signs, magnitudes, and significance levels of the estimated coefficients are reasonably stable across comparable models. Absence of such stability could indicate problems with model specification.

Models 1 and 2 would be identical to Models 1 and 2 from POLICY BULLETIN NO. 5 except for the inclusion of two additional explanatory variables – the cost of capital (ΔC) and existing (or lagged) capital stock (K_{t-1}). These additional variables were proposed by HHB. As in BULLETIN

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21 *Id.* at 355-358.

22 *Id.* at 366-367.

23 *Id.* at 362.

24 *Id.* at 381-382.

25 *Id.* at 382-383.

26 J. M. Wooldridge, ECONOMETRIC ANALYSIS OF CROSS SECTION AND PANEL DATA (2002) at 282-3; W. Newey and K. West, *A Simple Positive Semi-Definite, Heteroscedasticity and Autocorrelation Consistent Covariance Matrix*, ECONOMETRICA, 55, 1987a, pp. 703-708. Some researchers recommend always reporting robust standard errors. Gujarati, *supra* n. 17 at 383.

27 R^2 is a rather standard measure of goodness of fit that takes on values between 0 and 1. It is interpreted as the percent of variation in the dependent variable explained by the regression. Gujarati, *supra* n. 17 at 74. R^2 and Pseudo-R^2 across the regressions are not comparable.

NO. 5, the null of RESET is easily rejected for Model 1, indicating the model is mis-specified in some way. Consequently, we do not discuss the results from that model. Model 2, alternately, easily survives RESET. Our prior Model 2 from BULLETIN NO. 5 also passed RESET, indicating that model likely did not suffer from specification errors. The results for Model 2 reported here support that finding. Neither of the two additional explanatory variables is statistically significant, and the coefficient on ΔU is barely affected (\$757.50 versus \$759.00).[28]

Model 3 is simply Model 2 estimated by WLS. This alternate estimation technique results in larger t-statistics, indicating the weighting procedure improved efficiency. Five of the six explanatory variables are now statistically significant. The estimated coefficient on UNE-P lines is \$931.80, which is about 23% higher than the estimate reported in POLICY BULLETIN NO. 2. Other statistically significant variables include revenues (ΔR), lagged capital stock (K_{t-1}), the period dummy variable, and the constant term. The cost of capital is not statistically different from zero, but has the correct sign (negative).[29]

In Model 4, the revenue (ΔR) and cost of capital (ΔC) variables are replaced with a substitute variable measured as total revenues divided by the user cost of capital Δ(R/c). This variable is commonly employed in investment regressions such as those estimated here, and serves as a proxy for the optimal capital stock.[30] All of the explanatory variables in Model 4 are statistically significant at the 5% level or better. The coefficient on UNE-P lines is \$688.10. Models 5 and 6 are more dynamic in their specification than proposed by HHB, including lagged values of Δ(R/c) and the dependent variable (I_{t-1}). These more dynamic specifications do not perform any better than the more simple models, and the sign, size, and significance of the UNE-P variable (ΔU) is unaffected.

Models 7 through 10 are varied specifications of the investment equation, and the results from these models are generally comparable with the others. In every case, the coefficient on UNE-P lines is positive, large, and statistically significant. The models perform well, with a high degree of statistical significance and no evidence they are mis-specified (by RESET). Across the full range of usable models (Models 2 through 10), the coefficient on UNE-P ranges from \$1011.40 to \$665.80, with an average coefficient of \$808.30.

For Models 11 through 20 (Table 2), the dependent variable is measured using our alternate measure of capital stock and investment (K', I'). Otherwise, these models are identical to Models 1 through 10. Models 12 through 20 pass RESET easily, suggesting the estimated

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[28] Passing the RESET does not imply that all potentially statistically significant variables are in the regression, only that the variables omitted from the regression do not bias the coefficients. The stability of the coefficient, therefore, is encouraging.

[29] Contrariwise, HHB report a positive and statistically significant coefficient on the cost of capital.

[30] Jorgenson and Stephenson, *supra* n. 6.

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coefficients are not influenced by specification error. In all ten models, the coefficient on UNE-P lines is positive and statistically significant. Across Models 12 through 20 (those passing RESET), the coefficient on UNE-P ranges from \$868.40 to \$523.80, with an average coefficient of \$655.20. Relative to Models 1 through 10, we observe less statistical significance of the existing capital stock (K) and period dummy variable in Models 11 through 20. The cost of capital (ΔC) is correctly signed and statistical significant in half the models in which it is included. As before, the more dynamic specifications are of little statistical consequence. Thus, we find no support for HHB's supposition that more dynamic specifications would alter our earlier conclusions.

D. *Levels versus Changes*

In the alternate models presented by HHB the explanatory variables are expressed in their annual levels rather than annual changes in levels as prescribed by the neo-classical model of investment. Besides being an atheoretic and arbitrary model choice, there are potentially severe econometric consequences of HHB's re-specification as described by Hill. Nevertheless, if we ignore the serious defects in using the levels rather than changes in the variables, we can evaluate whether or not the investment equation is better estimated using either the annual changes in the explanatory variables (as in POLICY BULLETIN NO. 5 and here) or the levels of the variables (as in HHB). We test the alternative specifications using the Davidson-MacKinnon *J* Test.[31]

The Davidson-MacKinnon *J*-test is performed by adding the predicated values from two rival regressions, say Phoenix and HHB, as an additional explanatory variable in the rival model. If this additional regressor is statistically significant in rival model HHB, but not in rival model Phoenix, then model Phoenix is the preferred specification (and vice versa).[32] More specifically, say Model Phoenix can be summarized as $I = a\Delta X$ and the HHB model as $I = bX$. The fitted values from each regression, respectively, are $\hat{I}_P$ and $\hat{I}_H$. The supplementary test regressions are:

$$\text{Phoenix:} \qquad I = a\Delta X + d\cdot\hat{I}_H$$

$$\text{HHB:} \qquad I = bX + e\cdot\hat{I}_P.$$

If the hypothesis $d = 0$ is not rejected, but the hypothesis $e = 0$ is rejected, then the Phoenix model is the better specification. Alternately, if the hypothesis $d = 0$ is rejected, but the hypothesis $e = 0$ is not rejected, then the HHB model is the better specification. This conclusion

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31 Gujarati, *supra* n. 17 at 490-491.

32 *Id.* at 491. A shortcoming of this approach is that we may observe statistical significance or insignificance in both models, which renders an ambiguous result. The *J*-test is only asymptotically valid, implying it may not perform well in very small samples.

is based on the fact that the influence of the variables in Model HHB, captured by the fitted value from that model, adds no additional explanatory power beyond that contributed by Model Phoenix.

We use Model 3 (from Table 1) to compare the rival specifications, one using changes in the explanatory variables (the Phoenix approach) versus the levels of the explanatory variables (the HHB approach). Inserting the predicted value from the HHB regression of investment in the Phoenix model, the estimated coefficient is 0.53 and the t-statistic is 0.54, which is *not* statistically significant. For the HHB regression, the predicted value from the Phoenix model is included as a regressor and the estimated coefficient is 1.0 and the t-statistic is 3.48, which *is highly* statistically significant. Thus, by the *J*-test, the Phoenix specification is preferred and the explanatory variables should be expressed as annual differences and not levels. Further, when the explanatory variables are expressed in levels, the estimated regression easily fails RESET, indicating that specification error is present.[33]

E. *Summary*

In sum, we find no evidence of 'weakness' in the results; the results are, in fact, extremely robust. We tried alternative measures of some variables, alternate estimation techniques, and dynamic model specifications, and none of these changes produced evidence conflicting with our earlier finding. Based on the analysis summarized here and the comments of HHB, we find no reason to question the empirical results from POLICY BULLETIN NO. 5. While our models cannot explain why investment responds to UNE-P competition, the results provide strong evidence that investment is impacted by such competition.

III. Conclusion

In POLICY BULLETIN NO. 5, we showed using econometric analysis and publicly availably data that Bell Company investment is positively related to UNE-P competition. Here, we show that this result is robust across a wide range of model specifications. These alternate specifications were recommended by Tom Hazlett, Art Havenner, and Coleman Bazelon (on behalf of Verizon) and Carter Hill (on behalf of Z-Tel). Despite re-specification and different estimation techniques, the measured effect of UNE-P competition on Bell investment remains large and statistically significant (in all models). These new empirical results are generally comparable to our earlier estimates, supporting the reasonableness of our chosen specification.

33 The RESET F is 4.59, which is significant at better than the 1% level.

We also show that, using statistical tests, our specification of the investment relationship is preferred to the arbitrary specification adopted by Verizon's advocates.[34]

Accordingly, the conclusion reached in POLICY BULLETIN NO. 5 below (citations omitted) continues to ring true:

> … the current cynicism, ideological bias and outright ignorance towards UNE-P and TELRIC pricing must come to an end. Like it or not, "Congress passed a ratesetting statute with the aim not just to balance interests between sellers and buyers, *but to reorganize markets by rendering regulated utilities' monopolies vulnerable to interlopers, even if that meant swallowing the traditional federal reluctance to intrude into local telephone markets*." As TELRIC does not result in confiscatory rates (if anything, they still remain on the "creamy" side in many jurisdictions), the growing push for BOC sector-specific relief (and, *a fortiori*, a decline in competitive pressures) is specious at best and raises troubling indications of regulatory capture at worst.
>
> If policymakers really want to maximize consumer welfare by protecting competition and not individual competitors (*i.e.,* the BOCs), then U.S. policymakers should stop dreaming that a monopolist will change its spots and invest in new facilities if only it received relief from "pesky" competitive

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[34] Despite the fact the data provide strong evidence of a positive relationship between Bell Company investment and UNE-P competition, we do not encourage policymakers to make investment a policy target. As noted in POLICY PAPER NO. 18, *Set It and Forget It? Market Power and the Consequences of Premature Deregulation in Telecommunications Markets* (July 2003) (http://www.phoenix-center.org/pcpp/PCPP18.pdf) a single-minded focus on capital expenditures by telecommunications firms is misplaced, since the impact to consumer and social welfare of increased capital expenditures is not always positive. Policymakers should focus on the efficient provision of telecommunications services, not whether or not the provision of such services is sufficiently capital intensive to satisfy equipment vendors.

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pressures. Instead, if policymakers focus on their core and interrelated statutory mandates – *i.e.*, (a) prevent dominant firms under their jurisdictions from exercising their market power by raising prices and restricting output; and (b) reduce entry barriers for new firms – then we might just get out of the current telecoms slump before it is too late.

Table 1. Summary of Results
(Dep. Variable: $\Delta K = I$)

	Model 1, OLS	Model 2, OLS	Model 3, WLS	Model 4, WLS	Model 5, WLS	Model 6, WLS	Model 7, WLS	Model 8, WLS	Model 9, WLS	Model 10, WLS
Constant	1.5+08	40.94	4.7+07	5.3+07	5.6+07	5.4+07	3.3+07	5.0+07	5.2+07	-1.6+06
	(2.23)*	(1.07)	(2.25)*	(4.27)*	(3.94)*	(3.69)*	(1.38)	(3.91)*	(3.97)*	(-0.12)
ΔR	0.84	0.45	0.75	…	…	…	0.89	0.74	…	1.21
	(1.49)	(1.72)**	(3.19)*				(3.53)*	(4.05)*		(6.35)*
ΔU	**1388.0**	**757.5**	**931.8**	**688.1**	**666.6**	**665.8**	**1011.4**	**927.0**	**688.9**	**937.6**
	(3.27)*	**(3.46)***	**(4.21)***	**(2.76)***	**(2.81)***	**(2.73)***	**(3.99)***	**(4.46)***	**(2.63)***	**(4.16)***
ΔC	-1.2+08	6.87	-6.3+07	…	…	…	-4.1+07	…	…	…
	(-0.68)	(0.33)	(-0.10)				(-0.54)			
K_{t-1}	-0.076	-0.036	-0.035	-0.065	-0.045	-0.036	-0.02	-0.035	-0.058	…
	(-2.71)*	(-0.71)	(-2.58)*	(-4.51)*	(-2.10)*	(-1.76)**	(-1.19)	(-2.71)*	(-3.24)*	
Period	-1.9+07	-67.57	-8.0+07	-8.3+07	-8.5+07	-8.2+07	-6.6+07	-8.1+07	-8.0+07	…
	(-2.02)*	(-3.78)*	(-3.84)*	(-5.55)*	(-5.34)*	(-4.77)*	(-3.06)*	(-4.58)*	(-4.93)*	
$\Delta(R/c)$	…	…	…	8.95	5.34	4.63	…	…	8.55	…
				(2.82)*	(1.23)	(1.14)			(2.69)*	
$\Delta(R/c)_{t-1}$		…	…		-4.11	-4.44	…	…		…
					(-0.96)	(-1.08)				
Net I_{t-1}	…	…	…		…	-0.17	-0.31	…	-0.15	-0.48
						(-0.78)	(-1.58)		(-0.72)	(-3.11)*
Adj. R^2	0.57	0.43	…		…	…	…	…	…	…
Pseudo.-R^2	…	…	0.28	0.29	0.29	0.29	0.31	0.28	0.30	0.21
RESET F	9.10*	1.51	1.52	1.53	1.36	1.81	1.91	1.49	1.77	1.07
White χ^2	33.91*	13.05	12.22	10.17	12.73	21.41**	26.42*	8.60	22.17*	13.26**

* Statistically Significant at the 5% level or better.
** Statistically Significant at the 10% level or better.
Notes: All t-statistics computed using Newey-West robust standard errors. Pseudo-R^2 is computed as the squared correlation coefficient between the actual and fitted dependent variable. In Model 2, I, ΔR, ΔU, and K_{t-1} are all divided by total switched access lines.

Table 2. Summary of Results
(Dep. Variable: ΔK′ = I′)

	Model 1, OLS	Model 2, OLS	Model 3, WLS	Model 4, WLS	Model 5, WLS	Model 6, WLS	Model 7, WLS	Model 8, WLS	Model 9, WLS	Model 10, WLS
Constant	4.5+08	7.08	-1.5+07	3.0+07	2.9+07	2.8+07	-2.0+07	2.9+07	2.8+07	-2.1+07
	(1.42)	(0.20)	(-0.85)	(4.14)*	(4.00)*	(3.72)*	(-1.16)	(3.23)*	(3.96)*	(-2.22)*
ΔR	0.58	0.32	0.77	…	…	…	0.75	0.51	…	0.60
	(2.88)*	(2.19)*	(4.84)*				(4.80)*	(3.41)*		(3.32)*
ΔU	**807.1**	**589.6**	**763.0**	**542.6**	**552.1**	**533.6**	**728.0**	**644.0**	**523.8**	**868.4**
	(6.66)*	**(4.70)***	**(5.15)***	**(3.19)***	**(3.09)***	**(2.89)***	**(4.90)***	**(3.30)***	**(2.93)***	**(3.85)***
ΔC	-5.6+06	-28.05	-1.7+07	…	…	…	-1.7+08	…	…	…
	(-0.06)	(-1.50)	(-3.08)*				(-3.12)*			
K'_{t-1}	-0.024	0.028	-0.019	-0.008	-0.012	-0.006	0.029	-0.013	-0.002	…
	(-4.10)*	(0.71)	(-2.04)*	(-0.83)	(-0.84)	(-0.40)	(2.52)*	(-1.35)	(-0.13)	
Period	-1.4+08	-46.61	-1.9+07	-3.6+07	-3.6+07	-3.4+07	-1.2+07	-3.9+07	-3.4+07	…
	(-3.25)*	(-3.15)*	(-1.00)	(-2.14)*	(-2.07)*	(-1.75)**	(-0.60)	(-1.98)**	(-1.82)**	
Δ(R/c)	…	…	…	8.22	9.14	8.75	…	…	7.77	…
				(4.85)*	(3.09)*	(3.35)*			(3.86)*	
$\Delta(R/c)_{t-1}$		…	…		-1.04	-1.10	…	…		…
					(-0.40)	(-0.43)				
Net I'_{t-1}	…	…	…		…	-0.12	-0.25	…	-0.12	-0.06
						(-0.48)	(-1.15)		(-0.48)	(-0.32)
Adj. R^2	0.71	0.38	…		…	…	…	…	…	…
Pseudo.-R^2	…	…	0.40	0.23	0.22	0.23	0.20	0.20	0.23	0.19
RESET F	4.94*	1.01	0.53	0.54	0.59	0.55	0.38	1.16	0.48	0.75
White χ^2	18.63*	5.51	7.03	6.16	7.64	10.25	8.38	8.30	9.17	1.05

* Statistically Significant at the 5% level or better.
** Statistically Significant at the 10% level or better.
Notes: All t-statistics computed using Newey-West robust standard errors. Pseudo-R^2 is computed as the squared correlation coefficient between the actual and fitted dependent variable. In Model 2, I′, ΔR, ΔU, and K'_{t-1} are all divided by total switched access lines.