



ELSEVIER

Journal of Public Economics 71 (1999) 189–211

JOURNAL OF
PUBLIC
ECONOMICS

Public radio in the United States: does it correct market failure or cannibalize commercial stations?

Steven T. Berry^{a,b}, Joel Waldfogel^{b,c,*}

^aYale University, New Haven, CT, USA

^bNBER, 1050 Massachusetts Avenue, Cambridge, MA 02138, USA

^cThe Wharton School, Philadelphia, PA 19104-6372, USA

Received 1 May 1997; received in revised form 1 April 1998

Abstract

Because broadcasters can capture only part of the value of their product as revenue, there is the potential for a classic problem of underprovision. Whether public support corrects a market failure depends on whether the market would have provided similar services in the absence of public broadcasting. We address these questions by asking whether public and commercial classical stations compete for listening share and revenue as well as whether public stations crowd out commercial stations. We find evidence that public broadcasting crowds out commercial programming in large markets, particularly in classical music and to a lesser extent in jazz. © 1999 Elsevier Science S.A. All rights reserved.

Keywords: Crowding out; Entry; Market failure; Public goods; Public radio

JEL classification: H41; L33; L82

1. Introduction

Radio signals are pure public goods whose total value to society is the sum of their value to advertisers and listeners.¹ While programming with total value in excess of its costs should be provided, the market provides only programming that

*Corresponding author. The Wharton School, Philadelphia, PA 19104-6372, USA. Tel.: +1-215-898-7148; fax: +1-215-898-7635; e-mail: waldfogj@wharton.upenn.edu

¹Although technologies (such as cable) exist for making radio excludable, much listening occurs in cars, making exclusion difficult.

attracts enough listeners so that advertising revenue covers costs.² Because broadcasters can capture only part of the value of their product, there is the potential for a classic problem of underprovision. Some programming with total value in excess of its cost will not be provided. At the same time, because of free entry there is a possibility of excess entry of stations into popular formats.³ Because there is no reason to expect the market to provide the right amount of radio broadcasting, it is interesting to examine the determinants of broadcast provision that does occur. Current policy debates also motivate interest in this topic.⁴

This study examines market and government provision of radio broadcasting in the U.S. The first goal of this study is to identify possible areas of underprovision by the market. Although commercial firms provide most types of programming in most markets, the market provides a much greater variety of programming in larger markets. This suggests that any problem of inefficient underprovision – failure to provide programming with total value in excess of its costs – occurs in small markets. For example, while the market provides classical music programming in most of the 25 largest U.S. markets, commercial stations provide classical music in only nine of the remaining markets among the 165 examined in this study. A similar pattern holds for jazz as well as programming targeted at black and Hispanic audiences.

The U.S. is one of the few nations relying almost exclusively on the market for provision of radio broadcasting.⁵ Most European countries fund broadcasting with radio or combined radio/television receiver license fees. Although commercial broadcasting in the U.S. generated US\$8.9 billion in revenue in 1993 (see Duncan, 1994), total government support for radio in 1993 totaled only US\$160 million.⁶ While small overall, government support for radio is targeted at nonprofit ('public') radio stations offering a small number of programming formats: news, classical music, and jazz. Commercial firms are also active in the provision of each of these types of programming.

Whether public support alleviates possible underprovision problems depends on whether the market would have provided the services offered by public broadcas-

²See Samuelson (1954) for a discussion of correct public goods allocation. See also Bradford and Hildebrandt (1977) for a discussion of valuing public goods based on demand for their complements.

³If a type of programming attracts enough listeners in a market to generate advertising revenue sufficient to finance multiple stations, the market will provide multiple stations even if they offer identical programming. Mankiw and Whinston (1986) discuss the possible inefficiency of free entry in theory. Berry and Waldfogel (1996) examine the problem of excess entry into commercial radio broadcasting and is a companion to the present study.

⁴On December 6, 1994, Speaker of the U.S. House of Representatives, Newt Gingrich, remarked that, "One of the things we're going to do this year, I hope, is to zero out the Corporation for Public Broadcasting, which has been eating taxpayers' money" (De Witt, 1994).

⁵See Head (1985) for a discussion of broadcast finance around the world.

⁶Stations supported by the Corporation for Public Broadcasting (CPB) receive a total of US\$160 million in combined federal, state, and local government support.

ters in their absence. At the same time, whether public and commercial programming can displace one another – and whether commercial service can adequately replace public programming – depends on whether the two forms actually offer similar programming. Because radio programming is not priced, we cannot determine the value of commercial or public stations to listeners, nor can we generally determine the welfare implication of a commercial station's replacement by a public station. Welfare implications of crowding out are straightforward only when commercial and public stations offer perfectly substitutable programming. In that circumstance, a public station's replacement of a commercial station would add public expense without affecting listener welfare. The welfare implication of an additional (commercial or public) station offering perfectly substitutable programming is also clear: it brings additional cost without additional listener benefit.

The feasibility of welfare analysis in this hypothetical polar case places attention on the substitutability of commercial and public stations (within formats), which we study indirectly by asking whether public and commercial stations compete for listening share and revenue. We examine substitutability directly with a comparison of programming aired at public and commercial classical music stations. We then ask whether public stations crowd out commercial stations.⁷ In this study we present new data, and our approach is to describe the data and document basic relationships. We defer to subsequent work attempts to derive functional forms for estimation from underlying models of utility.⁸

We present evidence consistent with the hypothesis that public and commercial broadcasting offer substitute programming in jazz and, especially, classical music. We find explicit evidence of a crowding out relationship between commercial programming in jazz and especially classical music. We find no evidence that public and commercial news programming are substitutable. Given our estimated relationships, we estimate the extent of commercial provision of classical and jazz programming that would occur in the absence of public programming. We also examine the distribution of government support across markets and broadcast programming formats, asking whether public support appears to be targeted to offset underprovision by the market. Does government support foster programming in markets that would otherwise be unserved by such programming? Or does government support for public broadcasting serve mainly to cannibalize service that the market would otherwise provide?

Our study proceeds as follows. First we offer a positive description of the provision of radio broadcasting. Section 2 describes the data employed in the study. Section 3 documents how commercial and public provision of broadcasting

⁷This study is related to other studies asking whether government crowds out private activity, such as Cutler and Gruber (1996). This study is also related to the literature on how public spending crowds out private charity. See Posnett and Sandler (1989), Khanna et al. (1995), and Kingma (1989).

⁸See Berry and Waldfogel (1996) for such a study of commercial radio broadcasting.

services vary with market size. Some formats are rarely provided by the market in small cities, suggesting a possible underprovision problem that government intervention might correct. Section 3 also documents that listening increases with available product variety, indicating that the extent of available programming variety matters to people and, by extension, that the absence of programming variety has negative consequences. In Section 4 we examine whether public and commercial programming appear to be substitutes. Section 5 measures the extent of crowding out. Based on the estimated relationship between public and commercial stations, in Section 6 we simulate the commercial response to the hypothetical absence of public classical and jazz broadcasting. Section 7 discusses the pattern of government support for public broadcasting, by size of market and whether it receives commercial service. We conclude with a discussion of next steps for the research.

2. Data

The basic data for this study are information on entry, programming format, and listening for stations in 165 major U.S. markets. Data for this study are drawn from a variety of sources. We obtain data on listening to commercial stations from Arbitron (1993), which reports average quarter hour (AQH) listening for each commercial station in each of nearly 300 U.S. markets during Spring 1993. AQH listening measures the number of persons listening for at least 5 min during an average quarter hour. The Arbitron data allow us to distinguish between stations broadcasting from within the metropolitan stations where they are heard (which we term ‘inside stations’) and stations received in the metro area but broadcasting from elsewhere (‘outside stations’). Duncan (1993) provides information on programming format for each commercial station. We use Duncan’s classification to divide stations into 16 commercial formats.⁹ We use these two sources together to calculate both the number of stations broadcasting in each format in each market (N) and the format’s listening share (s) in the market. We calculate each of N and s by format separately for inside and outside stations. Duncan includes format information for 165 markets.

Our information on public radio comes from five separate sources. The Radio Research Consortium provided us with lists of public stations that in principle are receivable in each metro area. The Corporation for Public Broadcasting (CPB) provided a list of public stations receiving CPB support, along with each station’s

⁹The commercial 16 formats we use, based on Duncan’s data, are: adult contemporary, album oriented rock, black, big band/nostalgia, country, contemporary hit radio (top 40), classical music, classic album oriented rock, full service/variety, jazz, news/talk, oldies, religious, soft adult contemporary, Hispanic, and unknown.

1993 support by source.¹⁰ According to Mr. Young Lee of CPB, CPB-supported stations account for the vast majority of public listening.¹¹ These are the stations we include as public stations in the study. National Public Radio (NPR) provided a file containing programming format information for each public station. We classify public stations into seven format groups: classical music, classical/news, jazz, jazz/news, news, other/news, and other.¹² NPR also provided data on total listening to public stations, by market, for 88 markets in the sample. The public listening figure includes both inside and outside public stations. It also includes all public stations, not just those that are CPB-supported.

We use the information to create a cross section with the following information for each market: (1) number of inside stations by format for each commercial and public format; (2) number of outside stations by format for each commercial and public format; (3) inside listening (listening to inside stations) by format for each commercial format; (4) outside listening for each commercial format; (5) total public listening – unlike other data, which are available in all 165 markets, these are available for only 88 markets; and (6) revenue to inside public (CPB-supported) stations, by revenue source and public programming format, for each market. Finally, we have economic and demographic characteristics of each market, including population, average income, the distribution of education, and the number of colleges and universities. These are from Arbitron (1994) derived from Census data.

3. Entry and the size of the market

In this study we are concerned with possible market underprovision of broadcast services, as well as the possible displacement relationship between commercial and public stations. As a first step toward identifying possible areas of market underprovision this section describes the pattern of public and commercial broadcast programming. We also describe the pattern of public programming. We examine how commercial and public provision of radio broadcasting vary with the size of the market. In particular, we examine the relationship between market size

¹⁰Major funding sources in the data include membership support, business underwriting, federal government, state and local government, and college support.

¹¹A substantial number of noncommercial stations are not supported by CPB, but these are small, typically college stations.

¹²We classify a station as ‘classical’ if its programming is more than 50% classical and less than 10% news (28% of CPB-supported stations), classical/news if more than 50% classical and more than 10% news (7%), jazz if more than 50% jazz and less than 10% news (7%), jazz/news if more than 50% jazz and more than 10% news (2%), other if more than 50% other and less than 10% news (29%), other/news if more than 50% other and more than 10% news (20%), and news if more than 50% news (6%). This classification is mutually exclusive.

and the presence of stations in a format. We then examine the relationship between programming variety and listening.

3.1. Market size and format presence

The size of the market affects the number of firms entering the market, and the number of stations, both inside and outside the market, grows in market size.¹³ Yet, the number of stations in each format provides a poor measure of the extent of product variety available to consumers. Because stations within each format offer similar programming, consumers have similar listening options regardless of the number of stations in a format beyond the first. Consequently, whether a market has a station in a format – ‘format presence’ – provides a better measure of available product variety. Table 1 shows how format presence varies by market size for each commercial and public broadcasting format. The table also shows the average number of formats available in each market.

The market provides a large amount of program variety in large markets. Of 16 commercial formats, markets in the largest population quintile have an average of 12.5 formats available inside the metro (13.3 including stations broadcasting from outside the metro). By contrast, markets in the smallest population quintile have an average of only 8.2 inside formats (9.6 including the outside stations). The relationship between total formats available (from inside or outside stations) is similarly monotonic.¹⁴ All but four formats (classical, full service/variety, jazz, and Hispanic) are market-provided in over three-quarters of the largest markets. Of the 32 markets in the sample with populations that are over 10% Hispanic, 31 have in-metro Hispanic stations.

The smallest population quintile includes metropolitan areas with fewer than 246,000 persons. Of the 33 markets in this population range, the market provides classical and jazz programming in two cities each and classic album oriented rock programming in three. Public stations provide classical music in 11, and jazz in five, of the 33 smallest markets. The second smallest population quintile includes 33 markets with populations between 246,000 and 364,000. None of these markets has a commercial classical station, and only two have a commercial jazz station. Ten of these markets have a public classical station, and four have a public jazz station. In the middle population quintile of markets, including the 32 markets with population between 364,000 and 561,000, commercial stations provide classical

¹³See Berry and Waldfogel (1997) for detailed information on the number of stations in each format by size of market.

¹⁴The positive relationship between market size and programming variety is not driven by a proximity of small markets to large ones. Small markets in our study are generally not merely adjacent suburbs of large markets. Indeed, the 10 smallest markets in the study are: Pueblo, CO; Altoona, PA; Bloomington, IL; Waterloo-Cedar Falls, IA; Sioux Falls, SD; Fargo, ND; Wheeling, WV; Duluth, MN; Cedar Rapids, IA; and Wilmington, NC. Only one of these (Wheeling, WV) is contiguous with a top 50 market (in this case, Pittsburgh, PA).

Table 1
Format presence by population quintile

Format	1	2	3	4	5	Overall
Adult contemporary	84.85%	81.82%	84.38%	100.00%	96.97%	89.70%
Album oriented rock	81.82%	78.79%	75.00%	100.00%	96.97%	86.67%
Black	18.18%	45.46%	46.88%	64.71%	78.79%	50.91%
Big band/nostalgia	72.73%	63.64%	43.75%	70.59%	87.88%	67.88%
Country	96.97%	87.88%	93.75%	97.06%	100.00%	95.15%
Contemporary hit radio (top 40)	90.91%	72.73%	87.50%	100.00%	100.00%	90.30%
Classical	6.06%	0.00%	9.38%	11.77%	57.58%	16.97%
Classic album oriented rock	9.09%	18.18%	43.75%	47.06%	81.82%	40.00%
Full service/variety	57.58%	42.42%	43.75%	58.82%	57.58%	52.12%
Jazz	6.06%	6.06%	9.38%	23.53%	42.42%	17.58%
News/talk	69.70%	78.79%	84.38%	79.41%	93.94%	81.21%
Oldies	78.79%	69.70%	84.38%	88.24%	90.91%	82.42%
Religious	63.64%	66.67%	68.75%	82.35%	81.82%	72.73%
Soft adult contemporary	51.52%	78.79%	75.00%	88.24%	96.97%	78.18%
Hispanic	6.06%	15.15%	21.88%	20.59%	45.46%	21.82%
Unknown	24.24%	33.33%	37.50%	32.35%	42.42%	33.94%
Public classical	21.21%	12.12%	21.88%	50.00%	24.24%	26.06%
Public classical/news	12.12%	18.18%	9.38%	26.47%	12.12%	15.76%
Public jazz	9.09%	9.09%	3.13%	17.65%	36.36%	15.15%
Public jazz/news	6.06%	3.03%	3.13%	8.82%	15.15%	7.27%
Public news	12.12%	9.09%	6.25%	11.77%	30.30%	13.94%
Public other	15.15%	15.15%	12.50%	23.53%	33.33%	20.00%
Public other/news	6.06%	9.09%	21.88%	17.65%	45.46%	20.00%
Any public	66.67%	54.55%	62.50%	88.24%	84.85%	71.52%
Number of commercial formats inside	8.18	8.39	9.09	10.65	12.52	9.78
Number of commercial formats (including outside the Metro)	9.64	10.82	10.91	11.62	13.33	11.27
Number of public formats inside	0.82	0.76	0.78	1.56	1.97	1.18
Number of formats inside	9.00	9.15	9.88	12.21	14.48	10.96
Number of markets	33	33	32	34	33	165

and jazz programming each in three cities while public stations provide classical programming in 10 cities and jazz in two. The fourth population quintile includes 34 cities with populations between 561,000 and 1,198,000. The market provides classical programming in four markets and jazz programming in eight, while public stations provide classical music programming in 26 and jazz in nine. Only in the top quintile, including cities over 1,198,000 persons, is commercial provision of classical music programming more prevalent than public provision. Commercial stations provide classical programming in 19 of the 33 largest markets, compared with only 12 served by public stations. Public stations provide jazz programming in 17 of these cities, compared with 14 served by commercial jazz stations.

Table 1 clearly shows the areas of possible inefficient underprovision. Six formats are provided by the market substantially less frequently than the other 10:

classical music, jazz, classic album oriented rock, and soft adult contemporary, as well as black and Hispanic formats. These formats are provided by the market especially infrequently in small markets. There are commercial classical and jazz stations inside of only five and seven markets among the roughly 100 cities in the three smallest population quintiles, respectively.

Two questions come to mind as one examines Table 1. First, does the market fail to provide programming with total value in excess of its costs? Commercial classical provision, for example, is common in the largest markets but substantially less common in the fourth population quintile. One can infer that there is some level of population (in the range of quintiles 4 and 5) allowing a commercial classical station to attract enough listeners to cover costs with advertising revenue. As population dips below the implied breakeven level, stations cannot be financed with advertising revenue alone. However, if programming has any value to listeners, for the range of market sizes just below the largest, the total value of (nonexistent) commercial classical programming would exceed the cost of provision. If programming has substantial value to listeners, many markets should have classical stations.

Second, is there a relationship between commercial and public provision in related formats? Outside of the top population quintile, commercial stations provide classical programming in only nine (of 132) markets. The public sector, by contrast, provides classical programming in nearly half (57) of these cities outside the largest quintile. Of the 69 markets outside the top two quintiles not served by public classical stations, only four have commercial classical stations broadcasting from inside the metro. Because such markets have no public stations, it is not possible that public provision is displacing commercial entry. Rather, commercial entry in such markets is presumably not viable.

In larger markets, displacement appears more plausible. Consider commercial and public classical provision across markets of different sizes. Commercial provision is rare in cities smaller than those in the top quintile and jumps substantially in the largest cities. Public provision, by contrast, rises slowly across market sizes until the top quintile, when it falls, perhaps because of the prevalence of commercial provision. We return to the question of whether public stations crowd out commercial stations in Section 5 below.

3.2. Listening and product variety

We care about the amount of program variety only if it has value to listeners. Although we cannot measure the value of variety to listeners, this section examines the relationship between program variety in a market and listening. If variety is valuable to listeners, then we expect to observe a larger fraction of the population listening in markets with greater programming variety.¹⁵

¹⁵Even if program variety does not attract additional listeners, it may be valuable to existing listeners by allowing them to listen to more preferred programming.

Our data set includes information on the numbers of inside and outside stations broadcasting in 23 distinct programming formats, 16 commercial and seven public. A crude but natural way of measuring the product variety available in a market is simply the number of different formats available. We have commercial listening shares for 165 markets. Of these we have public listening shares for 88 markets. Consequently, we examine the relationship between variety and listening in two different ways. For the 88 markets with total (commercial + public) listening data, we examine the relationship between total listening and the number of commercial and public formats available inside or outside the metro. We also examine the relationship between commercial listening and the number of commercial formats available (from inside or outside the metro) for all 165 markets. Both relationships are positive. A regression of the share of population listening to commercial radio (s_c) on the number of formats available (NF) yields (standard errors in parentheses):

$$s_c = \frac{0.128}{(0.009)} + \frac{0.0025}{(0.0008)} * NF.$$

The positive relationships may not demonstrate positive impacts of variety on listening. Rather, they may reflect endogeneity in the number of available formats. It is possible that more varieties of stations enter the market in metropolitan areas with greater tastes for variety. To measure the impact of variety on listening, we need a source of exogenous variation in variety, which we find in population. The larger is a metropolitan area's population, the more stations it can support. Even if tastes are identical in metro areas of differing populations, the number of stations (and formats available) will differ. Hence, population is a suitable instrument for the number of varieties. A regression of the number of formats on population yields:

$$NF = \frac{10.69}{(0.1608)} + \frac{0.599}{(0.0001)} * \text{Population (millions)}.$$

Using population as an instrument for NF , the IV estimate of the relationship between commercial listening and NF is:

$$S_c = \frac{0.0553}{(0.0222)} + \frac{0.0090}{(0.0020)} * NF.$$

We obtain similar results when we regress total listening on the number of public and commercial formats available. We conclude that variety attracts listeners and is therefore valuable. As a result, there is some reason to be concerned about the market's failure to provide as much programming variety in small areas as it does in large areas.

4. Are public and commercial stations substitutes?

The main programming formats offered by CPB-supported public stations are news, classical music, and jazz. Other programming provided by public stations includes folk music, world music, pop music, and eclectic music.¹⁶ The three main formats provided by public stations, news, classical, and jazz, are similar in name to their three commercial counterparts. This section explores whether public and commercial programming appear to be substitutes.

We recognize that commercial and public stations within a format are not identical. Indeed, unless they simultaneously broadcast the same programming, no two stations are identical. However, some stations are more similar than others, and this similarity will have observable implications. In the extreme case of perfect substitutes, identical stations will simply split a market by ‘stealing’ listeners from one another. Thus, the presence of additional stations with similar programming will reduce listening at the first station. Further, an additional identical station reduces welfare because it adds costs but no benefits. By contrast, two stations offering distinct programming – and drawing different types of listeners – will draw each others’ listeners to a lesser extent. The presence of a second, dissimilar station will be associated with smaller (or perhaps no) reductions in listening at a first station.

Using this logic we attempt in this section to measure the similarity of public and commercial programming in three formats (classical, jazz, and news). We appeal to the data for indirect evidence of substitutability in the extent to which public and commercial stations draw the same listeners. First, we ask whether the presence of a public station in a format reduces a local commercial station’s listening share. We do not have format-level public station listening data, so we cannot perform the analogous reverse exercise. However, we do have format-level revenue data for public stations. Consequently, our second approach to this question is to measure the impact of public and commercial stations on public station listener-related revenue (from members and business underwriters). For classical music stations, we also study the substitutability of commercial and public stations directly, by comparing their programming.

4.1. Public station presence and commercial listening

To test the substitutability of public and commercial programming, we regress commercial listening, by public format, on a constant, the number of inside commercial stations in the format, the number of outside commercial stations in the format, the number of inside public stations in the format, and the number of outside public stations in the format. We also include the following market characteristics: the percent black and Hispanic, the percent college educated,

¹⁶See CPB (1994).

per-capita income, and region dummies. For these regressions and those that follow, public classical includes both public classical and public classical/news formats, public jazz includes both jazz and jazz/news formats, and public news includes both public news, classical/news, jazz/news, and other/news.¹⁷ Two of the hybrid categories appear in more than one category. These regressions include only markets with commercial listening in the format (therefore, we include only markets with either inside or outside commercial stations in the format). We recognize that numbers of commercial and public stations inside the metro area are potentially endogenous variables. Hence, we discuss the likely direction of bias in OLS estimates, and we report IV estimates where suitable instruments are available.

OLS results by format, in Table 2, show that commercial listening increases significantly in the number of inside and, to a lesser extent, outside commercial stations in the format. The number of inside public stations is negatively related to the commercial listening share, but the relationship is significant only for classical (and nearly significant in the news/talk format). Each inside commercial classical station increases commercial classical listening by 0.2 percentage points, and each inside public classical station reduces commercial classical listening by 0.15 percentage points. The average public station's listening share is between 0.2 and 0.4% of the population.¹⁸ Hence, while there appears to be some substitutability of commercial and public classical programming, public classical listeners cannot all be drawn from commercial stations.

The possible endogeneity of inside station entry raises a question about the direction of bias in OLS estimates of the effect of public entry on commercial listening. If the unobservable factor affecting both public entry and commercial listening is a 'taste for radio listening,' then we expect higher commercial listening in the same places we observe greater public entry. This sort of unobservable will cause the OLS coefficient to understate the true extent of displacement. On the other hand, if the unobserved variable affecting both public entry and commercial listening is a 'taste for publicness,' then the OLS coefficient will overstate displacement. Intuitively, one expects the importance of tastes for publicness to be greater, the larger is the difference between public and commercial programming. This, in turn, places attention on direct evidence on programming substitutability.

We also obtained IV estimates of the relationship between inside public entry

¹⁷Including both straight classical, jazz, or news and hybrid (for example, classical/news) stations in our measure of the number of public stations exacerbates the general problem that public and commercial stations in a format may offer different programming. To the extent that we group unlike programming with straight programming within a format, we introduce measurement error in the true number of public stations in a format. This will bias our procedure away from finding any displacement.

¹⁸We can compute this only approximately because, while we separately observe the numbers of public stations broadcasting from inside and outside the metro areas, we only observe total public listening. The average public listening share per inside (total) public station is 0.4% (0.2%).

Table 2
Commercial listening share (*100) and commercial and public stations

Estimation technique:		Classical	Jazz	News/talk	All	All
		OLS	OLS	OLS	OLS	IV ^a
Constant	Coef.	0.0603	-0.5332	-0.07	11.99	11.5378
	Std. err.	0.14	0.18	0.39	0.7091	0.8607
Inside commercial stations this format	Coef.	0.1999	0.317	0.3681	0.0821	0.1578
	Std. err.	0.05	0.05	0.05	0.0186	0.0610
Outside commercial stations this format	Coef.	0.0114	0.0782	0.2265	0.0414	0.0433
	Std. err.	0.06	0.07	0.04	0.0173	0.0219
Inside public stations this format	Coef.	-0.1526	-0.0599	-0.1092	-0.1293	-0.6397
	Std. err.	0.04	0.07	0.08	0.1059	0.5048
Outside public stations this format	Coef.	-0.0086	0.0625	-0.0144	0.0183	-0.0321
	Std. err.	0.02	0.08	0.05	0.0574	0.0722
Percent black	Coef.	0.1422	0.0707	1.1945	1.7574	1.3432
	Std. err.	0.37	0.51	0.70	1.3199	1.4720
Percent Hispanic	Coef.	0.389	0.1051	0.5899	1.9018	0.8521
	Std. err.	0.24	0.22	0.45	0.8898	1.2266
Percent college educated	Coef.	0.4957	-0.2025	0.2559	-1.8244	-0.4788
	Std. err.	0.17	0.23	0.51	0.9411	1.5509
Average per capita income (000)	Coef.	-0.003	0.0166	0.0131	0.0517	0.0320
	Std. err.	0.00	0.00	0.01	0.0254	0.0307
North Central	Coef.	-0.1026	0.1513	-0.1604	0.0494	0.1459
	Std. err.	0.06	0.09	0.17	0.3074	0.3433
South	Coef.	-0.1582	0.188	-0.4437	-0.3670	-0.5471
	Std. err.	0.08	0.09	0.20	0.3554	0.4510
West	Coef.	-0.1556	0.1619	0.1131	-0.7049	-1.0664
	Std. err.	0.08	0.08	0.19	0.3553	0.5029
R^2		66.58	74.48	58.00	32.81	26.63
N^b		47	46	146	165	165

^a Instruments include number of colleges and universities, as well as total population, number of blacks, Hispanics, and college-educated persons.

^b Markets with either inside or outside commercial stations in the format are included.

and commercial listening using the following strategy for choosing instruments. The viability of a commercial or public station depends on the absolute number of listeners it can attract. Thus, variables related to market size (such as terms in population and the numbers of people with different ethnic and educational backgrounds) will affect entry but not listening shares. Furthermore, because many public stations are associated with colleges, we also employ the numbers of colleges and universities as an instrument for public station entry. Although the instruments do not explain variation in inside stations in the small samples by format, our instruments do a reasonable job of explaining the variation in total inside commercial and public stations across all 165 markets in the sample.¹⁹ Column 4 of Table 2 shows OLS estimates of the relationship between total

¹⁹Population and its square are important and statistically significant determinants of the inside-the-metro commercial and public station entry.

commercial listening and inside and outside public and commercial entry, along with various controls. The last column reports IV estimates of the relationship between entry and listening. Of greatest interest for our purpose is the coefficient on inside public stations. While the OLS coefficient is -0.13 (with a standard error of 0.11), the IV coefficient is consistent with a substantially larger effect (-0.60), although rather unprecisely estimated (with a standard error of 0.50). That the OLS coefficient is larger supports the notion of unobservable tastes for listening generally, as opposed to ‘publicness.’

The evidence on listening suggests that commercial and public classical stations are substitutes, at least to some degree. The general absence of statistically significant relationships between public presence and commercial listening in the other two formats suggests that public and commercial programming in these formats attract distinct audiences and, by extension, that programming in jazz and news are less similar across the public–commercial divide. IV estimates grouping formats suggest that OLS gives conservative estimates of substitutability.

4.2. Public and commercial station presence and public station revenue

If public and commercial stations have similar programming, then the presence of commercial stations will draw not only listeners but also listening-based contributions from public stations. We define listener-based contributions as those from members, whose contributions reflect valuation of the programming, and revenues from business and foundation underwriters, which, like advertising revenue, also depend on audience sizes.

Our revenue measure is per-capita listener based revenue (to inside stations in this format) per station in this format. We regress this on the number of inside public stations beyond the first, the number of outside public stations, the numbers of inside and outside commercial stations, per capita income, and the percent of college graduates in the population. We include in the samples only markets with inside public stations in the format. Public station revenue declines with the number of commercial stations in the format for each of the three formats. However, the decline is (marginally) significant only for classical music. This result arises in both OLS and IV estimates (using the instruments described above).

Taken with the relationship between public stations and commercial listening, this result reinforces the idea that commercial and public classical stations offer substitute programming. The absence of significant relationships for jazz and news again suggests that public and commercial stations in these formats attract distinct audiences.

4.3. Direct evidence on the substitutability of commercial and public programming

In addition to the indirect tests for substitutability, we can also directly examine programming information. The strongest indirect evidence of substitutability

uncovered above is between commercial and public classical music stations. Hence, we have collected data on the musical pieces aired during September 1997 on three commercial and three public classical music stations.²⁰ We obtained the data from station websites, and we assembled a dataset of 2995 pieces of classical music. Using these data we compute the frequency distribution across composers for commercial and public stations.

Table 3 reports the fraction of aired musical pieces by each of the top 40 composers, as measured by frequency of airplay on sampled stations. Mozart is the most popular composer on both commercial (6.72%) and public (5.72%) stations. Bach²¹ is second, accounting for 5.54% of pieces on commercial and 5.55% on public stations. Seven of the top 10 composers on commercial stations are also in the public top 10. Of the top 40 public composers, 27 appear among the top 40 commercial composers as well. There are some substantial differences: Telemann, number 8 on the public list, is number 22 on the commercial list. Debussy, number 14 on the public list, is number 47 on the commercial list.

There is some evidence that these public stations play a greater variety of classical music. While the top 50 composers on these commercial stations account for over two-thirds (67.0%) of the music they air, the (different) top 50 composers on public stations account for only 61.4% of pieces aired on the public stations. The composer share HHI for commercial stations is 1.76, compared with 1.55 for public stations.

In addition to the information about music actually aired, we also obtained information about the favorite musical pieces for listeners at one public and one commercial classical music station (commercial WGMS, Washington DC and public WQED, Pittsburgh). Beethoven's Symphony #9 tops both lists. Eleven of the public WQED top 20 are also in the commercial WGMS top 20. Of the 'top 40' listed by public WQED, 28 of the pieces appear among the 'top 50 classics' listed by commercial WGMS. Given the large universe of extant classical pieces from which favorites could have been drawn, these lists appear similar. We leave it to the reader to determine the degree of substitutability of public and commercial classical programming.

5. Do public stations crowd out commercial stations?

We examine the possible displacement of commercial stations by public stations directly by regressing the number of commercial stations in a market on its market determinants (population, income, and other controls) along with the number of

²⁰The three commercial stations are KING (Seattle, WA), WTMI (Miami, FL), and WGMS (Washington, DC). The three public stations are WSHU (Fairfield, CT), WGBH (Boston, MA), and WUNC (Chapel Hill, NC).

²¹We group J.S. Bach with his heirs together under 'Bach.'

Table 3
Composers aired on selected classical music stations in September 1997

Composer	Rank		Percent of music aired (%)	
	Public	Commercial	Public	Commercial
Mozart	1	1	5.72	6.72
Bach	2	2	5.55	5.54
Beethoven	3	3	3.79	3.60
Haydn	4	6	3.61	2.96
Vivaldi	5	10	3.26	2.04
Schubert	6	9	2.38	2.10
Handel	7	8	2.11	2.21
Telemann	8	22	2.02	1.02
Mendelssohn	9	11	1.67	1.99
Brahms	10	12	1.67	1.88
Tchaikovsky	11	4	1.67	3.01
Dvorak	12	5	1.58	2.96
Purcell	13	62	1.50	0.27
Debussy	14	47	1.50	0.38
Copland	15	29	1.41	0.70
Boccherini	16	50	1.23	0.38
Rossini	17	23	1.06	0.91
Rameau	18	102	0.97	0.16
Strauss	19	7	0.97	2.74
Bizet	20	27	0.88	0.86
Respighi	21	38	0.79	0.54
Saint-Saens	22	16	0.79	1.40
Weber	23	35	0.70	0.59
Stravinsky	24	93	0.70	0.16
Gershwin	25	37	0.70	0.54
Shostakovich	26	51	0.70	0.32
Liszt	27	14	0.70	1.56
Ravel	28	21	0.70	1.02
Rachmaninoff	29	24	0.62	0.91
Schumann	30	17	0.62	1.34
Prokofiev	31	28	0.62	0.81
Hummel	32	92	0.62	0.16
Sibelius	33	43	0.53	0.48
Puccini	34	45	0.53	0.43
Nielsen	35	176	0.53	0.11
Holst	36	42	0.53	0.48
Gabrieli	37	61	0.53	0.27
Wagner	38	15	0.53	1.45
Rimsky-Korsakov	39	20	0.53	1.02
Britten	40	329	0.44	0.05

public stations in the format. As in our estimates of listening displacement above, we recognize the possible endogeneity of public station entry. Because market size measures appear in the displacement equation directly, however, we cannot use

them as instruments for public entry. Instead, we discuss the likely direction of bias in OLS. Casual examination of the pattern of commercial and public provision above suggests that the scope for commercial–public displacement varies by market size. If commercial classical stations are not viable in markets outside the top two quintiles when operating without public competition, then they will not be displaced by public entry in those markets. Hence, we allow the relationship between public and commercial stations to vary by population quintile. Table 4 presents these regression results for classical music, jazz, and news formats. Given the apparent substitutability of public and commercial classical programming documented above, we expect the strongest displacement effects (if we find any) in classical music.

The number of commercial classical stations broadcasting from within a metro area depends strongly and positively on population (although the effect of population declines as population increases) and negatively on the number of commercial classical stations receivable in the metro area but broadcasting from elsewhere. Each outside-the-metro commercial classical station reduces inside

Table 4
Do public stations crowd out commercial stations? (dependent variable: number of stations inside the Metro in this format)

Variable	Classical		Jazz		News/talk	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Constant	-0.6078	0.201	-0.2602	0.289	2.1155	0.583
Population (m)	0.2361	0.060	0.2705	0.091	0.7363	0.197
Population squared	-0.0161	0.003	-0.0171	0.005	-0.0449	0.011
Number of outside commercial stations in this format	-0.2114	0.074	-0.2321	0.106	-0.103	0.060
Number of outside public stations in this format	0.0088	0.027	-0.0317	0.109	0.0548	0.068
Number of colleges and universities	0.0089	0.004	0.0052	0.005	0.0102	0.012
Per capita income (US\$000)	0.0106	0.007	-0.0008	0.009	-0.0304	0.020
Number of college-educated persons	0.0038	0.004	0.0067	0.006	-0.0009	0.013
West	0.1588	0.101	0.0856	0.143	0.4568	0.287
North Central	0.0396	0.076	-0.0926	0.110	-0.3933	0.238
South	0.0228	0.088	-0.0243	0.128	-0.2881	0.255
Number of public stations in this format ^a						
Pop. quintile 1	0.0577	0.098	0.0062	0.207	-0.5768	0.286
Pop. quintile 2	-0.067	0.092	-0.0704	0.227	0.0043	0.215
Pop. quintile 3	-0.0838	0.097	-0.1604	0.308	-0.4426	0.249
Pop. quintile 4	-0.2102	0.062	-0.1861	0.151	0.0383	0.182
Pop. quintile 5	-0.5079	0.105	-0.2938	0.148	0.3951	0.170
<i>N</i>	164		164		164	
<i>R</i> ²	64.13%		33.48%		61.01%	

Note: the table reports regressions of numbers of commercial stations in the format on measures of market size and the number of public stations in the format, interacted with market size quintile dummies. The sample include 164 large U.S. metropolitan areas in 1993.

classical presence by 0.21 stations. As expected, the effect of local public classical stations varies by market size. In the three smallest market quintiles the number of public classical stations bears no significant relationship to the number of classical stations provided by the market. Public entry bears a significant negative relationship to commercial entry in the largest markets, however. In the fourth quintile each public classical station is associated with a 0.2 station reduction in the number of commercial stations (with a standard error of 0.06), and in the top quintile each public classical station reduces commercial entry by 0.5 stations (0.10).

If we view public entry as exogenous, then the estimated relationships between the numbers of public and commercial stations reflect the causal impacts. In the largest markets, for example, these estimates indicate that each additional public classical station reduces commercial classical entry by half a station. Consequently, an additional public station in a market in the largest quintile raises the total number of classical stations in a market by one half. Public entry in markets outside the top two population quintiles has no effect on commercial entry. Rather than cannibalizing commercial stations, such entry goes straight toward providing services that the market does not provide. Public entry outside the largest markets adds to the total number of public stations without displacing any commercial stations.

Results for jazz are rather similar, although the apparent displacement effect is weaker. As in classical, there is no significant displacement relationship in the bottom three market quintiles. In the next-to-largest quintile, each additional public jazz station is associated with a reduction in commercial jazz entry by 0.19 stations (with a standard error of 0.15). In the top quintile each additional public jazz station is associated with a reduction in commercial jazz entry by 0.29 (0.15). Column 3 of Table 4 provides results for the relationship between public news and commercial news/talk. There is no clear pattern of displacement. This is perhaps to be expected, given the differences between programming on the two types of stations. Public news consists largely of the news-oriented National Public Radio programs ‘Morning Edition’ and ‘All Things Considered,’ while commercial news/talk includes a large talk component.

For reasons discussed above, the number of commercial classical stations may be endogenously determined with the number of commercial stations. Given that the crowding-out regressions (in Table 4) include market size measures (population, etc.) as regressors, it is difficult to find suitable instruments for the number of public stations – variables affecting the number of public stations that do not also determine the number of commercial stations.²² Short of finding suitable instruments we can make an intuitive argument about the likely direction of bias in the

²²We experimented with a number of possible instruments, including the number of colleges and universities and the numbers of college educated persons. While some of these variables were significantly related to the number of public stations, the resulting IV estimates of the effect of public stations on commercial stations were very imprecise.

OLS estimates. The contrast between OLS and IV evidence in the commercial listening equation suggests that numbers of both commercial and public stations depend positively on unobserved ‘tastes for radio.’ Such unobservables would induce a positive relationship between commercial and public entry. Consequently, OLS would provide conservative estimates of the true impact of public stations on commercial stations.

6. The commercial response to an absence of public classical and jazz stations

Given the evidence of a displacement relationship between public and commercial stations in classical music and, to a lesser extent, in the jazz format, it is interesting to estimate the impact of a hypothetical absence of public funding on the commercial provision of broadcasting services. Such an exercise requires a model of public station revenue – allowing determination of the number of public stations that could subsist without government subsidies – and is beyond the scope of this paper. However, we can simply pose a related question: How many markets would be served by classical music and jazz stations in the absence of public stations?²³ This is not meant as a simulation of a plausible policy. Rather, because much public radio broadcasting would continue in the absence of government support, this exercise provides a lower-bound estimate of the extent of service that would be available if government subsidies to public broadcasting were eliminated.

To perform this exercise, we estimate separate probit models on commercial classical and jazz presence with the number of public commercial and jazz stations, respectively, on the right-hand side along with other station determinants such as population. These probits are reported in Table 5. We allow the impact of public stations on commercial presence to vary for the top two population quintiles for classical music. Jazz coefficients do not vary by population quintile in this specification.

We simulate the models both with actual numbers of public stations and with no public stations (in conjunction with actual values of other right-hand side variables). We refer to these as ‘default’ and ‘no public’ simulations. We calculate the number of markets served in the absence of public stations as follows: We assume that all markets currently served by commercial stations would remain served by commercial stations in the absence of public stations. We then add the markets which are served under the no public simulation but neither in reality nor

²³In addition, if endogeneity of public stations biases the coefficients away from a finding of displacement, then simulations of the elimination of public stations will underestimate the extent of commercial offset of withdrawal of public programming.

Table 5
 Probit estimates of commercial classical and jazz presence

	Classical		Jazz	
	Coef.	Std. err.	Coef.	Std. err.
Constant	-5.6506	1.749	-3.4335	1.296
Total population (millions)	1.3534	0.981	3.0919	1.305
Population squared	-0.0177	0.405	-1.688	0.889
Population cubed	-0.00299	0.028	0.294	0.164
Number of outside commercial stations	-1.9058	0.874		
Number of outside public stations in this format	0.0074	0.185	-0.0446	0.496
Per capita income (000)	0.0595	0.048	-0.0324	0.034
Number of college-educated persons	0.0322	0.034	0.0575	0.026
Region dummies				
West	0.7351	0.735	-0.4664	0.524
North Central	0.2342	0.601	-0.6913	0.483
South	-0.0969	0.745	-0.361	0.469
Number of public stations in this format			-0.7452	0.374
Number of public stations in this format				
× Bottom three population quintiles	-0.2824	0.588		
× Quintile 4	-0.8088	0.496		
× Quintile 5	-2.1	0.764		
<i>N</i>	165		165	

Note: the dependent variable is whether a market has at least one commercial station in the format (classical or jazz). Independent variables include measures of market size and the number of public stations in the format. For classical music, the effect of public stations on commercial presence is estimated separately for markets of different sizes.

under the default simulation.²⁴ We compare these simulated numbers of markets served with the numbers actually currently served by either public or commercial stations.

Currently, 88 of 165 markets are served by either public or commercial classical stations (or both). Of these, 68 are served by public classical stations; 28 are served by commercial classical stations (eight markets are served by both types). If public stations were eliminated, 60 markets served exclusively by public classical stations would lose access to classical programming. In exchange, commercial stations would enter 10 markets not currently served by commercial stations, and 38 markets would have classical music programming.

While the market would not offset much of the loss of public stations, the offset – measured solely by whether a market is served by any classical station – is substantial in large markets, especially for classical music. Currently, 26 of the largest 32 markets are served by either commercial or public classical stations. Of

²⁴We predict that a market has commercial service if the probit prediction exceeds 50%.

these 26, 12 are served by public stations, and 19 by commercial stations (five by both). In the absence of public classical stations, commercial firms would continue to serve the 19 markets they already serve and enter an additional seven markets. In the top population quintile, the same number of markets currently receiving either public or commercial classical music would receive commercial classical programming in the absence of public broadcasting. In markets below the top quintile, the withdrawal of current public stations begets no additional commercial entry.

Currently, 29 of the largest 32 markets have commercial or public jazz programming. Sixteen of these markets are served by public jazz stations and 13 other markets have commercial jazz stations. In the absence of public jazz stations, 16 markets would have commercial jazz stations. Thus, the loss of public service in 16 markets would be only partially quantitatively offset by entry of commercial jazz service in three markets. There is no commercial jazz entry offsetting the simulated absence of public jazz stations outside the top population quintile.

Depending on the similarity of commercial and public programming, the simulation results can raise questions about funding public broadcasting in the largest markets, particularly for classical music programming. If public and commercial classical programming were identical, and if the same number of large markets receive classical programming with or without public broadcasting, then government funds would obviously be wasted providing classical programming in those markets. On the other hand, if public and commercial programming are sufficiently different so that the distinct benefit of public classical programming to its listeners, beyond the benefit of commercial classical programming, exceeds its cost of provision, public funding of classical music – even if it crowds out commercial classical programming – may not be wasteful.

Results of the simulation also clearly show that, in the absence of public broadcasting, persons living outside the largest markets would receive very little classical music or jazz programming. While we cannot say whether such programming has value to listeners in excess of its costs – and therefore whether its provision actually corrects market failure – its provision is also not clearly wasteful. That is, public provision of jazz and classical programming outside the largest markets is not duplicative of commercial service that would be provided in its absence.

7. Does public funding correct underprovision or displace commercial programming?

This section examines the pattern of government support for public radio across markets to roughly assess how public broadcast provision is divided between displacing commercial entry and providing programming in areas where the market would not. In the latter case it is at least possible that public provision

corrects inefficient underprovision. If commercial and public programming were identical within classical and jazz formats, these calculations would provide a measure of wastefulness of public broadcast funding. Because commercial and public programming are not identical, these calculations show the amount of funding supporting public broadcasting *similar* to programming that the market would provide in its absence.

Of their overall 1993 operating budgets of US\$391.6 million, CPB-supported public stations received 40% of their income from government sources. Most of the government support is from state, rather than federal or local sources, with the largest component (14.9%) from public colleges. The CPB provided 13.7% (US\$53.7 million) of these stations' operating budgets. The bulk of the remainder of the stations' funds is provided by listeners (24.1%) and business underwriting (17.3%).

Of US\$32.9 million in federal, state, and local government support for public classical (including classical/news) stations, slightly over a third (38%) of government support for public classical stations is allocated to stations in markets that the simulations indicate would receive commercial classical programming in the absence of public classical programming. Thus, 38% of public funding supports classical programming that is similar to programming that market would provide in its absence. Of the US\$15.5 million in government support for public jazz (including jazz/news) stations, 43% supports programming similar to what commercial stations would offer in their absence.²⁵ Almost all of these government subsidies support stations in large (quintile 5) markets that would have commercial provision in the absence of the public stations' presence.

8. Conclusion

This study has examined provision of radio broadcasting services by the market in the U.S., along with the pattern of public radio. Although the market provides most broadcast formats in most markets, some formats – notably classical music and jazz – are provided less frequently by the market. We examine the interaction between commercial and public provision of broadcast services in classical music, jazz, and music, and we find evidence of substitutability of commercial and public programming in jazz, and especially classical music. We document programming similarity between public and commercial classical music stations. Furthermore, public entry appears to displace commercial entry in large markets. Although the

²⁵Recall, however, that although we find a direct displacement effect of public jazz stations on commercial jazz stations, we found no other evidence of jazz programming substitutability above. Because we find no evidence of substitutability of public and commercial news programming, there is no evidence that any public funding of news programming supports duplication of programming that the market would provide in its absence.

bulk of government support for broadcasting goes to public stations in markets without commercial competition, over a third of public funding of stations airing jazz and classical music programming is allocated to public stations in the markets which would be served by similar commercial programming in the absence of public broadcasting.

Arguments in this paper cannot demonstrate whether public funding of radio broadcasting is wasteful. Rather, we focus attention on the degree of similarity of commercial and public programming. Our findings of substitutability in classical music programming (and evidence of displacement in both classical music and jazz) do not demonstrate that public funding that displaces commercial programming in these categories is unjustified. Whether public funding of programming that displaces similar commercial programming is justified depends on the degree of similarity between public and commercial programming.

It is important to note that the results of this study do not necessarily imply that funding of public radio should be reduced. This study has examined the allocation of the current public radio budget across markets. The determination of the correct size of the public radio budget is outside the scope of this study. Even if it were true that some public radio funding should be withdrawn from some large markets, it is entirely possible more funding should be allocated to public radio in other markets. Such a determination requires information, that we currently lack, on the value of public broadcasting to its listeners in those markets.

While this study has documented many empirical regularities, the descriptive estimates we have presented do not allow us to realistically model the impact of public subsidies on available programming. The next step for this research is the development of realistic structural models of commercial and public entry and revenue, allowing simulation of alternative government funding policies.

Acknowledgements

We thank Shelly Cagner of Arbitron, James Duncan of Duncan's American Radio, Craig Oliver of the Radio Research Consortium, and Young Lee and Janice Jones of the Corporation for Public Broadcasting for help getting the data. Seminar participants at Georgetown, UCLA, Wharton, Yale, and the Harvard/MIT public economics workshop provided useful comments. We alone are responsible for the views, as well as any errors, in the paper.

References

- The Arbitron Company, 1994. *Radio Metro Market Guide, 1993–1994*. The Arbitron Company, New York.
- The Arbitron Company, 1993. *Radio USA, Spring 1993*. The Arbitron Company, New York.

- Berry, S.T., Waldfogel, J., 1996. Free entry and social inefficiency in radio broadcasting. NBER working paper 5528.
- Berry, S.T., Waldfogel, J., 1997. Public radio in the United States: does it correct market failure or cannibalize commercial stations? NBER working paper 6057.
- Bradford, D.F., Hildebrandt, G.G., 1977. Observable preferences for public goods. *Journal of Public Economics* 8 (2), 111–131.
- Corporation for Public Broadcasting, 1994. *Public Radio: Fiscal Year 1993 Programming*. Corporation for Public Broadcasting, Washington.
- Cutler, D.M., Gruber, J., 1996. Does public insurance crowd out private insurance?. *Quarterly Journal of Economics* 111 (2), 391–430.
- De Witt, K., 1994. Gingrich foresees a world without public broadcasting. *New York Times*, December 6, 1994, sect. 1, p. 9.
- Duncan, J.H., 1993. *American Radio, Spring 1993*. Duncan's American Radio, Indianapolis.
- Duncan, J.H., 1994. *Duncan's Radio Market Guide, 1994 ed.* Duncan's American Radio, Indianapolis.
- Head, S.W., 1985. *World Broadcasting Systems: A Comparative Analysis*. Wadsworth, Belmont, CA.
- Khanna, J., Posnett, J., Sandler, T., 1995. Charity donations in the UK: new evidence based on panel data. *Journal of Public Economics* 56 (2), 257–272.
- Kingma, B.R., 1989. An accurate measurement of the crowd-out effect, income effect, and price effect for charitable contributions. *Journal of Political Economy* 97 (5), 1197–1207.
- Mankiw, N.G., Whinston, M.D., 1986. Free entry and social inefficiency. *RAND Journal of Economics* 17 (1), 48–58.
- Posnett, J., Sandler, T., 1989. Demand for charity donations in private non-profit markets: the case of the U.K. *Journal of Public Economics* 40 (2), 187–200.
- Samuelson, P.A., 1954. The pure theory of public expenditures. *Review of Economics and Statistics* 36, 387–389.