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PHOENIX CENTER POLICY PAPER SERIES

Phoenix Center Policy Paper Number 33:

The Broadband Efficiency Index: What Really Drives Broadband Adoption Across the OECD?

George S. Ford, PhD
Thomas M. Koutsky, Esq.
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(May 2008)

Phoenix Center Policy Paper No. 33

The Broadband Efficiency Index: What Really Drives Broadband Adoption Across the OECD?

George S. Ford, PhD†
Thomas M. Koutsky, Esq.*
Lawrence J. Spiwak, Esq.‡

Abstract: In this PAPER, we assess the performance and efficiency of OECD countries with respect to broadband Internet subscription. Using the econometric technique of Stochastic Frontier Analysis, we estimate scores indicating the efficiency with which a country converts its economic and demographic endowments into broadband subscriptions. With very few exceptions, we find that broadband subscription in OECD countries is consistent with those endowments—about two thirds of OECD countries have an efficiency rate of 95% or better. Significantly, the United States has an efficiency index of 96.7%, which is slightly higher than Japan (96.3%) and Korea (95.8%). Consistent with earlier research, we find that economic and demographic endowments explain nearly all of the variation in broadband subscriptions (91%). This finding suggests that public policy's role for broadband adoption may be more effective if it is targeted at improving or mitigating the adverse effects of those underlying demographic and economic conditions, such as computer ownership and education programs. Finally, because countries have different demographic and economic conditions, the most effective mix of policies will vary from country-to-country. As such, our findings indicate that blindly following the policies of countries "ranked" higher in the OECD raw rankings is not likely to result in optimal success.

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† Chief Economist, Phoenix Center for Advanced Legal & Economic Public Policy Studies.

* Resident Scholar, Phoenix Center for Advanced Legal & Economic Public Policy Studies.

‡ President, Phoenix Center for Advanced Legal & Economic Public Policy Studies.

The views expressed in this paper are the authors' alone and do not represent the views of the Phoenix Center, its Adjunct Fellows, or any of its individual Editorial Advisory Board members. We are indebted to Randy Beard, Adjunct Fellow, for his assistance in formulating the economic model presented in this paper.

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I. Introduction

The Internet has become an essential component of communications and a growing body of literature has established the significance of its role in economic growth, productivity and competitiveness. A recent study by Gillett, Lehr & Sirbu (2006) found that communities where broadband was available "experienced more rapid growth in employment, the number of businesses overall, and businesses in IT-intensive sectors, relative to comparable communities without broadband."[1] As a result, many countries have initiated national policies for broadband Internet access and subscriptions and many more are considering such policies. It is not surprising that countries oftentimes feel that they are in the middle of a "Broadband Arms Race" in which the adoption and diffusion of broadband infrastructure and technology is seen as a key to a country's economic future.[2]

In large part, comparisons of broadband infrastructure and adoption among more developed countries are based on the widely-reported figures regarding

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[1] S.E. Gillett, W.H. Lehr & M. Sirbu, *Measuring Broadband's Economic Impact*, Final Report, p. 3 (Feb. 28, 2006) (available at: http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs2006/mitcmubbimpactreport_2epdf/v1/mitcmubbimpactreport.pdf); *see also* G. Ford & T. Koutsky, *Broadband and Economic Development: A Municipal Case Study from Florida*, 17 REVIEW OF URBAN & REGIONAL DEVELOPMENT STUDIES 216 (2005).

[2] Gillett *et al.*, *supra* n. 1, at 3, specifically note that in order for a community to realize many economic gains from broadband, "broadband had to be used, not just available."

broadband adoption across member countries of the Organisation for Economic Co-Operation and Development ("OECD"). These raw "broadband subscriptions per capita" data and the rankings thereof are reported by the OECD on a biannual basis.[3] To make the data more sensibly comparable across countries with widely disparate populations, the OECD normalizes (or conditions) the data on population, expressing subscription counts in per-capita terms. However, as the significant differences across OECD countries are not limited to population, citing to raw OECD data—without further analysis—presents a misleading picture of broadband adoption and provides a poor basis upon which responsible public policy can be developed.[4] A more relevant comparison of broadband success takes into account a wide range of economic and demographic endowments, looking not to raw subscriptions as an efficiency measure but rather at a failure to perform up to expectations. Put simply, a country with low GDP can be a more "efficient" adopter of broadband than a rich country even if its raw, broadband subscriptions per capita rate is lower.

In PHOENIX CENTER POLICY PAPER NO. 29, we first proposed a tool to make such comparisons.[5] Using broadband subscriptions and country-specific data on income, income inequality, education attainment, age, and so forth, we used regression analysis to calculate a predicted broadband subscription rate and then compared this to the actual subscription rate. This difference, which equals the disturbance of the regression, was then normalized to become the Broadband Performance Index ("BPI").[6] Countries that fell well short of expectations were deemed poor performers, and those that were above expectations were good performers. Most countries performed in line with expectations, but there were a few obvious special cases of over- and underperformance.

In this PAPER, we build upon our prior work by using a different approach to assess and compare the adoption of broadband in the thirty OECD countries.

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3 The latest OECD broadband data (to December 2007) is available at http://www.oecd.org/sti/ict/broadband. The OECD updates this data every six months.

4 *See, e.g.*, C. Holahan, *The Sad State of U.S. Broadband*, BUSINESS WEEK (May 22, 2008).

5 G.S. Ford, T.M. Koutsky & L.J. Spiwak, *The Broadband Performance Index: A Policy-Relevant Method of Comparing Broadband Adoption Among Countries*, Phoenix Center Policy Paper No. 29 (June 2007)(available at: http://wwwe.phoenix-center.org/pcpp/PCPP29Final.pdf). For an analysis of the United States, *see* G.S. Ford, T.M. Koutsky & L.J. Spiwak, *The Demographic and Economic Drivers of Broadband Adoption in the United States*, Phoenix Center Policy Paper No. 31 (Nov. 2007) (available at: http://wwwe.phoenix-center.org/pcpp/PCPP31Final.pdf).

6 *See* Section II.A, *infra*, for the calculation.

Here, we calculate a Broadband Efficiency Index ("BEI"), which is derived (directly) using the regression technique of Stochastic Frontier Analysis ("SFA"). With this alternative, the "technical efficiency" with which endowments are converted into the subscription can be separated from the typical econometric disturbance. The BEI, which is computed within the estimation technique, measures how far a country is from the frontier of broadband subscription (that is, the subscription rate observed under optimal efficiency). The further a country is from the frontier, the lower its efficiency.

For comparison purposes, we estimate and compute in this paper both the BPI and the BEI using the most-recent OECD data. Despite the theoretical and practical differences in computation, the two measures of performance yield very similar results. Greece, Ireland, Slovakia, the Czech Republic, New Zealand and Luxembourg are all relatively poor performers. In contrast, Iceland, Belgium, and Portugal are exceptional performers, with broadband adoption rates well above expectations. The other OECD countries are all good performers, meaning that they are currently converting their demographic and economic endowments into subscriptions at a very high rate of efficiency. Significantly, the United States has an efficiency index of 96.7%, which is slightly higher than the purported "broadband miracles" of Japan and Korea (96.3%, 95.8%),[7] consistent with the results of our earlier paper. As a result, our new findings again reveal that the United States is improperly criticized in for lagging behind its peers in broadband adoption.[8] In addition, our results suggest that the common legal and policy framework for telecom in the European Union ("EU") has not led to common results. There is a wide variety in efficiency among EU membership, with some EU countries exhibiting low efficiency.

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[7] *See* T. Ebihara, "Understanding the Japanese Broadband Miracle," (Apr. 7, 2007) (available at: http://www.itif.org/files/Ebihara_Japanese_Broadband.pdf); C.P. Larsen, "Experiences from Korea," p. 8 (Jan. 20-27, 2006) (available at: http://www.acreo.se/upload/Publications/Events/Bredband-060207-Larsen.pdf); I. Tuomi, EU Joint Research Center, "The Korean Broadband Miracle" (2004) (available at: http://www.meaningprocessing.com/personalPages/tuomi/articles/KoreaMiracle.pdf); *see generally* T. Bleha, *Down to the Wire,* 84 FOREIGN AFFAIRS 111 (2005) (noting that Japan and South Korea "will lead the charge in high-speed broadband over the next several years").

[8] For example, *see* Letter from Consumer Federation of America, *et al.* to Chairman Kevin J. Martin, Chairman, Federal Communications Commission (U.S.) (Nov. 13, 2007) (available at: http://www.publicknowledge.org/pdf/fcc-letter-20071113.pdf), which claims that "[t]he U.S. is clearly trailing most of our major economic rivals in broadband speed transmission speed, investment, subscribership and competitiveness."

We believe that our findings are relevant to telecom policymakers worldwide. It is important for policymakers to understand the conditions that drive the rate of broadband adoption and the extent to which telecom policy may have a role. It is not uncommon for advocates to claim that a country is "behind" a peer in "broadband subscriptions per capita" to support a desired policy outcome, but our analysis demonstrates that such arguments are likely misguided. Raw subscription rates are exceedingly poor indicators of relative efficiency. While we believe that telecom policy can play an important role in the diffusion and adoption of broadband technology, its influence and motivation is complex. What we attempt to do in this PAPER is provide a basis for understanding the factors that drive broadband adoption and provide some methods for policymakers to examine targeted responses to the particular conditions that may be holding back the pace of broadband adoption in their country. For example, we show below that income inequality is a major factor that explains the rate of broadband adoption in the United States, so programs targeted at mitigating that effect (such as computer training and ownership programs) may be an effective means of driving up the overall rate of adoption.

This PAPER is organized as follows. In Section II, we provide the basic theoretical underpinnings of the estimation approaches and calculations of the efficiency measures (i.e., BPI and BEI). Next, in Section III, we summarize the details of the estimation. Results are summarized in Section IV, with conclusions in Section V.

II. Empirical Framework

Our statistical approach is straightforward. Using data on broadband subscription rates and demographics across the OECD, we first employ our technique set forth in POLICY PAPER NO. 29 and use a regression analysis to quantify the relationship between economic and demographic endowments and subscription. In particular, we examine GDP per capita, income inequality, education, population age, population density, relative size of the country's largest city, household size, business size, telephone penetration, and the price of broadband services.[9] We find that each one of these demographic and economic conditions is a statistically significant determinant of broadband subscription. In

[9] Throughout this paper we called these demographic and economic conditions "endowments." We regard them as such because telecom policymakers generally have very little control over these conditions. As a result, broadband policy at best can only affect the efficiency with which a country's economy converts these endowments into broadband subscriptions.

fact, taken together, our regression shows that these factors explain 91% of the differences in the broadband subscription rate of the 30 OECD countries.

Using the results of that regression, we then compare the actual and predicted subscription rates to see whether a country meets, exceeds, or falls below what would be reasonably expected given its demographic and economic endowments. In this PAPER we use two methods of making this comparison. In our first effort at developing a policy-relevant means of comparing broadband adoption across countries, we computed a Broadband Performance Index ("BPI"), derived from the difference in actual and predicted subscription, for each OECD country as a simple index with which to compare how that country performs relative to expectations.[10] In contrast, the BPI calculation was relative. Stated simply, the BPI benchmarked the broadband penetration of one country relative to the poorest performer in the OECD and generated an index from that comparison. In this PAPER, we employ Stochastic Frontier Analysis to generate a measure of performance directly. Unlike the least squares method of our earlier PAPER, the frontier analysis computes a measure of efficiency as part of the estimation process itself that is separate and independent from statistical noise. We call this measure of performance the Broadband Efficiency Index ("BEI").

Stochastic Frontier Analysis ("SFA") is ideally suited to comparing the performance of OECD countries with regard to broadband subscription rate. In essence, SFA is a linear regression technique (estimated by maximum likelihood) with a disturbance that has two components—a standard two-sided disturbance and an additional strictly non-negative disturbance.[11] In the present context, this latter part of the disturbance is a directly estimated measure of performance in that it captures inefficiency in the conversion of endowments into broadband subscription. With SFA, statistical noise and efficiency are separated, so that an arguably cleaner measure of performance is rendered (at least relative to the BPI).[12]

While the frontier approach seems suited to this challenge, it is not without its problems. Least squares estimation is exceedingly robust, but frontier models

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10 *Supra* n. 5.

11 For discussions of SFA, *see, e.g.*, S. C. Kumbhakar & C. A. K. Lovell, STOCHASTIC FRONTIER ANALYSIS (2000); W. Greene, ECONOMETRIC ANALYSIS (2000), 394-97; T. J. Coelli, D. S. Rao, C. O'Donnell & G. Battese, AN INTRODUCTION TO EFFICIENCY AND PRODUCTIVITY ANALYSIS (2005).

12 The additional disturbance term must be estimated, however, and in some cases no inefficiency component can be extracted from the data.

are estimated by maximum likelihood and convergence can be fickle to model specification. In some cases, the efficiency measure cannot be adequately estimated and the frontier approach devolves into least squares. In other cases, convergence is not achieved. However, using the general empirical format of POLICY PAPER NO. 29, we are able to get sensible results for both least squares and frontier specifications.

In this PAPER we calculate both the BPI and the BEI, so we can compare the results of the two approaches. Doing so provides similar, but not exact, predictions regarding efficiency. The strongest evidence of good and bad performance is generally consistent across both procedures. Consequently, if the frontier analysis fails to converge or poorly estimates the efficiency measures, the least squares approach of the BPI remains a viable option.

A formal description of our econometric approach is as follows. Let the relationship between (per capita) broadband subscription and a country's endowments be $f(X_i,\beta)$, so that

$$B_i = f(X_i, \beta)\,. \tag{1}$$

Given the standard disturbance term of least squares regression, we have

$$B_i = f(X_i, \beta)\exp(v_i)\,. \tag{2}$$

If there are k endowments, then Equation (3) can be expressed in econometric form as:

$$\ln B_i = \beta_0 + \sum_{j=1}^{k} \beta_j \ln X_j + v_i\,, \tag{3}$$

which is the model estimated by POLICY PAPER NO. 29. Using the estimates from Equation (3), in POLICY PAPER NO. 29 we then compute the Broadband Performance Index ("BPI") as

$$BPI = \hat{v}_i \,/\, \max(|\,\hat{v}_i\,|)\,, \tag{4}$$

where the BPI is scaled so that it lies between -1 and 1, with larger (more positive) values indicating better performance than endowments would suggest (and negative values poor performance). A value near zero indicates performance is consistent with the country's demographic and economic endowments.

A problem with this approach is that the disturbance v measures not only variations in the efficiency of endowment conversion but also statistical noise. Ideally, this noise could be separated from the measure of efficiency, thereby providing more useful policy guidance. Further, efficiency should be measured from an ideal performance, so the efficiency measure needs to be one-sided.

To incorporate efficiency into the estimation process itself, let θ capture the varying degrees of efficiency in the conversion of endowments to subscription. Now, Equation (2) becomes

$$B_i = f(X_i, \beta)\theta_i \exp(v_i) \tag{5}$$

where θ_i is the level of efficiency for country i [where $0 < \theta \leq 1$]. When $\theta = 1$, the country is optimally efficient in its conversion of endowments into subscription; a value of $\theta < 1$ indicates some degree of relative inefficiency. (Of course, efficiency can only be established relative to the countries in the sample.) Efficiency cannot exceed the ideal, so $\theta \leq 1$. The econometric specification of the regression model becomes:

$$\ln B_i = \beta_0 + \sum_{j=1}^{k} \beta_j \ln X_j + v_i - u_i \ . \tag{6}$$

where $u_i = -\ln(\theta)$ if we restrict $u_i > 0$ then we have $0 < \theta \leq 1$. Equation (6) is the standard specification for Stochastic Frontier Analysis ("SFA") where the term u_i is the estimated inefficiency term, which is strictly positive (one-sided). If there is no efficiency variation (either it is zero or cannot be estimated), then Equation (6) is identical to Equation (2) and we have least squares estimation.

Practically, the term u measures the percentage by which a country fails to achieve the ideal conversion rate of endowments into broadband subscriptions. The error term v_i, alternately, is a standard two-sided disturbance and captures the statistical noise. In estimation, the distribution of u_i must be specified and available distributions are the exponential, truncated normal, half normal, among others. We assume the distribution of u is exponential.[13]

From Equation (6), the Broadband Efficiency Index ("BEI") is computed using

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13 The ranking of efficiency is typically robust to distributional assumptions, though the efficiency measure itself may vary. Coelli *et al.*, *supra* n. 11, at 252.

$$BEI = \exp(-u_i)\,, \tag{7}$$

where the BEI is simply the "technical efficiency" parameter θ from SFA. The BEI has a maximum value of 1.0 and a minimum value of 0.0. Values closer to 1.0 imply greater efficiency, with a value of 1.0 indicating optimal efficiency.

III. Empirical Details

For estimating Equations (3) and (6), we use the broadband subscription data published biannually by the OECD. The last three periods of available data are used to render a sufficient sample size of recent data. Given the short period covered (18 months), we do not treat the data as a panel.[14] The explanatory variables are identical to those used in POLICY PAPER NO. 29 with two exceptions—both the subscription and price data are updated.[15] Further details are as follows.

A. *Regressors and Expectations*

The vector *X* contains 14 variables including a constant term. *PRICE* is an index of broadband price in country *i*, *GDP* is gross domestic product per household in country *i*, *GINI* is the nation's Gini Coefficient (a measure of income inequality) in country *i*, *EDUC* is the percent of persons with post-secondary or tertiary education in country *i*, *AGE65* is the percent of the labor force age sixty-five or older as a percentage of the labor force in country *i*, *DENSITY* is the number of households per square kilometer in country *i*, *BIGCITY* is the percent of the population living in the country's largest city in country *i*, *PHONE* is the number of telephones (landline and mobile) per 100 persons in country *i* and $PHONE^2$ is its square to allow for non-linearity,[16] *HHSIZE* measures persons per household in country *i*, *BUSSIZE* measures persons per business establishment in country *i*, and *JUNE07* and *DEC06* are dummy variables that equals 1 for the relevant period of the data (0 otherwise). All continuous variables are in natural log form.

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14 Panel estimation was attempted, but we were unable to estimate non-zero technical efficiency parameters.

15 We also corrected a coding error for Australia's household size.

16 Specification tests indicated a non-linear relationship with respect to *PHONE*, so we include the square of the regressor.

Based on earlier research, we have the following expectations regarding the regressors. The following variables are expected to have negative signs: *PRICE* (though we cannot claim that Equation 1 is a demand curve), *AGE65*, *GINI*, *BUSSIZE* and *PHONE*^{2}.[17] Positive signs are expected on these variables: *GDPCAP*, *EDUC*, *DENSITY* and *PHONE.* We do not have an a priori expectation for the *BIGCITY* since *DENSITY* is held constant. Furthermore, a large urban population is not simply a measure of population density but may reflect other factors. We make no *a priori* predictions on the sign of *HHSIZE* due to conflicting effects. *HHSIZE* might be negative since it "corrects" for the per-capita nature of the dependent variable (only one connection is needed per household), but larger households may have larger demands for broadband services. The time dummy variables are expected to have negative signs, since broadband subscription grows over time.

B. *Data Sources*

The bulk of the data is provided by the OECD FACTBOOK 2006 and the World Bank's WORLD DEVELOPMENT INDICATORS 2006.[18] Subscription rate data, ranking, and population are provided by the OECD. We estimate the model using the latest three periods of data for a total of 90 observations (December-06, June-07 and December-07). Most of the regressors are at least three-year lags (with the exception of *PRICE*), due to data availability.[19] Using lagged values has some advantages, since it commonly asserted that broadband impacts economic development and other economic and demographic factors. Thus, the lagged data helps attenuate the potential for simultaneity bias.[20] We use the last year of data available for all periods. All values of the regressors are constant over the sample.

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17 The variable *BUSSIZE* is expected to be negatively signed since the subscription data is in per capita terms. In other words, larger values of *BUSSIZE* indicate fewer businesses thereby indicating fewer business subscriptions on a per capita basis.

18 Organisation of Economic Co-operation and Development, OECD FACTBOOK—ECONOMIC, ENVIRONMENTAL AND SOCIAL STATISTICS 2006 (available at: http://miranda.sourceoecd.org/vl=632386/cl=39/nw=1/rpsv/fact2006/); World Bank, WORLD DEVELOPMENT INDICATORS 2006.

19 With few exceptions, the variables used in the regression change very slowly, if at all, over time.

20 D. Gujarati, BASIC ECONOMETRICS (1995), 654. This choice of lag was also motivated by the available data.

Price data is provided by an OECD report providing detailed price data for broadband services.[21] Of all the variables, price is the most difficult to measure since there are many prices paid for broadband services in a population. Further, most of the subscriptions were not initiated under the current price, so simply using current average advertised rates may lead to incorrect results. Any single measure of price cannot be exactly indicative of prices paid. Nevertheless, we expect price to be an important determinant of subscription, so we include the variable as a regressor. While the price variable has the expected sign and is statistically significant in the regressions, we nevertheless caveat our findings by observing that a single index of price for broadband service suffers from numerous shortcomings. Others have done the same.[22]

Data on *GDPCAP*, *EDUC*, *AGE65*, *DENSITY*, *TAXES*, and *PHONE* are all provided by the OECD FACTBOOK 2006. WORLD DEVELOPMENT INDICATORS also provided data for *BIGCITY*. Missing observations on some variables were filled using other data sources. Notably, the *BUSSIZE* variable is computed using population and business establishment data, the latter of which was unavailable for four countries.[23] We estimate using least squares regression the number of business establishments for the four countries from the data available.[24]

C. *Estimation Specifics*

Since the subscription rate is akin to a penetration rate, we estimate Equation (3) by weighted least squares ("WLS") to account for the non-constant variance of the dependent variable.[25] In the natural log form, the variance of B_i is $(1 - B_i)/N_i{\cdot}B_i$ where N is population, so the least squares and frontier regressions are weighted with $N_i{\cdot}B_i/(1 - B_i)^{0.5}$. We use the same weight for the frontier estimation, and the inefficiency component of the error is assumed to follow the

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[21] Organisation of Economic Co-operation and Development, OECD COMMUNICATIONS OUTLOOK 2007 (available at: http://213.253.134.43/oecd/pdfs/browseit/9307021E.PDF), Tbl. 7.14.

[22] S. Wallsten, *Broadband and Unbundling Regulations in OECD Countries,* AEI-Brookings Joint Center Working Paper No. 06-16 (June 2006) (available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=906865).

[23] These countries include Australia, Canada, Greece and Japan.

[24] *See* Greene, *supra* n. 11, at 259-63; R. Pindyck and D. Rubinfeld, ECONOMETRIC MODELS & ECONOMIC FORECASTS (1991), 219-23. The same approach was adopted in Ford *et al*. (June 2007), *supra* n. 5.

[25] G. S. Maddala, LIMITED DEPENDENT AND QUALITATIVE VARIABLES IN ECONOMETRICS (1983), 29. This specification is the minimum chi-square method for the linear and log-linear model.

exponential distribution. Convergence of the SFA was fickle, but was achieved in this specific format.

IV. Results

The econometric results and descriptive statistics are summarized in Table 1. Model 1 is estimated by WLS and Model 2 by SFA. The coefficient estimates across techniques are similar. Table 2 provides the BPI and BEI estimates for each country, and the countries are sorted by relative efficiency scores. Each country's ranking for the latest available broadband raw subscription data is also provided in the table.

Both models exhibit good statistical significance, with all regressors significant at the 5% level or better.[26] All signs are as expected. The (unweighted) R^2 of Model 1 is 0.91, so 91% of the variation in sample broadband subscription rates is explained by the model. Consequently, non-policy variables explain nearly all variations in subscription rates. For the least squares model, we cannot reject the null hypothesis of RESET ("no specification error") at even the 10% level, but the null hypothesis of White's test ("homoscedastic disturbances") is rejected.[27] So, robust standard errors are used. For Model 2, the ratio of the standard deviations of the inefficiency and noise components is 0.79 ($\lambda \approx 0.79$), so the inefficiency components is nearly as variable as the statistical noise.

A. *Marginal Effects and Influence*

Marginal effects for Model 1 are interpreted as those from an *average* effects model. The coefficients from Models 2 and 4, alternately, describe the *frontier*. Note that in Model 2, the estimated coefficients are unbiased and consistent except for the constant term. Typically, frontier analysis focuses on efficiency estimates, rather than the coefficients, but we also summarize the marginal effects from this model.

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26 Note that robust standard errors are used to compute the t-statistics for Models 1 and 3.

27 Given the large number of regressors, White's test for heteroscedasticity is based on regressing the squared residuals on the fitted and square of the fitted value from the regression. As detailed by Wooldridge, this test is useful in that the test statistic (χ^2) has only two degrees of freedom yet remains asymptotically valid. It is a special case of White's test for heteroscedasticity. J. Wooldridge, ECONOMETRIC ANALYSIS OF CROSS SECTION AND PANEL DATA (2002), 126-27, 177-78.

For Model 1, the marginal effects are as follows. Other than the time dummies, the largest effect is *PHONE*, with an elasticity of 2.0 (computed at the sample mean). Second is *GINI* with an elasticity of -1.2, and then *GDPCAP* (0.58), *AGE65* (-0.55), *PRICE* (-0.39), *HHSIZE* (0.35), *BUSSIZE* (-0.23), *EDUC* (0.20), *BIGCITY* (-0.20) and *DENSITY* (0.03). The partial R^2 values for the regressors are *AGE65* (0.66), *GINI* (0.54), *PRICE* (0.42), *GDPCAP* (0.38), *BUSSIZE* (0.33), *BIGCITY* (0.31), *PHONE* (0.27), $PHONE^2$ (0.26), *EDUC* (0.20), *HHSIZE* (0.12) and *DENSITY* (0.09). For both measures of influence, it appears that income, price, population age, and historical telephone demand are the key determinants of broadband subscription. The influence of *BUSSIZE* indicates that ranking countries on the basis of "per-capita" broadband connections (as the OECD does) may be an inherently flawed method of normalizing data.[28]

The marginal effects from Model 2 are very similar to those from Model 1 (as expected). For Model 2, the largest effect is again *PHONE*, with an elasticity of 2.84 — a very large effect. Second is *GINI* with an elasticity of -1.14, and then *GDPCAP* (0.55), *AGE65* (-0.55), *PRICE* (-0.31), *HHSIZE* (0.24), *BUSSIZE* (-0.19), *EDUC* (0.16), *BIGCITY* (-0.15) and *DENSITY* (0.03). The partial R^2 values for the regressors are *AGE65* (0.66), *GINI* (0.54), *PRICE* (0.42), *GDPCAP* (0.38), *BUSSIZE* (0.33), *BIGCITY* (0.31), *PHONE* (0.27), $PHONE^2$ (0.26), *EDUC* (0.20), *HHSIZE* (0.12) and *DENSITY* (0.09). Again, income, price, population age, and historical telephone demand are the key determinants of broadband subscription.

Table 3 utilizes the results of our regressions to analyze the marginal effects that each regressor has upon broadband penetration in each of the thirty OECD countries. We use the estimates from Model 1. The values in the table are constructed by first computing the contribution of each regressor to the departure of a country's subscription rate from the OECD mean subscription rate.[29] We then express this contribution as a percentage of all the contributions of the regressors.[30]

Table 3 demonstrates the magnitude, in percentage terms for comparability, which a particular factor plays in explaining each particular country's expected

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28 On this point, *see also* S. Wallsten, *Understanding International Broadband Comparisons,* Technology Policy Institute (May 2008).

29 If β is the coefficient, X_i the country's regressor value, and X the mean, the contribution is $\beta(X_i - X)$.

30 Each regressor's contribution is $\beta(X_i - X)$, so the values in the table for Country i and regressor j are $\beta_j(X_{ji} - X_j)/\Sigma|\beta_j(X_{ji} - X_j)|$.

rate of broadband adoption in reference to the OECD mean. For example, the *PRICE* variable has a negative sign, so a country with a relatively high price will have a lower expectation of broadband subscription. The high price in the Czech Republic, which is 16% above the sample average, explains 17.1% of the country's negative departure from the sample mean. Conversely, the Czech Republic's smaller than average business size (*BUSSIZE*) drives up its expected broadband subscription level by 20%.

Table 3 helps explain why there can be dispute between commentators over the importance of certain factors—because not every factor plays a role in every country.[31] For example, consider population density (*DENSITY*), which our analysis shows to be significant in many countries but which some commentators dispute.[32] Table 3 shows that *DENSITY* plays a major role in explaining the broadband adoption rate in countries like Australia (-20.2%), Belgium (+10.4%), Canada (-21.7%), Finland (-10.1%), Japan (+11.8%), the Netherlands (+10.1%), and New Zealand (-11.6%), which all have population densities substantially departing from the OECD average. Population density also plays a smaller but not insignificant role in the United States (-3.3%) but other factors (notably income inequality, *GINI)* play a more important role. In other words, population density does matter—but to a different degree in the thirty OECD countries. This observation accentuates our finding that appropriate broadband policies need to be nuanced and tailored for a country's particular demographic and economic condition.

In interpreting Table 3, one should not regard large percentage contributions to imply that there are large departures from the mean of the regressors, however. If a country is average in all respects except for, say, *DENSITY*, then 100% of its departure from the sample mean subscription rate will be explained by *DENSITY*, even if the departure is small. For this reason, we have included the predicted and sample average values of $\ln B_i$ and the percentage difference of the two. An examination of the data suggests that in most cases, however, large

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31 The primary defect in the "density does not matter" argument is that those making such claims operate in a univariate setting. For example, density may strongly related to subscription, but if high density countries have relatively higher prices or low incomes (or differences in a variety of other factors), the variation across countries in these other factors can mask the role of density in a univariate framework. Univariate analysis is rarely useful, and the true influence of density can only be determined in a multivariate setting like that used here.

32 *See* Ebihara, *supra* n. 7, at 5; *see* Daniel K. Correa, *Assessing Broadband in America: OECD and ITIF Rankings* (Apr. 2007), 5-6 (available at: http://www.itif.org/files/BroadbandRankings.pdf).

values in Table 3 are associated with large departures from the sample mean of the regressors (and this is true for *DENSITY*). But, large departures from the mean are not always associated with large values in the table, since in some cases there are more influential variables. In fact, Korea's density is further from the mean than Japan's, but the influence of *AGE65* in Korea overwhelms the effect of *DENSITY*.

B. *Measures of Performance*

Our measures of performance, the BPI and BEI, for the four models are provided in Table 2. An illustration of the BEI is provided in Figure 1. The efficiency measures are averaged over the three periods of data for presentation, and the countries are sorted by relative performance.

For about two-thirds of the OECD countries, the BEI is 0.95 or better, indicating that most countries are performing very well in terms of converting endowments into broadband subscription. As already mentioned, the endowments explain almost all of the variation in subscription (91%), so there is little room for inefficiency explanations.

Surprises among the top performers are Portugal, Belgium and Turkey. Portugal, arguably a poor performer with a raw subscription rank of 23rd, is actually the 3rd best performer with a BEI of 0.983. While Portugal's overall subscription rate is low, the country's expected subscription is reduced by its unfavorable endowments for *GDPCAP*, *GINI*, and *EDUC*, as shown in Table 3. Belgium is ranked 12th in the raw OECD data, but its efficiency score is 0.99. Turkey likewise is indicated as having respectable efficiency (BEI 0.963) despite being ranked 29th in the raw subscription data.

These surprises are important because they can provide policymakers a more nuanced view of broadband adoption trends. If you were simply to look at the OECD rankings, then you would not likely give Portugal, Belgium and Turkey a second thought. Our tools instead indicate that they are models worthy of study and even possibly emulation.

The opposite is true—having a high ranking by the OECD does not mean that a country is doing a particularly good job. For example, Luxembourg is a very weak performer on our efficiency index (BEI 0.769) given its subscription rank (9th). The poorest performers are unquestionably Greece (BEI 0.619), the Slovak Republic (BEI 0.651), Ireland (BEI 0.696), the Czech Republic (BEI 0.755), and Luxembourg (BEI 0.769). This same set of countries is also labeled poor performers by the BPI. It seems these countries have the most to be concerned about regarding broadband subscription.

It is also interesting to observe that Japan (BEI 0.958) and South Korea (BEI 0.963), sometimes touted as broadband policy "miracles,"[33] are middle-of-the-pack performers in the OECD, according to the BPI. The U.S. is slightly more efficient than both with a (point estimate) BEI of 0.967 (which is close enough to conclude they are statistically equal). In addition, the BEI reveals a significant difference between EU member states, with some ranking near the top and others near the bottom. This indicates that while there is a common legal framework for telecom policy in the EU, to date there is nothing close to common results.

C. *Calculating the Frontier*

In Table 4, we provide the December 2007 subscription rates for the OECD countries in two forms. In the first column, the actual subscription rate as published by the OECD is provided, and the second column ranks these rates. These are the data commonly cited in discussions of relative performance across OECD countries with respect to broadband subscription.

In the third column of the table, the frontier subscription rate is listed. The frontier is computed by setting the measure of technical efficiency (the BEI) for all countries equal to 1.0. Remaining differences between the actual and frontier subscription rates are accounted for now only by the statistical noise normally included in the random disturbance term of a regression. Note that if the two-sided error term v from Equation (6) is large enough, the frontier subscription rate may be below the actual subscription rate.

Table 4 demonstrates that the broadband "rankings" released by the OECD and used continually by advocates, in fact, have very little to say about the efficiency of broadband adoption. Table 4 shows that with a few exceptions, the rankings of actual and frontier subscription rates are similar. This means that even if all OECD countries were perfectly and equally efficient in converting endowments to broadband penetration, that action often has very little effect on the final raw "rankings" that the OECD reports. Demographic and economic conditions so pervasively drive the broadband subscription per capita number that utilizing the "ranking" of OECD countries, conditioned only on population, to advocate for or against broadband policy changes is nonsensical.

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33 *See supra* n. 7.

Our method of analysis strongly indicates that "ranking" countries by broadband subscriptions per capita makes little sense. One can use our tools to determine where any particular country would rank if it was optimally efficient in converting its endowments into broadband subscriptions ((BEI = 1.0) and then derive its rank. This "what if" approach in essence provides a "ceiling" for each country's broadband ranking among the OECD. For instance, if Luxembourg became optimally efficient, then it would lead the OECD in broadband. On the other hand, if the United States were optimally efficient, then its December 2007 rank would be 14^{th}—only one place higher than its actual rank of 15^{th}. This analysis demonstrates that using the per capita rankings as a basis for making policy comparisons and decisions is a fool's errand.

D. *Efficiency Improvements*

For the analysis of performance just presented, we compute the BPI and BEI as an average over the three time periods of data in the sample. By comparing the SFA efficiency index from last and first period of data, we can determine which countries are most significantly increasing their efficiency over time. We suspect that the least efficient countries will improve the most, and this result would suggest that the OECD countries are converging to a more efficient outcome.

Table 5 presents the ratio of the BEI from December-07 to the BEI from December-06 (BEI_{D07}/BEI_{D06}) from Model 2. All the BEIs are summarized in the table. The larger the ratio, the larger the increase in the efficiency over the twelve month period. In Table 5 we see that Greece and to a lesser extent the Slovak Republic, both poor performers, are significantly improving in efficiency over time. In the eighteen month period, the efficiency of Greece countries rose by about 67%. Ireland is improving as well, with about a 22% improvement in efficiency. We observe modest improvements in efficiency for other poor performers including the Czech Republic (1.105) and Luxembourg (1.117). Most of the better performers have little room for relative improvement, and this is confirmed in Table 5.

V. Conclusion

The diffusion of broadband technology is perhaps the most significant telecom policy challenge of the last thirty years. Policymakers need to have useful tools that help them determine whether their policies are having an impact on broadband subscription. Unfortunately, while countries are routinely "ranked" by organizations like the OECD on their broadband subscription rates, those postings and surrounding rhetoric have very little analytical foundation for showing that there are *policy-relevant* differences between countries that explain those rankings. Our analysis suggests that broadband adoption is intimately tied to demand-side factors like income inequality and education, and policies directed at those factors may be more cost effective than supply-side subsidies and regulation. While not particularly useful rhetorically, the fact is that demography, geography, and economic conditions affect the rate of broadband adoption and those conditions cannot necessarily be affected directly or indirectly by communications policy.

We do not mean to suggest that policymakers should be content with the current level of performance, or that broadband policy is irrelevant. Indeed, our results should encourage policymakers to focus their attention on policies that will cultivate or enhance the endowments that increase broadband adoption or that will counterbalance the adverse effects of endowments that suppress broadband adoption. For example, programs focused on overcoming the effect of income and income inequality might significantly spur broadband adoption. ConnectKentucky's "No Child Left Offline" program is an example of such a program.[34]

Broadband policy is a serious issue and policymakers deserve serious tools of analysis. We find herein that much of the rhetoric regarding broadband "rankings" and "broadband miracles" is suspect at best. In fact, the "better" performers in a rhetorical sense often fail to live up to expectations. In particular, both Japan and Korea rank below the United States, Canada and France in broadband efficiency, which suggests that their relatively high rates of broadband adoption have less to do with different telecom policy approaches and more to do with demographic and economic conditions such as population density and age. Even though Japan and Korea have fiber optic networks serving large portions of the population, these advanced networks appear not to have influenced substantially broadband adoption. Our analysis shows that broadband adoption in Iceland, Portugal and Belgium are substantially more efficient in converting their demographic and economic conditions into broadband subscriptions than Japan, Korea, Germany and the United States.

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34 B. Marshall, *No Child Left Offline,* RICHMOND REGISTER (Sep. 25, 2007) (available at: http://connectkentucky.org/NR/rdonlyres/378120B6-E7D2-48E4-AC58-9FCA2C588E6A/0/Article_NCLO_ModelLab_92507.pdf). Obviously, the subscription to broadband service is dependent on computer ownership, and many poorer households cannot afford a computer. *See, e.g.,* http://www.connectkentucky.org/technology_solutions/no_child_left_offline.php. The Kentucky program aims to provide low cost or free computers to low income households.

As always, this analysis should be considered one part of the portfolio of evidence needed to drive public policy. Further research is warranted and encouraged.

Table 1. Summary of Econometric Results

	Model 1 WLS	Model 2 SFA	Mean
	Coef. (t-stat)	Coef. (t-stat)	Mean [St. Dev.]
Constant	-14.457	-15.392	…
	(-6.01)*	(-6.01)*	
lnPRICE	-0.395	-0.314	3.863
	(-7.44)*	(-5.42)*	[0.29]
lnGDPCAP	0.584	0.551	10.146
	(6.82)*	(6.12)*	[0.42]
lnGINI	-1.183	-1.142	3.419
	(-9.51)*	(-9.66)*	[0.18]
lnEDUC	0.203	0.157	3.092
	(4.34)*	(2.45)*	[0.43]
lnAGE65	-0.550	-0.549	3.247
	(-12.12)*	(-12.77)*	[0.34]
lnDENSITY	0.034	0.030	4.245
	(2.79)*	(2.57)*	[1.41]
lnBIGCITY	-0.196	-0.146	2.792
	(-5.80)*	(-3.47)*	[0.50]
lnHHSIZE	0.345	0.243	1.025
	(3.22)*	(2.14)*	[0.22]
lnBUSSIZE	-0.229	-0.191	3.688
	(-6.13)*	(-4.84)*	[0.56]
lnPHONE	5.818	6.092	4.850
	(5.36)*	(5.19)*	[0.29]
lnPHONE^2	-0.581	-0.600	23.601
	(-5.12)*	(-4.91)*	[2.68]
DEC06	-0.076	-0.024	0.333
	(-3.99)*	(-6.86)*	[0.47]
JUNE06	-0.179	-0.073	0.333
	(-7.32)*	(-3.80)*	[0.47]
Unw. R^2	0.91	…	
RESET F	2.00	…	
White χ^2	10.47*	…	
Obs.	90	90	
$\ln\sigma^2(v)$	…	-5.81*	
$\ln\sigma^2(u)$	…	-6.28*	
λ	…	0.79	

* Statistically significant at the 5% level.

Table 2. Broadband Performance Index and Broadband Efficiency Index

(Rank of Raw Subscription Rate for Dec-07 Data in Parenthesis)

Model 1	BPI	Model 2	BEI
Iceland (3)	1.000	Iceland (3)	0.995
Belgium (12)	0.303	Belgium (12)	0.990
Portugal (24)	0.285	Portugal (24)	0.983
Switzerland (5)	0.171	Switzerland (5)	0.980
Turkey (29)	0.157	Denmark (1)	0.979
Denmark (1)	0.156	Finland (6)	0.977
Finland (6)	0.114	France (13)	0.976
Norway (4)	0.088	Norway (4)	0.975
France (13)	0.072	UK (11)	0.974
Hungary (25)	0.062	Canada (10)	0.972
UK (11)	0.042	Netherlands (2)	0.970
Netherlands (2)	0.040	Sweden (8)	0.967
Sweden (8)	0.026	US (15)	0.967
Canada (10)	0.003	Turkey (29)	0.963
US (15)	-0.002	S. Korea (7)	0.963
S. Korea (7)	-0.006	Hungary (25)	0.960
Spain (21)	-0.012	Japan (17)	0.958
Japan (17)	-0.033	Italy (22)	0.957
Italy (22)	-0.038	Spain (21)	0.956
Poland (27)	-0.046	Poland (27)	0.953
Austria (18)	-0.069	Australia (16)	0.934
Mexico (30)	-0.073	Mexico (30)	0.931
Australia (16)	-0.079	Germany (14)	0.925
Germany (14)	-0.099	Austria (18)	0.906
New Zealand (19)	-0.179	New Zealand (19)	0.880
Czech Rep. (23)	-0.292	Luxembourg (9)	0.769
Luxembourg (9)	-0.336	Czech Rep. (23)	0.755
Ireland (20)	-0.470	Ireland (20)	0.696
Slovak Rep. (28)	-0.491	Slovak Rep. (28)	0.651
Greece (26)	-0.621	Greece (26)	0.619

Figure 1. Broadband Efficiency Index (2006/7)
(Rank of Raw Subscription Rate for Dec-07 Data in Parenthesis)

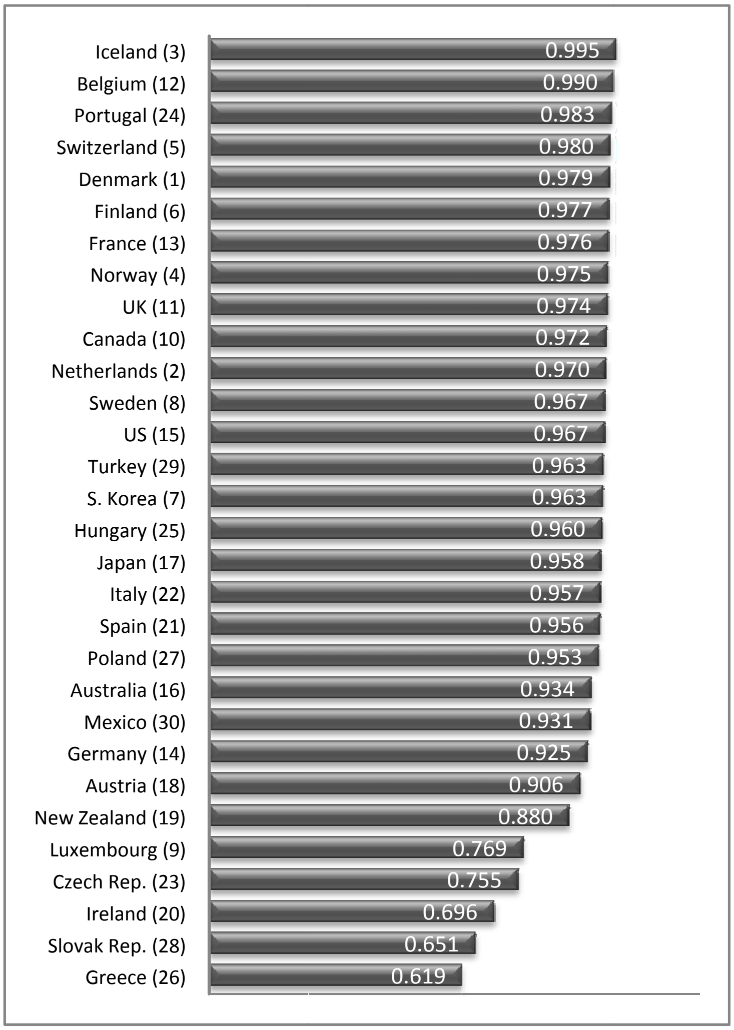

Table 3. Explaining Departures from the Mean Broadband Subscription Rate

(Continued on next page)

Country	Predicted $\ln B_i$	*Diff. from Mean*	*PRICE*	*GDPCAP*	*GINI*	*EDUC*	*AGE65*
		Sign >	-	+	-	+	-
Australia	-1.42	-13.6%	-3.9%	18.7%	0.2%	8.4%	8.8%
Austria	-1.60	-3.3%	-2.1%	20.8%	26.3%	-9.4%	-14.6%
Belgium	-1.59	-3.4%	1.4%	17.8%	-10.7%	6.9%	-33.0%
Canada	-1.34	-18.9%	-3.2%	20.6%	2.2%	18.2%	17.1%
Czech Republic	-1.74	5.4%	-17.1%	-19.2%	14.2%	-9.6%	-2.4%
Denmark	-1.10	-33.5%	11.8%	16.7%	33.6%	7.4%	-5.3%
Finland	-1.22	-26.1%	18.3%	17.2%	22.0%	10.2%	-0.8%
France	-1.50	-9.0%	13.5%	16.8%	18.9%	1.4%	-32.4%
Germany	-1.40	-15.3%	13.6%	8.8%	11.0%	1.8%	-16.1%
Greece	-2.16	30.7%	5.7%	-13.2%	-14.7%	-4.3%	-37.3%
Hungary	-2.07	25.7%	-6.6%	-36.6%	4.8%	-7.9%	-18.5%
Iceland	-1.80	9.2%	-4.0%	10.9%	-21.0%	2.0%	15.7%
Ireland	-1.45	-12.1%	7.3%	33.1%	0.7%	4.3%	9.4%
Italy	-1.74	5.3%	4.4%	5.5%	-12.4%	-13.7%	-27.4%
Japan	-1.46	-11.3%	16.2%	16.2%	-4.4%	14.7%	-4.3%
Korea	-1.11	-33.0%	3.7%	-13.3%	-3.4%	5.0%	43.8%
Luxembourg	-1.14	-30.8%	-1.8%	49.8%	14.2%	-6.2%	-11.3%
Mexico	-3.00	82.2%	-5.0%	-24.6%	-16.7%	-2.7%	21.3%
Netherlands	-1.00	-39.2%	7.6%	16.8%	24.3%	1.9%	5.0%
New Zealand	-1.62	-1.8%	-1.1%	-4.3%	-15.8%	9.9%	18.8%
Norway	-1.22	-25.9%	-6.1%	35.1%	19.5%	7.6%	-6.0%
Poland	-2.42	46.6%	-4.8%	-42.9%	-16.7%	-7.3%	-0.5%
Portugal	-2.08	26.3%	-4.3%	-25.9%	-21.5%	-17.4%	-0.8%
Slovak Republic	-2.30	39.7%	-11.3%	-27.6%	12.0%	-7.7%	2.9%
Spain	-1.68	1.8%	-20.1%	0.5%	2.7%	4.2%	-35.5%
Sweden	-1.20	-27.4%	10.9%	12.4%	24.0%	7.6%	-15.0%
Switzerland	-1.20	-27.3%	13.4%	21.7%	15.5%	4.2%	-0.7%
Turkey	-3.04	84.2%	-6.4%	-33.0%	-14.8%	-5.8%	14.3%
United Kingdom	-1.41	-14.2%	16.6%	21.4%	-9.8%	6.5%	-10.3%
United States	-1.47	-10.9%	-2.9%	25.6%	-13.3%	8.4%	10.0%
Average	-1.65	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3. Explaining Departures from the Mean Broadband Subscription Rate

(Continued from previous page)

Country	*DENSITY*	*BIGCITY*	*HHSIZE*	*BUSSIZE*	*PHONE*
	+	-	+	-	+
Australia	-20.2%	-7.1%	2.1%	23.8%	5.5%
Austria	2.2%	-10.4%	2.2%	-5.2%	5.6%
Belgium	10.4%	10.2%	2.2%	0.6%	5.5%
Canada	-21.7%	1.8%	2.3%	10.8%	1.6%
Czech Republic	2.6%	4.1%	-6.4%	20.0%	5.6%
Denmark	3.1%	-7.7%	-8.0%	-1.5%	4.8%
Finland	-10.1%	-0.9%	-10.2%	-3.9%	5.0%
France	3.6%	-1.1%	2.6%	-2.8%	4.6%
Germany	6.3%	12.0%	-8.2%	-16.6%	5.5%
Greece	1.1%	-11.7%	1.9%	4.5%	5.2%
Hungary	2.4%	-3.6%	1.8%	14.5%	3.1%
Iceland	-9.8%	-12.2%	-4.8%	17.1%	4.1%
Ireland	-1.3%	-11.8%	2.3%	-22.6%	5.5%
Italy	4.6%	10.4%	1.5%	15.2%	5.5%
Japan	11.8%	-12.9%	2.5%	-10.5%	4.6%
Korea	9.1%	-7.6%	7.8%	1.7%	5.1%
Luxembourg	3.3%	-1.3%	1.4%	5.5%	-6.3%
Mexico	-0.5%	-0.9%	3.1%	-2.3%	-64.5%
Netherlands	10.1%	13.2%	-9.0%	-5.8%	5.6%
New Zealand	-11.6%	-11.3%	2.5%	19.0%	3.9%
Norway	-9.4%	-1.9%	2.0%	7.8%	4.2%
Poland	2.4%	8.1%	1.4%	3.4%	-15.2%
Portugal	3.3%	-6.3%	2.2%	11.7%	5.3%
Slovak Republic	1.5%	7.6%	1.1%	-26.2%	-3.5%
Spain	1.7%	8.5%	2.9%	14.7%	5.6%
Sweden	-6.2%	-0.7%	-7.6%	12.7%	3.2%
Switzerland	5.2%	5.3%	-8.4%	-20.5%	4.9%
Turkey	0.5%	1.4%	5.2%	-7.8%	-28.9%
United Kingdom	8.9%	5.1%	2.4%	-11.5%	5.4%
United States	-3.3%	10.9%	1.3%	-21.4%	3.7%
Average	0.0%	0.0%	0.0%	0.0%	0.0%

Table 4. Actual and Frontier Subscription Rates and Ranks (December 2007)

Country	Dec. 2007 Subscription Rate	Rank	Dec. 2007 Frontier Subscription Rate*	Rank
Australia	0.233	16	0.271	11
Austria	0.196	18	0.250	15
Belgium	0.257	12	0.211	20
Canada	0.266	10	0.275	10
Czech Republic	0.146	23	0.249	16
Denmark	0.351	1	0.367	3
Finland	0.307	6	0.320	9
France	0.246	13	0.238	18
Germany	0.238	14	0.268	12
Greece	0.091	26	0.169	24
Hungary	0.136	25	0.143	27
Iceland	0.322	3	0.192	22
Ireland	0.181	20	0.335	5
Italy	0.172	22	0.191	23
Japan	0.221	17	0.255	14
Korea	0.305	7	0.359	4
Luxembourg	0.267	9	0.420	1
Mexico	0.043	30	0.057	29
Netherlands	0.348	2	0.393	2
New Zealand	0.183	19	0.228	19
Norway	0.312	4	0.323	8
Poland	0.088	27	0.096	28
Portugal	0.144	24	0.144	26
Slovak Republic	0.076	28	0.161	25
Spain	0.180	21	0.207	21
Sweden	0.303	8	0.330	6
Switzerland	0.310	5	0.328	7
Turkey	0.060	29	0.053	30
United Kingdom	0.258	11	0.258	13
United States	0.233	15	0.246	17

* Frontier subscription rates may be below actual subscription rates due to statistical noise. Raw rate data from OECD (http://www.oecd.org/sti/ict/broadband).

Table 5. Improvements in Efficiency
(Based on Model 2 Estimates)

Country	BEI_{D07}/BEI_{D06}	BEI Dec. 2006	BEI June 2007	BEI Dec. 2007	Average BEI
Greece	1.673	0.456	0.638	0.762	0.619
Slovak Republic	1.279	0.558	0.681	0.714	0.651
Ireland	1.217	0.625	0.703	0.761	0.696
Luxembourg	1.117	0.740	0.739	0.827	0.769
New Zealand	1.114	0.829	0.889	0.923	0.880
Czech Republic	1.105	0.719	0.753	0.794	0.755
Germany	1.099	0.869	0.951	0.956	0.925
Turkey	1.073	0.920	0.983	0.987	0.963
Australia	1.047	0.905	0.949	0.948	0.934
Poland	1.027	0.937	0.959	0.962	0.953
France	1.009	0.973	0.975	0.981	0.976
United States	1.009	0.962	0.969	0.970	0.967
United Kingdom	1.006	0.972	0.972	0.978	0.974
Austria	1.006	0.909	0.895	0.915	0.906
Belgium	1.000	0.990	0.989	0.990	0.990
Iceland	0.999	0.996	0.995	0.995	0.995
Italy	0.998	0.961	0.951	0.959	0.957
Canada	0.998	0.975	0.967	0.973	0.972
Hungary	0.997	0.974	0.934	0.970	0.960
Norway	0.996	0.977	0.974	0.973	0.975
Sweden	0.996	0.968	0.969	0.965	0.967
Spain	0.994	0.957	0.961	0.951	0.956
Mexico*	0.991	0.912	0.977	0.904	0.931
Finland	0.991	0.981	0.977	0.972	0.977
Portugal	0.990	0.987	0.985	0.978	0.983
Denmark	0.988	0.983	0.982	0.971	0.979
Switzerland	0.984	0.986	0.984	0.970	0.980
Japan	0.982	0.968	0.955	0.950	0.958
Netherlands	0.975	0.980	0.975	0.956	0.970
Korea	0.964	0.979	0.967	0.943	0.963