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VIA HAND DELIVERY

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554

Re: **REDACTED – FOR PUBLIC INSPECTION**
MB DOCKET NO. 07-57

Dear Ms. Dortch:

In accordance with the Order adopting the Protective Order,[1] enclosed please find two *redacted* copies of "Further Analysis of Econometric Evidence that Satellite and Terrestrial Radio Are Demand Substitutes," prepared by CRA International ("Further Analysis").

Per the Protective Order and staff instructions, Sirius and XM are filing today, under separate transmittal, one redacted, public version of the "Further Analysis" via ECFS, one unredacted copy with the Secretary's Office, and unredacted copies with Jamila Bess Johnson of the Industry Analysis Division of the Media Bureau. The unredacted version of the complete document will be made available for inspection, pursuant to the terms of the Protective Order, as applicable, at the offices of Wiley Rein LLP, 1776 K Street NW, Washington, D.C. 20006. Counsel for parties to this proceeding should contact Peter D. Shields at (202) 719-3249 or Nicholas M. Holland at (202) 719-4632 to coordinate access after they comply with the terms of the FCC's Protective Order. Parties seeking access to Confidential documents should serve the required Acknowledgement of Confidentiality on Peter D. Shields and Nicholas M. Holland at Wiley Rein LLP, 1776 K Street, NW, Washington, D.C. 20006.

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[1] *In the Matter of Sirius Satellite Radio Inc. and XM Satellite Radio Holdings Inc. For Approval to Transfer Control*, MB Docket No. 07-57, Protective Order, DA 07-3135 (rel. Jul. 11, 2007).

If you have any questions, please do not hesitate to contact the undersigned.

Sincerely,

Jennifer Hindin

Enclosures

Further Analysis of Econometric Evidence that Satellite and Terrestrial Radio Are Demand Substitutes

Timothy H. Savage
Martino De Stefano
Steven R. Brenner

CRA International

I. INTRODUCTION

1. On December 6, 2007, the Consumer Coalition for Competition in Satellite Radio ("C3SR") submitted notice of an ex parte presentation by Gregory Sidak, Hal Singer, and Allan Ingraham (hereafter "Sidak Ex Parte" or "Ex Parte").[1] The Sidak Ex Parte criticizes the econometric evidence of demand substitution between terrestrial AM/FM radio and satellite radio that CRA presented in two papers submitted to the FCC in this proceeding.[2] As part of its case, the Ex Parte also presents a series of regressions as an alternative to our econometric analysis.

2. Our analysis found a systematic inverse relationship between satellite radio penetration and the number of terrestrial radio signals; that is, satellite radio penetration is lower where there are more AM and FM signals, all else held equal. This is exactly the relationship one would expect if consumers view satellite radio and terrestrial radio stations as demand substitutes. The higher the quality of terrestrial radio service, as indicated by a greater number of terrestrial radio choices, the lower the proportion of consumers who choose to subscribe to satellite radio. Moreover, we extensively evaluated the robustness of this result and consistently confirm the relationship.3

3. The Sidak Ex Parte criticizes the use of this relationship as evidence of demand substitution, the basic econometric specification of the CRA analysis, how it "controls" for

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[1] J. Gregory Sidak, Hal J. Singer, and Allan Ingraham, *Preliminary Review of CRA Regression Analysis*, Ex Parte Submission by Consumer Coalition for Competition in Satellite Radio, December 6, 2007.

[2] Steven C. Salop, Steven R. Brenner, Lorenzo Coppi, and Serge X. Moresi, *Economic Analysis of the Competitive Effects of the Sirius-XM Merger* (July 24, 2007), Exhibit A to *Sirius-XM Joint Opposition.*, MB Docket No. 07-57 (hereafter "CRA FCC Report"). Steven C. Salop, Steven R. Brenner, Lorenzo Coppi, and Serge X. Moresi, *Further Economic Analysis of 'the Sirius-XM Merger* (November 9, 2007), Joint Ex Parte Submission of Sirius and XM, November 13, 2007 (hereafter "CRA FCC Reply Paper").

[3] CRA FCC Reply Paper, Appendix A.

population, the level of aggregation of the data used for the analysis, and the use of cross-section data. The Ex Parte also presents its own regressions, apparently in an attempt to show that our evidence of an inverse relationship between satellite and terrestrial radio is spurious.[4] We show here that none of these criticisms are valid and none of them undermine our analysis or its value as evidence of demand substitution between satellite and terrestrial radio. In addition, as a matter of economic theory, the regression models presented in the Sidak Ex Parte are misspecified, and their results are unreliable. Moreover, the results of our econometric analysis are fully consistent with other evidence and analysis presented in our earlier reports.

II. CRA'S ANALYSIS PROVIDES RELIABLE EVIDENCE THAT SATELLITE RADIO AND TERRESTRIAL RADIO ARE DEMAND SUBSTITUTES

4. The Sidak Ex Parte asserts that CRA's analysis provides no evidence of demand-side substitution between satellite radio ("SR") and terrestrial radio ("TR") because it fails to measure cross-price elasticity.[5] This assertion merely repeats, without elaboration or justification, the claim of earlier submissions by Sidak that we already have refuted.[6] Like the earlier Sidak submissions, the Sidak Ex Parte is wrong to claim that the *Merger Guidelines* exclude the use of evidence like this. As we explained in our FCC Reply Paper, the *Merger Guidelines* say that the agencies will "take into account *all* relevant evidence" and list a variety of types of evidence.[7] In particular, the *Merger Guidelines* explicitly recognize the relevance of evidence that buyers shift purchases between products "in response to relative changes in price *or other competitive variables*."[8] As a matter of economics, the quality of terrestrial radio is a relevant competitive variable, and the number of TR signals is a measure of such quality. Our analysis thus provides evidence that consumers reduce their purchases of satellite radio

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[4] Sidak Ex Parte at slides 8-12 (slide pagination assigned with the title slide as slide 1). To date we have not seen the code used to implement the generation of their datasets or their statistical analysis. Therefore we reserve comment on the estimation procedures that may have been used or other aspects of the implementation of their analysis. Nor have we confirmed that their results can be replicated.

[5] Sidak Ex Parte at slide 3.

[6] For the CRA refutation, *see* CRA FCC Reply Paper at ¶¶34-44. For earlier statements by Sidak of similar positions, see J. Gregory Sidak, *Third Supplemental Declaration* (October 1, 2007), Submitted to the FCC October 1, 2007 by The Consumer Coalition for Competition in Satellite Radio (hereinafter "Sidak 3rd Supplemental") at ¶¶2, 21-22, Table 2.

[7] U.S. Department of Justice and Federal Trade Commission, *Horizontal Merger Guidelines* (Issued April 2, 1992, Revised April 8, 1997) (hereinafter "*Merger Guidelines*") at §1.11 (emphasis added). For an extended discussion of this point, with citations to other authorities, *see* CRA FCC Reply Paper at ¶¶40-44.

[8] *Merger Guidelines* at §1.11 (emphasis added). The CRA FCC Reply Paper explained that Sidak's suspicion of evidence of responses to "other competitive variables" – expressed in his earlier submission – is inconsistent with both the *Merger Guidelines* and antitrust jurisprudence. CRA FCC Reply Paper at ¶¶49-50.

service as the quality of terrestrial radio increases relative to that of satellite radio. This is evidence that the services are demand substitutes.

5. We now turn to the Sidak Ex Parte criticisms of our econometric study and to the new regression results that it presents.

A. Basic Econometric Specification

6. Our regression analysis tests an economic hypothesis: does SR penetration (that is, the proportion of the population in a ZIP code that subscribes to satellite radio) vary inversely with the number of TR signals received in that ZIP code, thereby indicating that they are demand substitutes. As explained in our earlier paper filed with the FCC, the number of TR signals is a valid proxy for the quality of TR service relative to the quality of SR service.[9] Indeed, as we have pointed out previously, this same assumption is implicit in earlier filings by Sidak and the C3SR.[10]

7. If consumers view SR and TR service as demand substitutes, the proportion of consumers in a ZIP code (or ZCTA) who purchase satellite radio service should decline with increases in the number of AM/FM signals, *ceteris paribus.*[11] Our regression is specified appropriately to test this hypothesis. The dependent (or left-hand-side) variable of the regression is SR penetration and the explanatory (or right-hand-side) variables are the number of TR signals (flexibly captured by the use of a fifth-order polynomial), as well as variables to control for other potential influences on SR demand (household income, the percentage of people who commute by car, the percentage of the population in urban areas, and the percentage that is female).[12]

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[9] In an earlier Declaration filed in this proceeding Sidak objected that the number of AM/FM stations may not be a proxy for quality. Sidak 3rd Supplemental at ¶30. We answered that criticism in our Reply Paper. We explained why the number of AM/FM signals is a reasonable if not perfect proxy for the quality of terrestrial radio service. We also explained why our finding a robust relationship between SR penetration and the number of TR signals, despite number of TR signals being an imperfect proxy for TR quality, reinforces confidence in our results and conclusions, not undermines them. CRA FCC Reply Paper at ¶¶51-55.

[10] CRA FCC Reply Paper, ¶¶51, 54.

[11] ZCTAs are Census Bureau-defined ZIP Code Tabulation Areas, which closely approximate ZIP code areas and allow ZIP code and census block data to be merged. For a further discussion, and a description of the data used for our analysis, see CRA FCC Reply Paper, Appendix A at A2.

[12] CRA's regression specifies a very flexible functional form for the number of terrestrial radio signals, a fifth-order polynomial, in order to impose minimal constraints on the way in which the number of TR signals affects SR penetration. For more details on the specification and on the control variables used, see CRA FCC Reply Paper, Appendix A. That discussion also shows that our results are robust to the inclusion of additional control variables.

8. The Sidak Ex Parte claims that CRA's baseline regression model is misspecified because the dependent variable (SR penetration) measures *demand* for satellite radio service while the right-hand-side measures TR *supply*. This is a most peculiar interpretation of our specification, particularly in light of the explanation we provided in earlier submissions. We have explained that the number of TR signals is included as a regressor because it is a proxy for the *quality* of TR service experienced by consumers in an area. It is perfectly reasonable to test whether TR is a demand substitute by testing whether demand for SR declines as the quality of an alternative – namely terrestrial radio – improves relative to the quality of SR service. To object that the number of TR signals is a measure of TR supply misses the point. Changes in the number of TR signals supplied and thus available to consumers represent variations in the characteristics of a substitute, which is as appropriate to include in a demand relationship as would be the price of a substitute. Therefore, this criticism of our specification is not valid.

B. Geographic Granularity

9. The Sidak Ex Parte argues that many consumers listen to TR outside their ZIP code, and therefore the CRA analysis is performed at too disaggregated (granular) a level.[13] For both practical and conceptual reasons, however, this issue does not undermine the reliability of our results.

10. First, the Ex Parte overlooks the fact that aggregating the data to large geographic units itself is likely to introduce a measurement problem that is the flip-side of the one on which they focus. The number of available TR signals will vary across different locations within large areas. Consequently, an average of the number of TR signals received at locations across all of a wide area will inaccurately measure the number of terrestrial signals available to consumers who regularly listen only in narrower areas. This fact will make the more aggregated measure a poorer proxy for the quality of terrestrial radio service experienced by those consumers. Thus, merely observing that some consumers sometimes listen to radio outside their home ZIP codes is not sufficient to establish that a cross-section analysis based on substantially larger geographic units will measure the quality of terrestrial radio service more accurately than one based on ZIP codes.

11. Furthermore, the Ex Parte fails to acknowledge that, in any event, such measurement problems would not bias our analysis *toward* finding a relationship. To the contrary, such a

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[13] The Sidak Ex Parte also asserts that the CRA analysis presumes that the geographic market should be measured at the ZIP code level. This claim, however, rests on a misunderstanding. Our analysis focuses on whether cross-section variation in the quality of terrestrial radio service affects consumer demand for satellite radio, evidence on demand-side substitution relevant for product market definition. It does not define geographic markets. We do not claim that ZIP codes are relevant geographic markets. The geographic areas on which the cross-section analysis is based need not be relevant geographic markets for antitrust analysis.

problem would *reduce* the power of our econometric analysis to detect empirically a relationship between SR penetration and TR coverage that does exist.[14] As a result, this objection cannot explain away the existence of the robust empirical relationship actually found by our analysis. The fact that our analysis finds a robust inverse relationship between satellite radio penetration and number of TR signals, notwithstanding any such measurement problems, reinforces confidence in the findings, not the contrary.

12. Second, the Sidak Ex Parte suggests that the cross-section analysis might be run on data aggregated beyond the standard 5-digit ZIP code or ZCTA5 level to the ZCTA3 level.[15] But again there is no discussion of the effects of this change on the results of the analysis. As the authors of the Sidak Ex Parte themselves could have confirmed with the data and computer code provided to them, the relationship we estimate between SR penetration and TR coverage is robust to this aggregation of the data. Running the baseline specification reported in our earlier FCC papers on data aggregated to the ZCTA3 level yields essentially the same inverse relationship between SR penetration and the number of TR signals reported earlier. This is clear from Figure 1 (attached), which plots the relationships estimated both on ZCTA5 data and on ZCTA3 data.[16] Thus, as a practical matter, this aggregation has no substantial effect on the shape of the substitution relationship between SR penetration and TR coverage.[17, 18]

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[14] As our earlier report explained, if the number of TR signals used is a poorer measure of the quality of terrestrial radio that consumers experience, it would reduce the power of our econometric analysis to detect empirically a relationship between satellite radio penetration and AM/FM quality that does exist. CRA FCC Reply Paper at ¶55. Indeed, if aggregation of the data to larger geographic areas eliminated the statistical significance of the relationship between SR penetration and TR coverage that we find at the ZCTA5 level, or substantially reduced its magnitude, a very plausible interpretation would be that aggregation reduced the accuracy with which the data measured the TR coverage that consumers experience.

[15] *See* Sidak Ex Parte at slides 11 and 12, which present the results of regressions run on data at the ZCTA3 level. The ZCTA5's approximate 5-digit ZIP codes, while ZCTA3's approximate larger, 3-digit ZIP codes.

[16] The corresponding regression results are reported in Table 1.

[17] The two curves are positioned slightly differently, largely because each plots predicted SR penetration holding all explanatory variables other than number of TR signals constant at their median values, and the median values of some other explanatory variables are different for ZCTA3 and ZCTA5 data.

[18] The Sidak Ex Parte also suggests that data at the 5-digit ZIP code level contains "nonsensical" values with SR penetration exceeding 100%, in some cases substantially. The presentation does not, however, evaluate whether these values affect our findings. Our analysis truncates these values to 100%, as the presentation concedes, so that more extreme values are not used. In addition, as the Ex Parte does not acknowledge, only 72 of the 31,437 total observations have calculated SR penetration levels greater than 100%. Moreover, deleting these observations entirely does not alter the qualitative results of our analysis. We are surprised that the authors of the Sidak Ex Parte did not simply confirm this result themselves by using the data and computer code for our analysis provided to them.

13. Finally, the Sidak Ex Parte fails to provide adequate support for its apparent suggestion that the analysis should be carried out at the level of Arbitron-defined radio markets.[19] Many Arbitron-defined markets are quite large areas with considerable variation in the number of TR signals received. Aggregating the data to this level would exacerbate the aggregation problems identified above. Moreover, many consumers reside outside the universe of Arbitron-defined radio markets. Therefore, basing the analysis on Arbitron-defined market areas would involve throwing out relevant data (and substantial cross-section variation). In fact, those eliminated areas would include more rural geographic areas with few TR signals where SR penetration tends to be highest. Indeed, the earlier submissions of Sidak and C3SR focused on just these areas, so it is quite striking and peculiar that they now propose an analysis that excludes them.[20]

C. The Effects of Population

14. The Sidak Ex Parte claims that CRA's econometric results are only "measuring the strong correlation between population and the number of terrestrial signals."[21] To support this claim, the Sidak Ex Parte presents results from four alternative econometric analyses, each of which specifies the *number of SR subscribers*, rather than SR penetration, as the dependent variable. The results of these analyses apparently are intended to suggest that the statistically significant, negative relationship between consumer demand for SR and TR coverage disappears when one controls for population, which they include as an explanatory variable. However, the regression results reported in the Ex Parte are wholly unreliable because they are based on misspecified regression models.

15. The Sidak Ex Parte's regression models make the number of SR subscribers in a ZCTA the dependent variable while using population and the number of TR signals as explanatory variables.[22] Judging from the reported results, however, their specification of these relationships is fundamentally flawed. Their specification implausibly assumes that the increase in the *absolute number of SR subscribers* resulting from a given change in the number of TR signals (*e.g.*, from 20 to 21) is the same in every area *regardless of the population of the*

[19] *See* Sidak Ex Parte at slides 6, 9-10.

[20] *See* J. Gregory Sidak, *Supplemental Declaration of J. Gregory Sidak*, Exhibit B, C3SR Petition (July 9, 2007) at ¶¶24-25; and C3SR, *Consumer Vulnerability to a Satellite Radio Monopoly in Rural, Unserved and Underserved Geographic Area* (July 9, 2007), Attached to *Petition to Deny of the Consumer Coalition for Competition in Satellite Radio,* FCC Filing, MB Docket No. 07-57 (July 9, 2007). *Also see* CRA FCC Reply Paper at ¶¶51, 54.

[21] Sidak Ex Parte at slide 13.

[22] Sidak Ex Parte at slides 9-12. The general structure of the specifications is similar across the four regressions presented. The regressions differ in that one pair is run on data aggregated to the level of ZCTA3's and one pair on data at the level of Arbitron-defined market areas. One regression in each pair enters the number of TR signals as a single variable and the other as a fifth-order polynomial.

area.[23] For example, one result predicts that, all else equal, adding one TR station increases the number of subscribers to satellite radio by about 534 in every ZCTA3 area, *regardless of whether the total population of that ZCTA3 is 60,000 or 600,000 or 1,600,000.*[24] This is a nonsensical specification of how the number of TR signals affects the demand for SR.[25] Thus, it would be unsurprising – and meaningless – if this *particular* relationship between SR subscribers and TR signals is not statistically significant.[26]

16. In contrast, the relationship between SR demand and TR signals specified by our regression model is consistent with both demand theory and empirical practice. Based on this reasonable specification, our analysis finds a statistically significant, inverse relationship between demand for SR service and the number of TR signals. Our specification accounts for the effect of population on the number of SR subscribers in an area by seeking to explain *the proportion of the population* that subscribes to satellite radio. This is a natural and sensible way to deal with the fact that one expects the number of satellite subscribers in an area to vary with the area's population, all else equal. In fact, this treatment of population is common in the economic literature. Many empirical studies adjust for cross-section variation in population by estimating how various factors affect penetration (*i.e.*, the proportion of consumers who purchase the product or service). For example, this approach has been used in the academic literature on cable and satellite TV.[27]

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[23] Judging from the reported results, the regressions specify that the absolute number of SR subscribers in the geographic unit of observation depends on the effect of the number of TR signals *plus* the effect of population *plus* the effect of income *plus* the effects of other control variables.

[24] Sidak Ex Parte at slide 11. Population varies substantially across ZCTA3's. The 1st percentile value is 16,163; the 10th percentile value is 62,200; the 90th percentile value is 731,776; and the 99th percentile value is 1,641,596.

[25] As a technical econometric matter, the predicted effect on the number of SR subscribers of an increase in population is assumed to be entirely separate from and additive to the effect of an increase in the number of TR signals in the Ex Parte's regression models.

[26] As noted earlier, we have not seen the code used to implement the Ex Parte's statistical analysis or confirmed that their reported results can be replicated.

[27] Examples include: Andrew Stewart Wise and Kiran Duwadi, *Competition Between Cable Television and Direct Broadcast Satellite: the Importance of Switching Costs and Regional Sports Networks*, 1 JOURNAL OF COMPETITION LAW AND ECONOMICS 679 (2005) [studying the substitution between cable television and direct broadcast satellite services, using cross-sectional data and regressing DBS penetration rates on cable and DBS characteristics and demographic variables]; Tasneem Chipty, *Vertical Integration, Market Foreclosure, and Consumer Welfare in the Cable Television Industry*, 91 THE AMERICAN ECONOMIC REVIEW 428 (2001) [studying the effect of vertical integration on penetration rates of basic and premium cable services]; John W. Mayo and Yasuji Otsuka, *Demand, Pricing, and Regulation: Evidence from the Cable TV Industry*, 22 RAND JOURNAL OF ECONOMICS 396 (1991) [estimating demand for cable services using cable penetration rate as dependent variable]; Phanindra V. Wunnava and Daniel B. Leiter, *Determinants of Inter-Country Internet Diffusion Rates*, forthcoming AMERICAN JOURNAL OF ECONOMICS AND SOCIOLOGY [analyzing the determinants of inter-country Internet diffusion rates; the authors use a cross-section of countries and regress Internet penetration rates on countries' characteristics].

17. As a technical matter, our specification is consistent with demand relationships based on discrete choice demand models. Such a model analyzes the probability that a representative consumer chooses to subscribe to satellite radio. When projected to a population of consumers, the probability that a representative consumer subscribes becomes the proportion of consumers who subscribe, or SR penetration. Thus, by dividing the number of SR subscribers by population, we in effect recover a measure of the probability that a representative consumer in that area subscribes to SR. While calculated using population, this probability itself is not necessarily dependent on population in that area. Thus, our specification analyzes how the probability that a representative consumer subscribes to satellite radio varies with the quality of terrestrial radio service, an approach consistent with demand theory.[28]

18. Further empirical evaluation provides additional evidence that the Sidak Ex Parte is wrong to claim that our analysis fails to control adequately for population or that our results reflect only a "correlation" between population and the number of TR signals.

19. First, to illustrate empirically that the results of our analysis are not distorted by some failure to account adequately for the effects of population, we have run several additional versions of our regression, each of which includes a particular function of population as an additional explanatory variable. The functions used were: (1) population; (2) the natural log of population; (3) the inverse of population; or (4) a fifth-order polynomial of population.[29] Figure 2 plots the relationship between predicted SR penetration and the number of TR signals estimated using our original baseline specification and those estimated using each of the four separate functions listed above.[30] As Figure 2 demonstrates, the use of population as an independent explanatory variable has virtually no effect on the relationship between SR penetration and TR coverage.[31] This is further evidence that the relationship we find is not biased by our treatment of the effect of population.

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[28] In such models, the probability that a representative consumer purchases a good or service, rather than an "outside" good (*i.e.* does not purchase the good), depends on characteristics of the good in question relative to those of the outside alternative. In this case, TR coverage measures variation in a characteristic of an "outside" alternative to satellite radio. *See, for example,* Daniel McFadden, *The Measurement of Urban Travel Demand,* 3 JOURNAL OF PUBLIC ECONOMICS 303 (1974).

[29] The specification and analysis are otherwise as the same as the baseline regression previously reported. *See* CRA FCC Reply Paper, Appendix A.

[30] In each case predicted SR penetration is plotted holding other explanatory variables constant at their median values. Full results of these regressions are reported in Table 2.

[31] In each case, the use of population improves the fit of the model only incrementally. There is, however, no strong theoretical justification for including population as an independent variable when the dependant variable is expressed as the ratio of SR subscribers to population. More importantly, its use has virtually no impact on the relationship of interest between SR penetration and TR signals

20. Finally, to demonstrate further the error of the Ex Parte's claim that our empirical results are spuriously driven by a correlation between population and the number of TR signals, we also have constructed a simple statistical experiment. This experiment examines the Ex Parte's implicit conjecture that our regression analysis might be biased toward finding a negative relationship between SR penetration and TR signals even if the number of SR subscribers actually is unrelated to the number of TR signals.[32] The experiment, which is described in detail in the Appendix, demonstrates that the methodology of our statistical analysis does not find a spurious relationship between SR penetration and TR signals when such a relationship does not exist in the data.

21. In sum, none of the Sidak Ex Parte criticisms involving the treatment of population weaken the demand substitution evidence provided by our cross-section analysis. The claim that our results are nothing but the spurious reflection of a "correlation" between population and the number of TR signals is unfounded and incorrect.

D. Use of Cross-Section Data

22. The Sidak Ex Parte claims that CRA's analysis is flawed because it relies on cross-section data, and therefore "cannot explain whether a specific group of individuals substitute between satellite and terrestrial radio."[33] This claim is quite extraordinary. It is common practice for economists to investigate demand and substitution patterns using cross-section data.[34] Properly designed cross-section studies estimate the impact of various factors on consumers' choices from information on the variation across areas in consumer purchase patterns and those factors.[35]

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[32] *See* Sidak Ex Parte, slides 5, 13. The Ex Parte suggests that such a bias results from a relationship between population and TR signals and the fact that the dependent variable is the ratio of SR subscribers to population.

[33] Sidak Ex Parte at slide 4.

[34] Many examples of demand analyses using cross-section data can be cited, including analysis for similar subscription services by FCC economists and others. Examples include: Austan Goolsbee and Amil Petrin, *The Consumer Gains from Direct Broadcast Satellites and the Competition with Cable TV*, 72 ECONOMETRICA 351 (2004) [estimating a demand system for satellite, basic cable, premium cable, and local antenna]; Gregory S. Crawford, *The Discriminatory Incentives to Bundle in the Cable Television Industry*, forthcoming QUANTITATIVE MARKETING AND ECONOMICS [estimating a model of demand for cable television services]; Andrew Stewart Wise and Kiran Duwadi, *Competition Between Cable Television and Direct Broadcast Satellite: the Importance of Switching Costs and Regional Sports Networks*, 1 JOURNAL OF COMPETITION LAW AND ECONOMICS 679 (2005) [studying the substitution between cable television and direct broadcast satellite multichannel services]; Tasneem Chipty, *Vertical Integration, Market Foreclosure, and Consumer Welfare in the Cable Television Industry*, 91 THE AMERICAN ECONOMIC REVIEW 428 (2001) [studying the effect of vertical integration on penetration rates of basic and premium cable services].

[35] As in the CRA analysis, cross-section demand analyses control for variations across areas – such as differences in the income levels or the demographic characteristics of consumers – that could affect observed consumer choices.

23. Use of cross section data to investigate demand patterns is common, particularly where, as here, adequate data are unavailable from natural experiments of how consumers in a particular area respond to changes in conditions over time.[36] As explained in our earlier submissions, the history of satellite radio services has not generated data on consumer responses to changes in price over time on which reliable estimates of demand elasticity can be based.[37] But there is cross-section variation in the number of terrestrial radio signals, which we have used to investigate how consumers' subscriptions to satellite radio service respond to variation in the quality of the terrestrial radio alternative.

E. Usage Substitution over Time

24. The Sidak Ex Parte suggests that one should test for demand substitution between satellite and terrestrial radio by evaluating the relationship between usage of satellite and the usage of terrestrial radio over time by given populations.[38] A comparison of usage over time could be a relevant analysis, alongside our cross-section econometric analysis. In fact, our earlier submissions present available survey evidence on changes in usage of terrestrial radio and other audio entertainment by individual consumers when they activate or deactivate satellite radio subscriptions.[39] These data show dramatic changes that suggest strong substitution between satellite radio and other forms of audio entertainment.

- [redacted]
- [redacted]

[36] It should be noted that even demand analyses based on time series data do not necessarily analyze the behavior of "a specific group of individuals" that does not change. The group of consumers about whose behavior time series data provide information often will change somewhat over time, because individuals move in or out of the area, or begin or cease consuming as they age. For example, the DOJ and FTC often have analyzed point-of-sale scanner data, which have these characteristics. *See*, Federal Trade Commission and U.S. Department of Justice, *Commentary on the Horizontal Merger Guidelines* (March 2006) at 6, 14, 28-29.

[37] CRA FCC Reply Paper at ¶¶35-39.

[38] Sidak Ex Parte at slide 7.

[39] CRA FCC Reply Paper at ¶¶61-67 presents the results described below and answers objections to this evidence made by Sidak in earlier submissions. *Also see* CRA FCC Paper at ¶¶22, 23, 57.

[40] [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

25. We agree that this is further evidence that consumers substitute between satellite radio and other forms of audio entertainment, including terrestrial radio.

III. CONCLUSIONS

26. None of the criticisms of the Sidak Ex Parte undermine the reliability of CRA's econometric analysis. Our analysis shows that the proportion of consumers who subscribe to satellite radio declines as the number of terrestrial radio signals increases, *ceteris paribus*. The Ex Parte presentation is wrong to claim that this is not significant, quantitative evidence that consumers consider terrestrial radio and satellite radio to be demand substitutes.

27. Although this response to the Sidak Ex Parte has focused on our econometric analysis, it is important to recognize that this econometric evidence is only one component of the overall evidence, as set out in our previous papers, that satellite radio and terrestrial radio are demand substitutes. The fact that this econometric evidence is consistent with other evidence of demand substitution further reinforces confidence in its reliability.

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41 [redacted]

42 [redacted]

43 [redacted]

44 [redacted]

Appendix: Statistical Experiment

1. In this Appendix, we describe a statistical experiment designed to test the "spurious correlation" conjecture in the Sidak Ex Parte. The design of this experiment is simple. We construct data on SR "subscribers" and penetration rates that are independent of, and therefore unrelated to, the number of TR signals and estimate our baseline specification using the constructed SR penetration rates as the dependent variable. If our econometric findings were simply the spurious result of a relationship between population and TR signals, estimation on the experimental data should continue to find a relationship, also spurious, using the constructed SR penetration. On the other hand, if estimation on the experimental data finds no relationship, where it is known that none exists, that result would refute the Ex Parte's claim of spurious correlation.

2. The methodology of the statistical experiment consists of the following five steps:

   a. Generate values for the number of SR "subscribers" in each ZCTA that are independent of the number of TR signals by assuming that consumers in every ZCTA are equally likely to subscribe to satellite radio. The constructed number of "subscribers" in each ZCTA is determined from a binomial distribution where the probability of success is set equal to the national SR self-pay penetration rate and the number of trials is set equal to the population of the ZCTA. The resulting, constructed number of SR "subscribers" is thus independent of the number of TR signals.[45]

   b. Calculate values for SR penetration by dividing the generated value for SR "subscribers" in each ZCTA by the *actual* population in the ZCTA. (This is the same procedure used to calculate SR penetration values from actual subscriber data.) Merge the constructed SR penetration by ZCTA with the actual values of the independent variables to create a dataset with the same number of observations and independent variables as the actual dataset, but a dependent variable that is, by construction, independent of the number of TR signals.

   c. Estimate our baseline econometric specification using the generated dataset.

   d. Repeat steps (a) through (c) 1,000 times to create 1,000 replications of the estimates of interest. Because the process used in step (a) to generate the number of "subscribers" in each ZCTA has random variation, we repeat these steps many times to ensure that the

[45] Other procedures could allow the likelihood of subscribing to SR to vary across ZCTAs while remaining independent of the number of TR signals. For example, the likelihood of subscribing in each ZCTA could be set equal to national penetration plus a random error term. Alternatively, the likelihood could be drawn randomly from the observed distribution of values for SR penetration across ZCTAs. These alternative methods also would yield constructed values for SR "subscribers" independent of the number of TR signals. Results of the experiment based on these other methods are qualitatively the same as those reported in detail here.

experimental results do not reflect only the outcomes of a few idiosyncratic draws. This approach also allows us to construct standard confidence intervals.

e. Compare the relationships estimated between SR penetration and TR signals from the 1,000 generated datasets to the same relationship estimated from actual subscriber data.

3. The results of this statistical experiment demonstrate definitively that the Ex Parte's "spurious correlation" conjecture is incorrect. When estimated on constructed experimental data in which there is no relationship between SR penetration and TR signals, our baseline econometric specification finds no evidence of a relationship between SR penetration and TR signals – a result that is contrary to the Ex Parte's claim of spurious correlation. The 1,000 replications run on the generated datasets estimate coefficients on the number of TR signals, and overall effects of the number of TR signals on SR penetration, that are very closely and symmetrically clustered around zero. In contrast, the same analysis run on the actual penetration data finds a strong, highly significant, inverse relationship between the actual SR penetration and the number of TR signals.

4. Figures 3 through 5 and Table 3 and 4 present the detailed results of this experiment.

a. For each of the 1,000 replications, Figure 3 plots the estimated coefficients for each term of the fifth-order polynomial used to measure the effect of TR signals on SR penetration. The estimated coefficients for each term are closely clustered around zero.

b. Table 3 reports summary statistics on the estimation of our baseline specification with the 1000 replications of data with constructed SR penetration. Approximately 5% of the estimated values of each coefficient on TR are statistically significantly different from zero at a 95% confidence level, precisely the result expected when the estimated effect is the result only of random chance. (At a 95% confidence level, one expects about 5% of estimates to be statistically significant in repeated samples purely as the result of random chance.)

c. Furthermore, even the few statistically significant coefficients have values that are very close to zero and are much smaller in magnitude than the coefficients estimated using actual data, as can be seen by comparing the maximum and minimum coefficient values reported in Table 3 with the coefficients estimated using actual subscriber data.

d. Table 3 also reports the results of a test of the joint significance of the polynomial coefficients. For about 95% of the 1,000 replications, a test using a 95% standard cannot reject the hypothesis that all five coefficients equal zero, again what one would expect purely from random chance with repeated samples.

e. Because our baseline regression specifies that the effect of TR signals on SR specification enters as a fifth-order polynomial, we also examine the estimated values of the polynomial (*i.e.*, the overall effect TR signals from the coefficients of all five terms of the polynomial) at 5, 25, and 50 TR signals. Figure 4 plots the polynomial values estimated with the 1,000 replications of constructed values and with the actual subscriber data. Figure 5 plots in greater detail the distributions of the polynomial values estimated with the 1,000 replications of constructed subscriber data. For each of the three TR signal levels used to evaluate the polynomial, the results of the 1,000 replications are tightly clustered around zero, while the values estimated using the actual subscriber data are negative and relatively far from zero.[46] Table 4 reports information on the values of the polynomial evaluated at the three values for TR signals, as estimated with actual data on SR penetration and for the 1,000 replications based on constructed SR penetration.

5. In sum, these experimental results provide further confirmation that our analysis is measuring an actual relationship between the proportion of the population that subscribes to SR and the availability and variety of TR service. This is strong evidence that consumers consider these services to be substitutes.

[46] The value of the polynomial must be zero when the number of TR signals is zero. The fact that SR penetration is estimated to decline as TR signals increase is indicated by the fact that the estimated value of the polynomial becomes a larger negative number for larger numbers of TR signals.

Figure 1
Relationship Between Predicted SR Penetration Rate and Number of TR Signals
ZCTA5 and ZCTA3

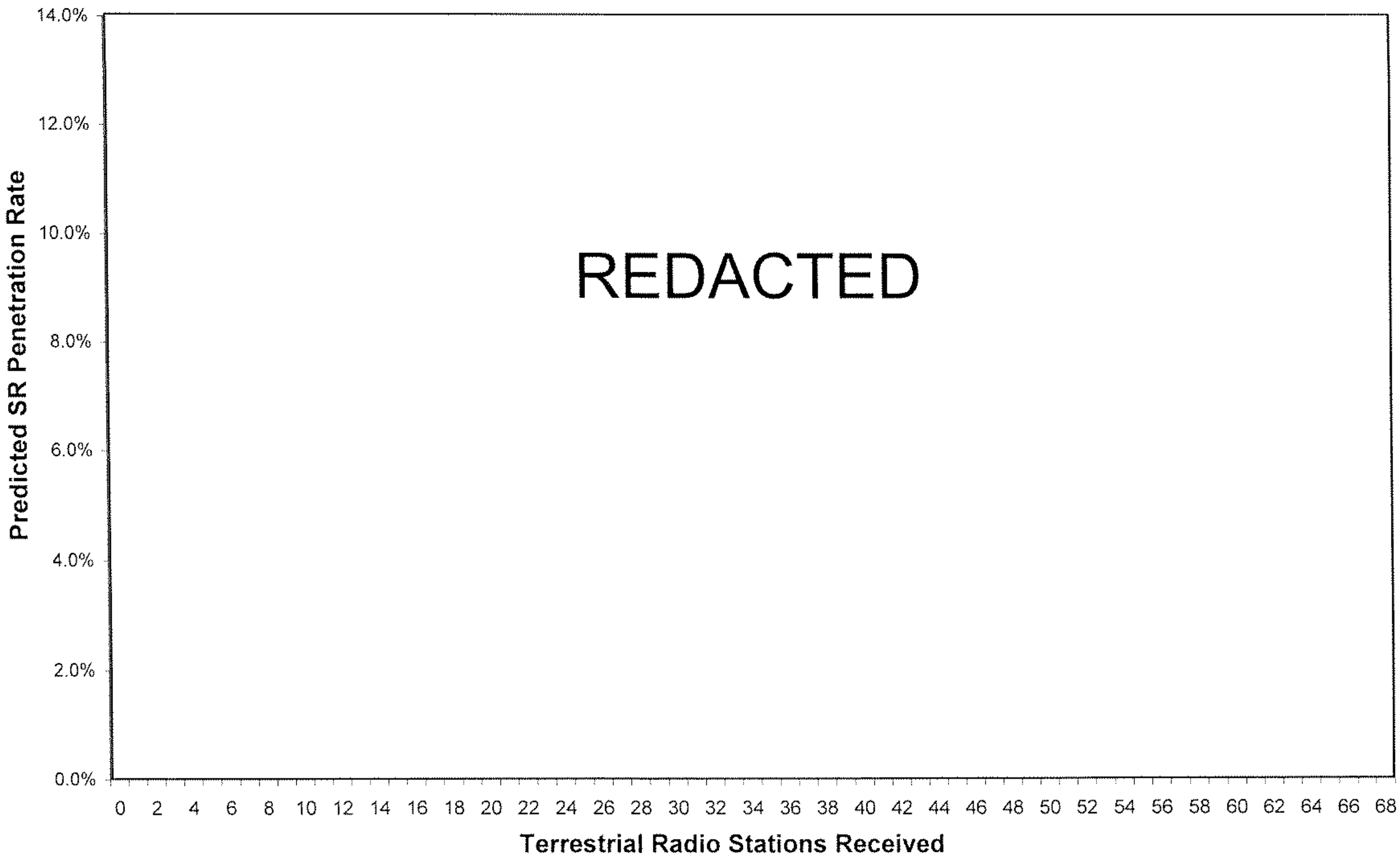


Table 1
Relationship Between Predicted SR Penetration Rate and Number of TR Signals
ZCTA5 and ZCTA3

	Baseline with ZCTA5 Data	Baseline with ZCTA3 Data
TR Signals		
TR Signals^2		
TR Signals^3		
TR Signals^4		
TR Signals^5		
Income	REDACTED	
Income^2		
% Go to Work by Car		
% Live in Urban Area		
[% Go to Work by Car] * [% Live in Urban Area]		
% Female		
Constant		
Observations		
Log-Likelihood		

Notes:
Coefficients are in bold, and t statistics are in brackets; * significant at 5%; ** significant at 1%.
When data are at the ZCTA5 level, standard errors are clustered by 3-digit ZCTA. When data are at the ZCTA3 level, robust standard errors are reported.
Probit models estimated by maximum likelihood.
"TR Signals" is the number of TR signals divided by 10.

Figure 2
Relationship Between Predicted SR Penetration Rate and Number of TR Signals
With and Without Function of Population as Explanatory Variable

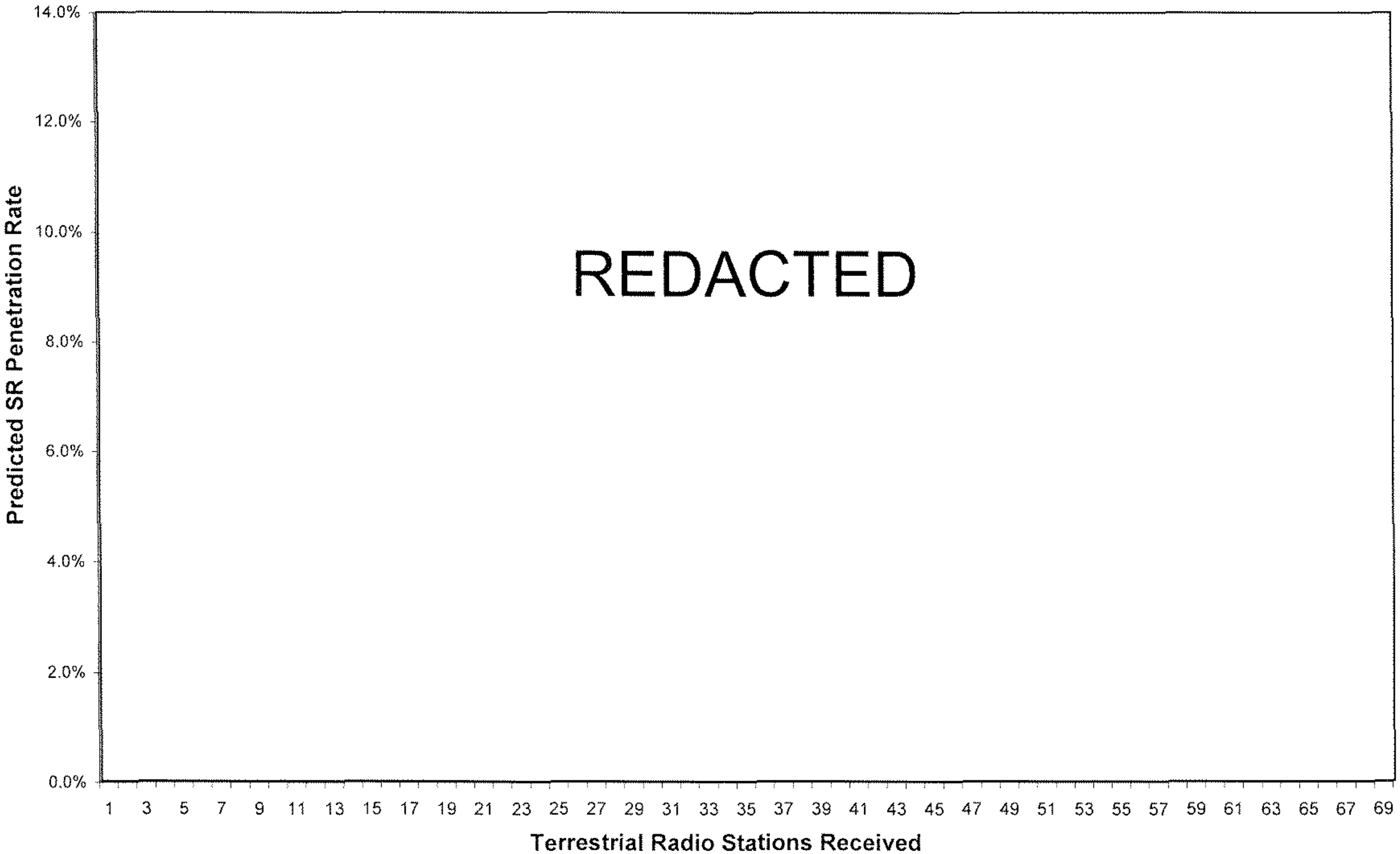
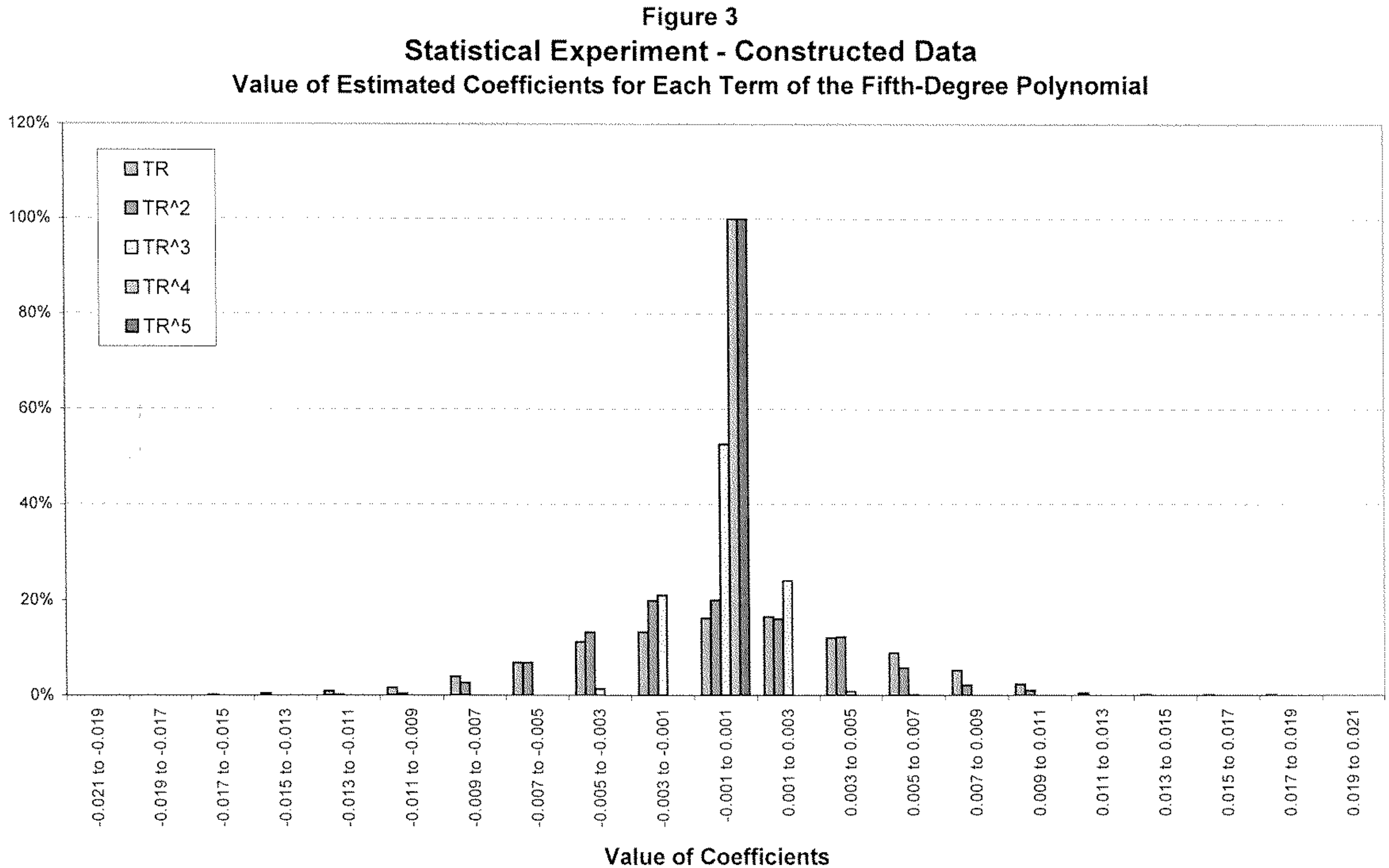


Table 2

Relationship Between Predicted SR Penetration Rate and Number of TR Signals
With and Without Function of Population as Explanatory Variable

	Baseline	With Population	With Log of Population	With [1 / Population]	With Polynomial of Fifth Degree
TR Signals					
TR Signals^2					
TR Signals^3					
TR Signals^4					
TR Signals^5					
Income					
Income^2					
% Go to Work by Car			REDACTED		
% Live in Urban Area					
[% Go to Work by Car] * [% Live in Urban Area]					
% Female					
ZCTA5 population / 1,000					
Log of ZCTA5 population					
Inverse of [ZCTA5 population / 1,000]					
[ZCTA5 population / 1,000]^2					
[ZCTA5 population / 1,000]^3					
[ZCTA5 population / 1,000]^4					
[ZCTA5 population / 1,000]^5					
Constant					
Observations					
Log-Likelihood					

Notes:
Coefficients are in bold, and t statistics are in brackets; * significant at 5%; ** significant at 1%.
Standard errors are clustered by 3-digit ZCTA.
Probit models estimated by maximum likelihood.
"TR Signals" is the number of TR signals divided by 10.



Note: Constructed data: the number of subscribers in each ZCTA is determined from the binomial distribution where the probability of success is set equal to [redacted] (the national self-pay penetration of satellite radio in our data) and the number of trials equals the population of the ZCTA.

Table 3

Statistical Experiment - Actual vs Constructed Data

Value of Estimated Coefficients for Each Term of the Fifth-Degree Polynomial

		TR	TR^2	TR^3	TR^4	TR^5
Results with Actual SR Penetration	REDACTED					
	Coefficient Significant at 5%	Yes	Yes	Yes	Yes	Yes
Results with Random SR Penetration (1,000 Replications)	**Mean***	0.00033234	-0.00023005	0.00006716	-0.00000864	0.00000040
	Standard Deviation*	0.00486874	0.00383243	0.00134483	0.00021412	0.00001259
	Maximum*	0.01768412	0.01097320	0.00537602	0.00065352	0.00004916
	Minimum*	-0.01398333	-0.01502264	-0.00402745	-0.00085093	-0.00003864
	Percentage of Significant Coefficients at 5%	4.7%	5.0%	4.4%	4.7%	4.7%
	At 5%, an F-test rejects the hypothesis that all coefficients equal zero in 4.8% of the replications.					

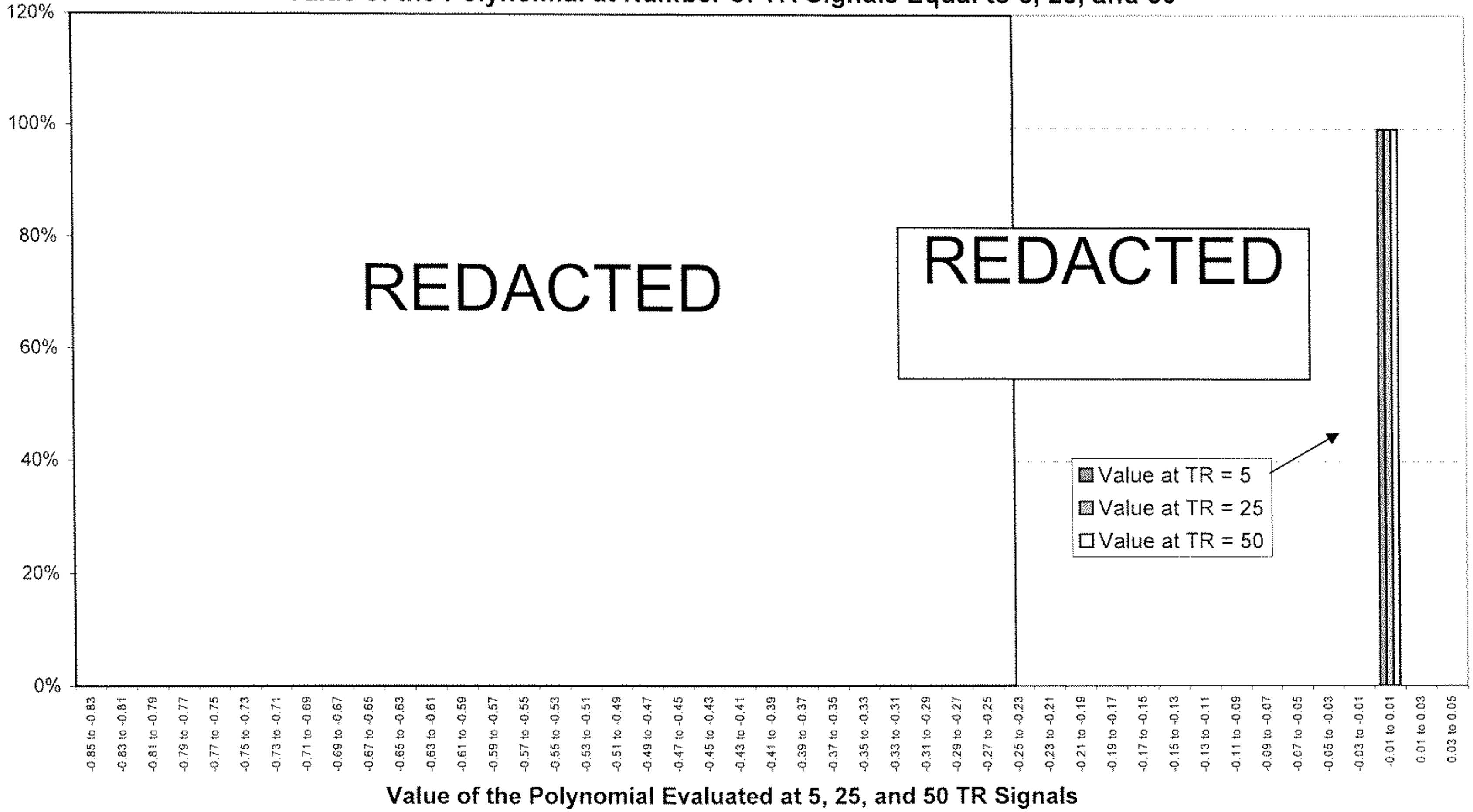
Note: Constructed data: the number of subscribers in each ZCTA is determined from the binomial distribution where the probability of success is set equal to [redacted] (the national self-pay penetration of satellite radio in our data) and the number of trials equals the population of the ZCTA.

* Mean, Standard Deviation, Maximum, and Minimum refer to the distribution of the 1,000 estimated coefficient values.

Figure 4

Statistical Experiment - Actual vs Constructed Data

Value of the Polynomial at Number of TR Signals Equal to 5, 25, and 50

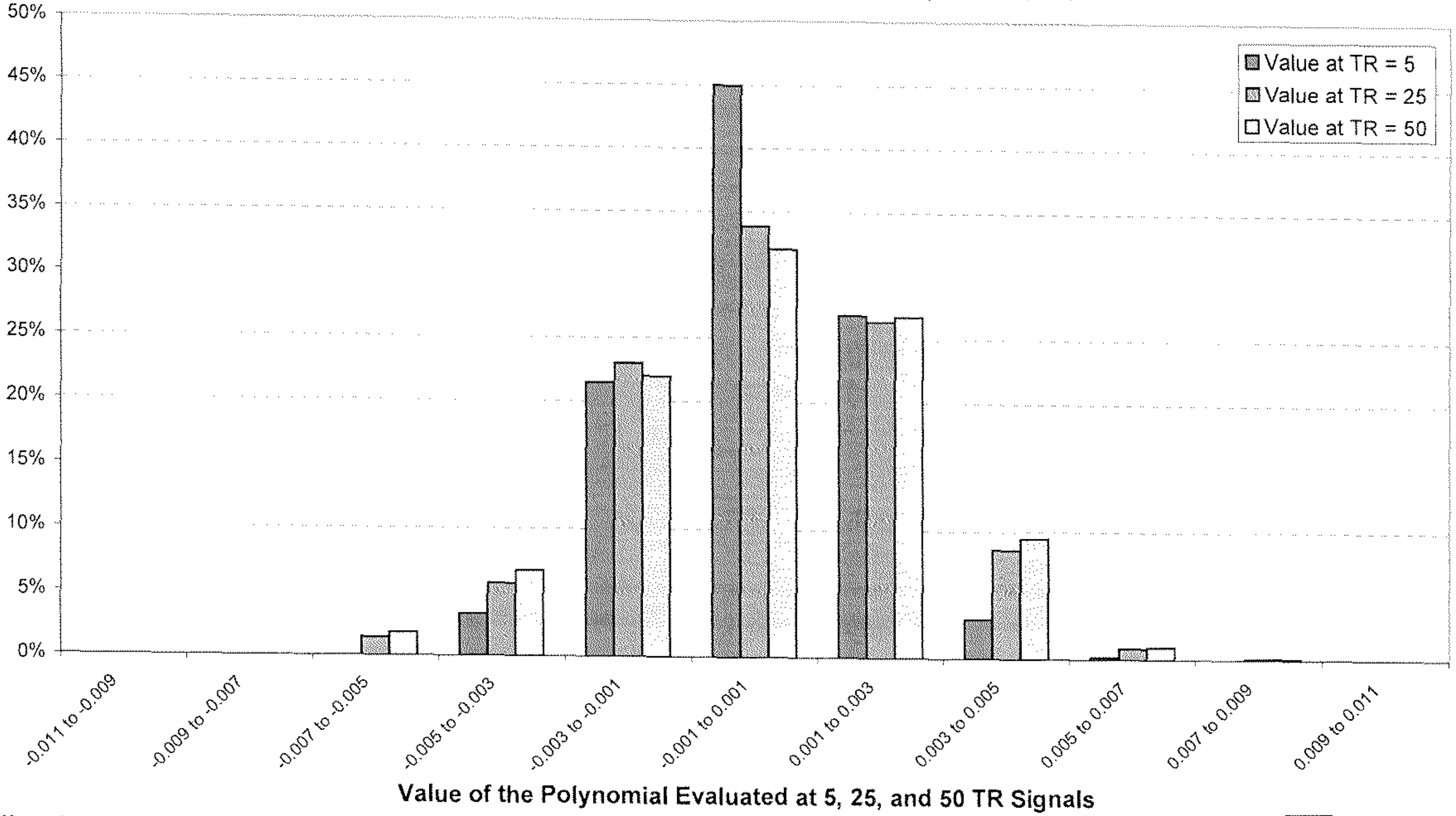


Note: 1) Constructed data: the number of subscribers in each ZCTA is determined from the binomial distribution where the probability of success is set equal to [redacted] (the national self-pay penetration of satellite radio in our data) and the number of trials equals the population of the ZCTA.
2) Results that use randomly generated data are pictured in more detail in Figure 5.

Figure 5

Statistical Experiment - Constructed Data

Value of the Polynomial at Number of TR Signals Equal to 5, 25, and 50



Note: Constructed data: the number of subscribers in each ZCTA is determined from the binomial distribution where the probability of success is set equal to [redacted] (the national self-pay penetration of satellite radio in our data) and the number of trials equals the population of the ZCTA.

Table 4
Statistical Experiment - Actual vs Constructed Data
Value of the Polynomial at Number of TR Signals Equal to 5, 25, and 50

		TR = 5	TR = 25	TR = 50
Results with Actual SR Penetration	Value of Polynomial	REDACTED		
Results with Random SR Penetration (1,000 Replications)	Mean*	0.000117	0.000144	0.000154
	Standard Deviation*	0.001650	0.002197	0.002312
	Maximum*	0.005707	0.007142	0.008014
	Minimum*	-0.004765	-0.006495	-0.006955

Note: Constructed data: the number of subscribers in each ZCTA is determined from the binomial distribution where the probability of success is set equal to [redacted] (the national self-pay penetration of satellite radio in our data) and the number of trials equals the population of the ZCTA.

* Mean, Standard Deviation, Maximum, and Minimum refer to the distribution of the 1,000 estimated polynomial values.