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George S. Ford, PhD.
Lawrence J. Spiwak, Esq.

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EVALUATING BROADBAND STIMULUS AND THE NATIONAL BROADBAND PLAN: ESTABLISHING EXPECTATIONS FOR BROADBAND RANKINGS

Abstract: The United States has recently reinvigorated its efforts to promote ubiquitous broadband at affordable prices for all Americans by both committing over $7.2 billion in stimulus funds and by requiring the Federal Communications Commission to issue a "National Broadband Plan." The big policy question is how do we evaluate the success or failure of these efforts? Despite the deep analytical defects the Organization for Economic Cooperation and Development's broadband rankings ("OECD"), many people nonetheless continue to use these rankings as a meaningful indicator of success and failure of broadband policy. As such, we briefly suspend criticism to establish a performance metric by which to assess the success or failure of new broadband interventions using the OECD's rankings. Utilizing standard models of diffusion, we estimate the counterfactual broadband subscription rank that can be used as a tool to assess whether these new broadband policy interventions are successful. Based on historical trends and without significant policy changes, the United States will likely increase its rank to 13th by 2012, with a statistical upper limit of ninth position. There is very little risk of a downward movement in rank. Given this trend and presumed analytical legitimacy of the OECD's rankings, our analysis finds that the United States must rank at least ninth among OECD countries within the next two to three years in order for the Obama Administration to claim with confidence that its policy interventions made a measurably positive impact on broadband adoption.

I. Introduction

As a result of the American Recovery and Reinvestment Act of 2009 ("ARRA"), the United States government is spending billions of dollars to increase broadband Internet availability and adoption via a myriad of programs administered by the National Telecommunications and

PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES
5335 Wisconsin Avenue, NW, Suite 440
Washington, D.C. 20015
Tel: (+1) (202) 274-0235 • Fax: (+1) (202) 318-4909
www.phoenix-center.org

Information Administration ("NTIA") and the Rural Utilities Service ("RUS"). The ARRA also requires the Federal Communications Commission ("FCC") to establish a National Broadband Plan "to ensure that all people of the United States have access to broadband capability and shall establish benchmarks for meeting that goal (§6001(k)(1)."[1] The Plan was released in March of 2010. In both the ARRA and the National Broadband Plan, the government has proposed an enormous outlay of both federal funds and manpower. An important question, then, is how do we know whether these programs are successful? As we show below, based on historical trends in the OECD, the United States will likely increase its rank to 13th by 2012, with a statistical upper limit of ninth position, *without significant policy changes*. There is very little risk of a downward movement in rank. Given this trend, our analysis finds that if policymakers continue to insist that OECD rankings should be the primary metric by which we evaluate the success or failure of U.S. broadband policy, then the United States must rank at least ninth among OECD countries within the next two to three years in order for the Obama Administration to claim with confidence that the broadband stimulus funds and the policies recommended by the National Broadband Plan made a measurably positive impact on broadband adoption.

Our analysis comports with statements made in a recent speech by FCC Chairman Julius Genachowski. Previewing the then-forthcoming National Broadband Plan, Chairman Genachowski argued for increased government involvement in broadband adoption and deployment because "we are lagging behind when it comes to broadband", citing to "[m]ultiple studies [that] have the U.S. ranked outside the top 10 when it comes to broadband penetration and speed."[2] Our analysis below reveals that a top 10 position is not only desirable, but also required to conclude (statistically speaking) that the Obama Administration's policies have been successful, at least when viewed through the lens of per capita subscription rankings.

II. Measurements of "Success"

To date, the measurement of "success" in broadband deployment and adoption has relied heavily on crude metrics. The measurement of deployment in the United States, for example, is largely limited to the FCC's database on availability by zip code. This data has been widely and legitimately criticized, since "availability" is achieved if only one household in the zip code has

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[1] CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN (2010) (http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296935A1.pdf)(hereinafter, the "National Broadband Plan").

[2] February 24, 2010 Prepared Remarks of FCC Chairman Julius Genachowski, *Mobile Broadband: A 21st Century Plan for U.S. Competitiveness, Innovation and Job Creation* (available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296490A1.pdf).

broadband service.[3] By far, the most widely used and influential metric for determining the success or failure for broadband adoption relies upon a comparison of broadband adoption across countries, and this measure has been used by the current administration, including President Obama.[4] Of these metrics, the most popular is the OECD's broadband rankings, wherein broadband connections are computed per capita for each country and then ranked from highest to lowest.

The OECD's broadband rankings are not without critics. In fact, we have been critical of the broadband rankings, not so much of the OECD for publishing the data (which is a valuable service), but of the way the OECD presents the data and the way those who improperly use the information for rhetorical purposes and, in some cases, to actually form policy positions.[5]

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[3] *See, e.g.,* U.S. General Accountability Office, *Broadband Deployment is Extensive throughout the United States, but It Is Difficult to Assess the Extent of Deployment Gaps in Rural Areas*, GAO-06-426 (May 2006) (available at: http://www.gao.gov/new.items/d06426.pdf) ("Based on our analysis it appears that these data may not provide a highly accurate depiction of deployment of broadband infrastructures for residential service in some areas (at 3)").

[4] *See, e.g., President-elect Barack Obama Lays Out Key Parts of Economic Recovery Plan* (Dec. 6, 2008) ("It is unacceptable that the United States ranks fifteenth in the world in broadband adoption")(available at: http://change.gov/newsroom/entry/the_key_parts_of_the_jobs_plan); Remarks of Commissioner Michael J. Copps, Pike & Fischer's Broadband Policy Summit IV, Washington, DC (June 12, 2008) ("the latest OECD study ranking the United States a sorry Number 15")(available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-282890A1.pdf); A. Feinberg, *Boucher "Has Some Ideas" on Stimulus Definitions, Looks to Genachowski to Lead on National Plan*, BroadbandBreakfast.com (June 18th, 2009) ("The $7.25 billion appropriated for broadband in the American Reinvestment and Recovery Act is "an historic opportunity" to improve America's rankings among [Organization for Economic Cooperation and Development] nations, Boucher said. America must improve her OECD rankings "for the sake of our national economy," he urged. "I know we can do better.")(available at: http://broadbandbreakfast.com/2009/06/boucher-has-some-ideas-on-stimulus-definitions-looks-to-genachowski-to-lead-on-national-plan). In contrast, *see* R. McDowell (FCC Commissioner), *Broadband Baloney*, WALL STREET JOURNAL (July 24, 2007) at A15 (available at: http://online.wsj.com/article/SB118524094434875755.html?mod=opinion_main_commentaries).

[5] *See, e.g.,* G.S. Ford, T.M. Koutsky and L. J. Spiwak, *The Broadband Performance Index: A Policy-Relevant Method of Comparing Broadband Adoption Among Countries*, PHOENIX CENTER POLICY PAPER NO. 29 (July 2007) (available at: http://www.phoenix-center.org/pcpp/PCPP29Final.pdf); G.S. Ford, T.M. Koutsky and L.J. Spiwak, *The Broadband Efficiency Index: What Really Drives Broadband Adoption Across the OECD?* PHOENIX CENTER POLICY PAPER NO. 33 (May 2008)(available at: http://www.phoenix-center.org/pcpp/PCPP33Final.pdf); G.S. Ford, PHOENIX CENTER PERSPECTIVES NO. 09-01: *Normalizing Broadband Connections* (May 12, 2009) (available at: http://www.phoenix-center.org/perspectives/Perspective09-01Final.pdf); G.S. Ford, PHOENIX CENTER PERSPECTIVES NO. 09-02: *Econometric Analysis of Broadband Subscriptions: A Note on Specification* (May 12, 2009) (available at: http://www.phoenix-center.org/perspectives/Perspective09-02Final.pdf); G.S. Ford, PHOENIX CENTER PERSPECTIVES NO. 09-03: *Be Careful What You Ask For: A Comment on the OECD's Mobile Price Metrics* (September 16, 2009)(available at: http://www.phoenix-center.org/perspectives/Perspective09-03Final.pdf); L.J. Spiwak, *OECD Research Faulty*, WASHINGTON TIMES (October 11, 2009) (available at: http://www.washingtontimes.com/news/2009/oct/11/oecd-research-faulty).

Despite this work and numerous other legitimate criticisms of the OECD rankings, many people involved in the broadband debate nonetheless continue to use the OECD rankings as a meaningful indicator of success and failure of broadband policy.[6] Although we believe there is a better and more policy-relevant means of benchmarking international broadband policies[7], so long as policymakers continue to insist that the OECD's methodology is the definitive metric, we suspend our critiques for the moment and, in this POLICY BULLETIN, establish a performance metric with which to assess the success of new broadband interventions using the OECD's rankings.

Specifically, we establish ranking boundaries that permit a (more) causal interpretation to changes in rank (or a lack thereof) arising from policy interventions. If the broadband stimulus funds and the implementation of the policies suggested by the National Broadband Plan are successful, then the expectation is that the United States' rank among OECD countries will rise.[8] The change in rank, however, can only be observed at some future time, implying the risk of confusing correlation with causation is very high.[9] But, as Dr. Carlos Kirjner, Senior Advisor to

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[6] *See, e.g.,* Yochai Benkler *et al., Next Generation Connectivity: A Review of Broadband Internet Transitions and Policy from Around the World,* Harvard Berkman Center for Internet and Society (October 2009) (available at: http://www.fcc.gov/stage/pdf/Berkman_Center_Broadband_Study_13Oct09.pdf); *but c.f.* G. Ford, *Whoops! Berkman Study Shows "Open Access" Reduces Broadband Consumption,* PHOENIX CENTER POLICY PERSPECTIVE 09-05 (November 12, 2009)(available at: http://www.phoenix-center.org/perspectives/Perspective09-05Final.pdf).

[7] In POLICY PAPER NO. 35, we proposed an economically meaningful conceptual framework for evaluating the success of broadband programs—the Broadband Adoption Index or BAI. See T. R. Beard, G. S. Ford and L.J. Spiwak, *The Broadband Adoption Index: Improving Measurements and Comparisons of Broadband Deployment and Adoption*, PHOENIX CENTER POLICY PAPER NO. 36 (July 2009) (available at: http://www.phoenix-center.org/pcpp/PCPP36Final.pdf), *and to be reprinted in* 62 FEDERAL COMMUNICATIONS LAW JOURNAL (forthcoming Spring 2010). While we present a particular form of the BAI in that paper, the index is better characterized as a conceptual framework than a particular algorithm. Put simply, the BAI approach requires first that a target be established, then the progress toward meeting that target be monitored and measured. Targets are established and progress measured based on the net social benefits from expanding availability or adoption of broadband services. This approach ensures that scarce social resources are directed to their highest valued use and implementation is economically and socially efficient. Our proposal is highly general and can accommodate social costs and benefits of broadband including social premia (*e.g.,* positive and negative externalities) and incorporate measurement of heterogeneous connection modalities. Whether the BAI-style approach to target setting or measurement will be widely employed has yet to be established, but we are hopeful that this, or another economically meaningful approach, will be adopted.

[8] *Supra* n. 4; *see also* M. Cooper, *A Data Driven Policy Conclusion: It's Time to Change Broadband Policy in America*, Columbia University, Columbia Institute on Tele-Information CITI Conference, State of Telecom: National Next-Generation Broadband Plans - Session on Emerging Market Structure (October 23, 2009)(available at: http://www4.gsb.columbia.edu/null/download?&exclusive=filemgr.download&file_id=732465).

[9] Since we can only observe rank changes in a world where the interventions apply, all rank changes occur during the intervention. Therefore, the tendency of the lay is to attribute all rank changes (positive or negative) to the intervention. Such attribution is invalid.

Federal Communications Commission Chairman Julius Genachowski, observed, "correlation is not causation."[10] For broadband policy, the risk of confusing correlation and causation is very high because the problem is of a temporal nature. That is, if rank rises or falls in the future, then the inclination is to attribute any such change (positive or negative) to the Obama Administration's actions, since both rank and policy have changed. Yet, rank may have changed without any change in policy, and the policy may change without any movement in rank. In order to assess whether broadband policies "caused" the increase in rank, we must first determine the *counterfactual rank* of the United States, which is the rank of the United States in a world without any policy changes.[11] The idea of *counterfactual* is described neatly by Cameron and Trivedi (2005):

> Let X be the hypothesized cause and Y the outcome. By manipulating the value of X, we can change the value of Y. Suppose the value of X is changed from x_1 to x_2. Then a measure of the causal impact of the change on Y is formed by comparing the two values of Y: y_2, which results from the change, and y_1, which would have resulted had no change in X occurred. However, if X did change, then the value of Y, in the absence of the change, would not be observed. Hence, nothing more can be said about causal impact without some hypothesis about what value Y would have assumed in the absence of the change in X. The latter is referred to as a counterfactual, which means hypothetical unobserved value.[12]

Counterfactuals are an essential ingredient to any analysis of policy interventions, yet this fact is often ignored in the study of communications policy.[13] To quantify the impact of an intervention, we must know the outcome, both with and without the intervention, yet we often observe only one of these outcomes. For example, if the U.S. rank among OECD countries in per capita broadband connections fell to 16th over the next year or so, then some might blame

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[10] C. Kirjner, *Reflections on Being Part of the National Broadband Plan Team – and a Look Ahead* (August 24th, 2009)(available at: http://blog.broadband.gov/?p=129).

[11] *See, e.g.*, D. Rubin, *Estimating Causal Effects of Treatments in Randomized and Non-Randomized Studies*, 66 JOURNAL OF EDUCATIONAL PSYCHOLOGY 688-701 (1974); G. Imbens and J. Wooldridge, *Recent Developments in the Econometrics of Program Evaluation*, 47 JOURNAL OF ECONOMIC LITERATURE 5-86 (2009).

[12] A. Cameron and P. Trivedi, MICROECONOMETRICS (2005) at 32.

[13] *See, e.g.*, G. S. Ford, *Finding the Bottom: A Review of Free Press's Analysis of Network Neutrality and Investment*, PHOENIX CENTER Perspectives No. 09-04 (October 29, 2009)(available at: http://www.phoenix-center.org/perspectives/Perspective09-04Final.pdf); J. Hauge and J. Prieger, *Demand-Side Programs to Stimulate Adoption of Broadband: What Works?* Working Paper (October 14, 2009) (available at http://ssrn.com/abstract=1492342).

the new policies of the Obama Administration for putting the country in reverse. However, even without such policy interventions, the U.S. position may have fallen to 16th due to the rapid rise in subscription by a country presently below a rank of 15th. Simply observing a change in rank, whether up or down, does not permit a legitimate assessment of the policy effect. The "treatment effect" of policy requires that we observe the outcome with the intervention (y_2) and have an estimate of the outcome without the intervention (y_1; the counterfactual). The difference between these two ($y_2 - y_1$) is the effect of the policy. Estimating the counterfactual OECD rank of the U.S. is one purpose of this BULLETIN. The techniques applied in this BULLETIN can also be used to evaluate expected changes in subscriptions and rank under alternative scenarios of broadband diffusion.

To establish a counterfactual (or expected) rank, we use two of the most popular functional forms for estimating diffusion processes—the Gompertz Curve and the Pearl (or Logistic) Curve.[14] Depending on the chosen parameters, both curves are capable of generating the familiar S-Shaped Diffusion Curve that matches almost all diffusion processes. We estimate these curves for each OECD country and use the estimates to extrapolate broadband subscription rates to December 2012. Using these forecasts, we then compute rankings of the OECD countries. These forecasts, and the ranks thereof, are based on the OECD's subscription rate data covering the years 2002 through June 2009 (the last period the data is available). Consequently, the established trends are based on data prior to the implementation of any new major policy interventions.[15]

Our extrapolations indicate that without intervention of the ARRA, or other major policy changes such as those proposed in the National Broadband Plan, the United Sates is likely to remain 15th in the very near term, but will move to 13th in 2012. Based on statistical confidence intervals, the near term outcomes have an upper bound of 11th position and lower bound of 15th. These boundaries suggest the risk of a downward movement is very low, but an upward movement without intervention is likely. By 2012, the U.S. rank among OECD member countries is likely to be ninth. Consequently, if policymakers insist upon using the OECD rankings as the definitive metric of the success or failure of U.S. broadband policies, then the United States must rank higher than ninth to conclude (with statistical confidence) that broadband policy interventions have impacted the country's OECD rank. The upward trend in

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[14] *See generally*, V. Mahajan and R. Peterson, MODELS FOR INNOVATION DIFFUSION (1985). For an application of the Gompertz Curve to broadband diffusion, *see, e.g.,* A. Cardenas, M. Garcia-Molina, S. Sales, and J. Capmany, *A New Model of Bandwidth Growth Estimation Based on the Gompertz Curve: Application to Optical Access Networks*, 22 JOURNAL OF LIGHTWAVE TECHNOLOGY 2460-2468 (2004).

[15] Since no serious actions have been taken through the first half of 2009, we believe June 2009 adoption data could be safely added to our forecast process once the data becomes available.

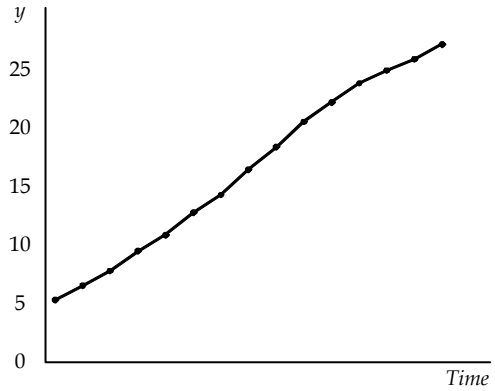
predicted rank implies that remaining in 15th place is consistent with a slight worsening of adoption trends in this United States. A fall in rank from 15th implies a statistically significant deterioration in adoption performance.

On the supply side, policymakers have committed to ubiquitous availability of broadband. Assuming 6% of U.S. households do not have availability today, that these households will subscribe at the same rate as households with access today, and that the stimulus renders service availability to all, the forecast rank by 2012 is 11th position, with an upper boundary of about eighth position and lower boundary of 14th position. Success in ubiquitous deployment, then, likely requires a rank of at least ninth for the United States among OECD countries, other things constant, and at least a one-position increase. Note that changes in rank due to ubiquitous coverage may not be large enough to permit strong conclusions on the impact of policy. That is, the predicted rise in rank is within the confidence interval of "no policy change."

III. Prediction Method

In Figure 1, the diffusion path for broadband connections per capita (variable *y*) in the U.S. is provided. As is apparent, the series follows the familiar S-shaped diffusion curve. A similar shape is observed for most all OECD countries over this time-period, making the Gompertz and Pearl Curves ideally suited to predict future values of the adoption rates. These functional forms are very flexible and can take on a variety of shapes, thereby permitting a close fit for each country. The parameters of these curves are estimated using individual country data.

Figure 1. Broadband Diffusion in the U.S.



Date	Actual	Predictions	
		Gompertz	Pearl
2002-Q2	5.53	5.14	5.46
2002-Q4	6.71	6.49	6.61
2003-Q2	7.94	7.98	7.92
2003-Q4	9.57	9.57	9.40
2004-Q2	10.91	11.25	11.03
2004-Q4	12.76	12.98	12.77
2005-Q2	14.22	14.73	14.59
2005-Q4	16.32	16.47	16.44
2006-Q2	18.16	18.18	18.27
2006-Q4	20.27	19.84	20.02
2007-Q2	21.87	21.44	21.67
2007-Q4	23.44	22.96	23.17
2008-Q2	24.51	24.40	24.51
2008-Q4	25.43	25.75	25.69
2009-Q2	26.65	27.00	26.70

The Gompertz curve can be written as:

$$y_t = \beta_0 \exp(\beta_1 \exp(\beta_2 t)) \quad (1)$$

where t is a time indicator (t = 1, 2, … T), y_t is broadband subscriptions per capita at time t, and the β_i are estimated parameters. This curve has been used before to estimate Internet diffusion.[16] The Pearl or Logistic Curve, which also has the familiar S-shape, can be written as:

$$y_t = \alpha_0 / (1 + \alpha_1 \exp(\alpha_2 t)) . \quad (2)$$

where the α_i are estimated parameters. The parameters are estimated using 14 periods of data for each of the 30 OECD countries (June 2000 through June 2009). All the data is published by the OECD.[17] As more data becomes available, the curves can be re-estimated and the predictions from these regressions can be evaluated.

Non-linear Least Squares is used to estimate the parameters of Equations (1) and (2). For the United States, the estimated coefficients are β(0.389, 2.29, -0.122) and α(0.313, 6.0, 0.236). The R^2 values for each curve exceed 0.998 for the U.S. data.[18] The actual and predicted values for the U.S. are provided in Figure 1. For the U.S. (and most other countries), the fitted curves are very good approximations of the actual data.

Predictions for future time periods proceed as follows. Using the estimated parameters for each country, we extrapolate the per capita connection rates for each country for the periods December 2009 through December 2012. The data is semi-annual, so there are seven predicted values. Predications are calibrated so that the predictions and actual values are equal in the final period of June 2009.

A. *An Analysis of Fit*

Both curves have three estimated parameters. The Pearl Curve tends to flatten out more quickly at the maturity level than does the Gompertz Curve, rendering more stable predications of rank in future periods. Which curve is "better" in a type of global sense can be evaluated by use of a holdout sample. In other words, we fit the curves by holding out the final period from the sample (t_{15} = June 2009). Using the estimated parameters from the smaller sample, we generate a prediction for the per capita subscription rate for this final period, $\hat{y}_{15}$, for all

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16 Other analyses of broadband diffusion have adopted the Gompertz curve. *See, e.g.,* A. Cardenas, M. Garcia-Molina, S. Sales, and J. Capmany, *supra* n. 14.

17 All data is downloaded from the OECD Broadband Portal, which can be found at http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html.

18 R^2 is computed as the squared correlation coefficient of the actual and predicted values.

countries. For each country, we then compute the Mean Absolute Percent Error ("MAPE") of the predictions for the final period using:

$$MAPE = (1/n)\sum |y_i - \hat{y}_i| / y_i \,, \tag{3}$$

the Mean Absolute Error ("MAE") using:

$$MAE = (1/n)\sum |y_i - \hat{y}_i| , \tag{4}$$

and the Root Mean-Square Error ("RMSE") using

$$RMSE = \sqrt{(1/n)\sum (y_i - \hat{y}_i)^2} \,, \tag{5}$$

where n is the number of countries (n = 30). These are standard procedures for evaluating the accuracy of a prediction.

This evaluation reveals a slight preference for the Pearl Curve. For the Gompertz Curve, the statistics are MAPE (0.0377), MAE (0.0092), and RMSE (0.0957); for the Pearl Curve, they are MAPE (0.0363), MAE (0.0082), and RMSE (0.0905). If we hold back two periods of data (t < 14, 15; December 2008 and June 2009), then for the Gompertz Curve we have MAPE (0.0699), MAE (0.0157), and RMSE (0.1251) and for the Pearl Curve we have MAPE (0.0673), MAE (0.0131), and RMSE (0.1144). A slight preference, again, is found for the Pearl Curve. Statistical analysis also reveals that the Pearl Curve provides a better within-sample match to the U.S. data.

B. *Confidence Intervals*

Forecasts using Equations (1) and (2) render point estimates of the per capita subscription rates for each country. These forecasts are estimates and, consequently, have distributions, which are described by the forecast error. Since we are predicting values into the future, we must account for the fact that the forecast error increases as we move away from the sample mean of the only regressor t (= 8.0). We do so using the standard formula.[19] The confidence interval widens as the predictions reach deeper into the future. That is, forecasts further in the future are made with less precision.

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[19] D. Gujarati, BASIC ECONOMETRICS (1995) at 137-8.

The forecast error for individual period predictions is:

$$s_f^2 = s^2\left[1+\frac{1}{15}+\frac{(t-8)^2}{20}\right] \tag{6}$$

where s_f^2 is the forecast variance, s^2 is the variance of the mean forecast, and t is the time-period (with mean 8 and variance 20). The confidence interval on the individual forecast range for a point estimate at time t is then $\hat{y}_t \pm 1.96 s_f$, which gets wider the further into the future the forecast period is.

Since we are predicting confidence intervals for the U.S. (but not the other countries), we are also interested in the Durbin-Watson Statistic ("DW"). In the presence of positive autocorrelation, the standard errors will be too small.[20] Consequently, the confidence interval will be too small. For the Pearl Curve, the DW exceeds the relevant critical value, so we may proceed to generate the necessary confidence intervals.[21] The DW for the Gompertz Curve is slightly below the lower limit, implying the confidence intervals for this curve may be too small. Again, the Pearl curve is preferred on statistical grounds.

IV. The Future of Subscription and Rank

The forecast subscription rates over the next few years are provided in Table 1. The point estimate is the prediction from the estimated equations, and the upper and lower bounds are the 95% confidence interval on the prediction. The predicted per capita subscription rate from the Gompertz Curve is slightly larger than the Pearl Curve, but the two approaches render very similar forecasts. Growth rates for the Pearl Curve are smaller than for the Gompertz Curve since the former converges to maturity level sooner rather than the latter.

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[20] Gujarati (1995), *id.* at 411.

[21] Since the time-trend is the only explanatory variable, the lower bound of the DW statistic (often called d_l) is the appropriate critical value for the test of serial correlation (thereby ignoring the typical indeterminate zone of the DW statistic). For details, *see* R. Pindyck and D. Rubinfeld, ECONOMETRIC MODELS & ECONOMIC FORECASTS (1991) at 144. The critical value is $d_l = 0.905$. For the U.S., the DW statistics are 0.66 for the Gompertz and 1.36 for the Pearl Curve.

Table 1. Predicted Connections-per-Capita for U.S., No Policy Change

		Forecasts						
	June-09 (Actual)	Dec-09	June-10	Dec-10	June-11	Dec-11	June-12	Dec-12
Gompertz								
Upper	…	0.292	0.304	0.315	0.326	0.335	0.344	0.352
Point	0.266	0.278	0.288	0.298	0.307	0.315	0.322	0.329
Lower	…	0.263	0.273	0.281	0.288	0.295	0.300	0.306
Pearl								
Upper	…	0.283	0.291	0.298	0.303	0.308	0.312	0.316
Point	0.266	0.275	0.282	0.288	0.293	0.297	0.300	0.303
Lower	…	0.267	0.273	0.278	0.282	0.285	0.288	0.289

Predictions for broadband connections-per-capita are made for every country based on parameters estimated using each country's data. We rank these predictions *à la* OECD. The rankings are provided in Table 2 below. The upper and lower bounds of the rank are calculated by re-ranking the countries after replacing the point estimate of y_t for the U.S. with the upper and lower bounds of its confidence interval.

Table 2. Forecast Rank for U.S. Among OECD Members, No Policy Change

		Forecasts						
	June-09 (Actual)	Dec-09	June-10	Dec-10	June-11	Dec-11	June-12	Dec-12
Gompertz								
Upper	…	14	14	14	12	11	11	10
Point	15	15	15	15	15	14	14	13
Lower	…	15	15	15	15	15	15	15
Pearl								
Upper	…	13	13	13	13	10	9	9
Point	15	15	15	15	15	15	15	13
Lower	…	15	15	15	15	15	15	15

Table 2 reveals that the expectation of rank from the Gompertz Curve is 15th in the very near term, with a possible move to 14th in 2011. The 95% confidence interval, however, indicates the U.S. could rank as high as 14th this year and rank about 10th by the end of forecast period. The threat of a downward move appears low, ceteris paribus, since the lower end of the confidence interval is 15th throughout the forecast period. A decline in rank, therefore, may be significant as it is unexpected. Based on the Pearl Curve, which fits the data better, the U.S. ranks 15th in the near term, but rises to 13th in 2012. Confidence interval analysis indicates the U.S. might rank as high as 13th in 2010 based on historical trends, and as high as ninth by 2012. Again, there is no reason to expect a decline in rank. This evidence suggests that an increase in U.S.

rank of a position or two in the next year is consistent with statistical variation. A two-position increase in rank by 2012 is expected without major policy changes.

The upper limit on ranks provides a threshold (or target) metric for broadband policies. If the U.S. ranks higher than 13th (based on the Pearl Curve) at the end of 2010, then this analysis suggests that new policies have been effective at increasing adoption beyond expectations (or, above the counterfactual increase without policy interventions). If not, we cannot conclude that policies have been effective, at least based on an analysis of rank, which appears to be the preferred assessment tool of the Obama Administration.

The primary goal of the ARRA, and a significant component of the National Broadband Plan, is ubiquitous availability in the U.S. of broadband service. While there is no actual count on how many homes are without broadband access today (of the sort counted by the OECD), the common view is less than 10% of homes presently do not have access to broadband service, and these homes are predominantly in rural areas.[22] The Pew Internet & American Life Project estimates about 7% of homes do not have access, while the FCC places that number at about 5% (though the agency admits the estimate is likely to be an understatement).[23] Assuming that the adoption rate of those without availability is equal to those with availability, then the U.S. adoption rate is conservatively 6% less (the average of the two figures) than it would be with ubiquitous service. By adding 6% to the U.S. connections-per-capita predictions, we can compute the U.S. rank among OECD members under the condition that the ARRA policies effectively deliver ubiquitous broadband.

Table 3 summarizes the predicted ranks of the U.S. over time assuming ubiquitous broadband is achieved by the new policies targeting this outcome. The calculations presume that ubiquitous coverage is achieved instantaneously—an unlikely outcome. Modifying that assumption requires only that the reader look to the predicted ranks further into the future. For example, assuming it takes two years to accomplish ubiquity, the predicted ranks from the end of 2011 or 2012 should be used. Predictions for 2009 are excluded since the achievement of ubiquity was not achieved by the end of that year.

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[22] J. Eggerton, *FCC: Three to Six Million Unserved By Broadband*, BROADCASTING & CABLE (Sept. 9, 2009).

[23] J. Horrigan, *Reasons People do not have Broadband at Home* (Jan. 21, 2009) (available at: http://www.pewinternet.org/Infographics/Reasons-people-do-not-have-home-broadband.aspx) (3.3% of all adults saying "Can't Get Access" and assuming 2.6 persons per home); Federal Communications Commission, September Commission Meeting, *Broadband Task Force Delivers Status Report On Feb. 17 National Broadband Plan* (Sept. 29, 2009), at Slide 34 ("This interpretation of the data probably underestimates the number of unserved housing units") (available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-293742A1.pdf).

Table 3. Forecast Rank for U.S. Among OECD Members, Ubiquitous Availability

		Forecasts						
	June-09 (Actual)	Dec-09	June-10	Dec-10	June-11	Dec-11	June-12	Dec-12
Gompertz								
Upper	…	…	12	10	10	10	8	7
Point	15	…	12	12	12	12	12	11
Lower	…	…	13	13	13	13	13	13
Pearl								
Upper	…	…	9	8	8	8	8	8
Point	15	…	13	12	12	11	11	11
Lower	…	…	15	14	14	14	14	14

From Table 3 we see that successful achievement of ubiquitous availability should result in an increase in rank of a few positions. Assuming the expanded availability takes a few years, the U.S. would rank about 11th (at the point estimate) if achieving ubiquitous service is successful. For the Pearl Curve predictions, the U.S. would rise to 11th based on current trends in adoption and ubiquitous coverage of networks. The upper limit of rank for the Gompertz and Pearl Curves is now about eighth in the final period, indicating the U.S. could be in the top 10 ranking in a few years if the stimulus plan is successful. In sum, if the Obama Administration is successful in achieving its goal, then the United States should have a top 10 ranking, or close to it, over the next few years.

V. Caveats

This analysis is based on predictions of the future. Any such predictions are subject to a variety of caveats. First, as the predictions reach further into the future, the confidence intervals widen. We have recognized this fact and have provided the confidence intervals on the predictions and ranks; we cannot of course eliminate forecast errors. After accounting for such variations, it is clear that the U.S. is likely to rank higher rather than lower, without any policy interventions. Second, these predictions are based on particular functional forms, but we have relied on the most commonly used. The in-sample predicted values fit the data very well for most countries. Third, the predictions in 2012 are seven periods into the future, and the parameters are based on only 15 observations. These long-term predictions should be interpreted with care. This concern does not imply this analysis is not worth doing, since some counterfactual must be established in order to facilitate a *causal* interpretation of changes in rank. Fourth, we adopt the ceteris paribus assumption in predicting rank, which is to say we assume the growth process in other countries is explained solely by the historical data. If other countries engage in subscription enhancing policies, then the predicted increases in rank reported here could be too high.

Fifth, from an analytical perspective, the OECD rankings are void and misleading, as we have documented in earlier work. Nevertheless, they are frequently used as evidence of success or failure in public policy debates, particularly by officials in the current Administration, so we suspend criticism and disbelief for the moment and attempt to provide some guidance on how the rankings may be used to evaluate the success or failure of new policies. If the OECD rankings are relevant, as is claimed, then some expectations about how new policies impact the rankings is a legitimate question, and we provide an answer here. Nevertheless, we encourage interested parties to adopt more legitimate and meaningful measures of industry performance that are not so heavily influenced by irrelevancies such as the average size of a household.

Sixth, the National Broadband Plan takes a very long run view of ubiquity, postponing network coverage of all U.S. homes 10 years into the future to 2020. Given available data, we question the legitimacy of forecasting per capita subscription rates that far into the future. Moreover, the character of broadband service and the Internet generally 10 years in the future is largely unpredictable. Hard targets (e.g., 4 Mbps by 2010) over such long-run horizons are of questionable merit.[24] That said, a longer run view is more consistent with the underlying supply- and demand-side characteristics of the industry.

Also worth mentioning is that there are two countries for which neither curve provide a good fit nor sensible forecasts: Germany and Mexico. Germany's subscription rate is rising sharply, and both curves render forecasts for Germany that rise very sharply as well. Continued growth at current rates seems unsustainable, but only time will tell. Germany is ranked above the U.S., so this problem may keep the U.S. ranked lower than it may be otherwise, rendering a conservative estimate of the U.S. rank. For Mexico, the problem arises in the later periods of data where the connections-per-capita rise very sharply. The curves fit the data reasonably well, but the country is presently in the rapid, early-stage growth process. This fact makes it difficult to predict a maturity level for Mexico. Mexico is, and remains, below the U.S. in subscription rate and rank over the forecast interval, so the data problems do not much influence the predictions for the United States.

Finally, as is always the case with predictions and forecasts, adding more data is desirable. Such data comes about every six months and updating this analysis is relatively easy. With more data, better statistical tests of success may be available. Also, different techniques may lead to tighter confidence intervals. Clearly, more research along these lines is encouraged. Nevertheless, we feel it is worthwhile to establish some target metrics today to form reasonable expectations about the future of rank in the U.S among OECD countries so as not to confuse

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[24] National Broadband Plan, *supra* n. 1, Exhibit 8-A.

correlation with causation and also to help root the debate in realistic expectations rather than rhetoric.

VI. Conclusion

Broadband subscriptions in the U.S. and other OECD countries continue to grow. As a consequence, the rank of the U.S. among OECD countries may change in the future. But broadband policy is also changing, and this creates the problem of false attribution. If the U.S. rank falls in the future, then new policies may be condemned as failures; if the U.S. rank rises, then new policies may be propped up as successful. Neither conclusion is legitimate absent some expectation on how rank would change without any policy change.

In this BULLETIN, we have employed commonly used techniques to predict the broadband per capita subscription rate and rank of the U.S. among OECD countries in the near future. Had policies been unchanged by the new Administration, the U.S. would likely hold on to its 15th position in the near term, though statistically the trends indicate that the U.S. could increase by a few positions in the next year or so. By 2012, absent any significant policy changes, the U.S. is predicted to rank 13th among OECD members, with an upper confidence limit of about ninth position. As for the $7.2 billion in stimulus funds and National Broadband Plan required by the ARRA to promote ubiquitous and affordable availability, if we are to conclude such policies helped increase the United States' ranking, then the U.S. must move into at least the ninth spot among OECD countries by 2011 or 2012 (assuming ubiquity can be achieved in that time frame).