



Rational praying: The economics of prayer

Timothy Tyler Brown*

University of California at Berkeley, 50 University Hall, MC7360, Berkeley, CA 94720-7360, USA

ARTICLE INFO

Article history:

Received 19 June 2007

Received in revised form 20 June 2008

Accepted 24 July 2008

JEL classification:

Z12

I12

Keywords:

Religion

Prayer

Grossman model

Social capital

ABSTRACT

Prayer, both public and private, is prescribed by most religious traditions. Patterns of prayer are shown to conform to an economic theory of spiritual health. With regard to the frequency of prayer, wages are predicted to correlate negatively, education is predicted to correlate positively, environmental factors that are supportive of prayer are predicted to correlate positively, and the expected “price” for participation in religious activity (the tithing in Judaism and Christianity and the Zakat in Islam) is predicted to correlate negatively. Empirical tests find the predictions of the model are supported for females, but only partially supported for males.

© 2008 Elsevier Inc. All rights reserved.

1. Introduction

Economists have been studying religious behavior for over 30 years including attendance at religious services, prayer, financial contributions to religious groups, the economic consequences of religion for individuals, the behavior of religious organizations, and competition between the various religious groups that form the religious marketplace (Iannaccone, 1998; Clain and Zech, 1999; Cameron, 1999; Branas-Garza and Neuman, 2004; Gruber, 2004, 2005; Gruber and Hungerman, 2006). However, of the various individual religious behaviors that have been studied, prayer arguably has been given the least attention and has never been the sole focus of any research to date.

What predictions does economic theory make about prayer? What patterns of praying does it suggest will occur? The answers to these questions are important as prayer is a relatively pure indicator of personal commitment to a given religious tradition. To the true believer, prayer is one of the primary ways by which the believer receives benefits from God. Thus, how often a person prays is one indication of the level of belief that a person places in their religious tradition. The degree to which a person believes that they will receive benefit from praying is the degree to which that person will be willing to bear a given level of opportunity cost. By understanding how opportunity cost varies among religious persons, the

frequency of prayer (and thus the likely level of commitment to a given religious tradition) can be predicted based on individual and geographical characteristics. This suggests that patterns of prayer will be quite specific and predictable, given a fully specified model, a model presented and empirically tested in this study.

Relative to the frequency of prayer, attending religious services and giving to religious groups are weaker indicators of religious commitment. Individuals who give little credence to a given religious tradition may still attend religious services for their social benefits, such as social support and mutual aid (Hull and Bold, 1989). In addition, such individuals may also contribute to religious organizations for the social status and organizational influence that such contributions bring (Iannaccone, 1997). In contrast, such individuals will pray infrequently, perhaps only in public gatherings where they can gain the social benefits available from public prayer.

This paper develops an economic model of prayer based on a widely used model of the demand for health (Grossman, 1972) which is modified to describe the demand for spiritual health and the spiritual activity of prayer. The model describes individual-level demand for prayer in the context of the three Western monotheistic religions: Judaism, Christianity, and Islam. The model is not intended to describe the individual religious behavior of individuals whose beliefs tend towards Eastern religions such as Hinduism or Buddhism. The model also does not describe the behavior of individuals who have developed their own individualistic spirituality. This is done not because these latter views are unimportant, but because models that describe the behavior of individuals whose religious worldview are Eastern in nature would be considerably

* Tel.: +1 510 643 4103; fax: +1 510 643 4281.

E-mail address: tbpetris@berkeley.edu.

different from the model presented here due to the appreciably differing views of reality of these groups relative to the three major monotheistic religions (e.g., see Daniels, 2005 for a discussion of “Buddhist” economics). Such models are topics for future research.

2. Literature review

As noted above, prayer has been given little attention in the literature on the economics of religion. Iannaccone (1990) analyzed data from the General Social Survey from 1983 to 1987 and found that the frequency of prayer weakly increases with age, but found no correlation with education or income. Branas-Garza and Neuman (2004) examined the behavior of Catholics in Spain in 1998 and found that the frequency of prayer strongly increases with age, but also found no correlation with education or income.

A larger set of related literature exists on attending religious services, one of the more specific times during which prayer is offered. Azzi and Ehrenberg (A–E) (1975) were the first to theoretically analyze the demand for attendance at religious services. They used a household production approach, which yielded the following predictions: a negative relationship between wages and attendance, a positive relationship between age and attendance, and a positive relationship between non-labor income and attendance. See Table 1 for selected empirical results from their study and the selected results of the other studies discussed in this section. Empirical work using this model was performed not only by A–E (1975), but also by Long and Settle (1977), Ehrenberg (1977), and Ulbrich and Wallace (1983). Neuman (1986) also applied a version of the A–E model to Israeli data. Sawkins et al. (1997) applied a version of the A–E model to UK data. Branas-Garza and Neuman (2004) applied a version of the A–E model to Spanish data. The A–E model is summarized by Iannaccone (1998).

Sullivan (1985) modified the A–E model and analyzed the simultaneous relationship between church attendance and financial contributions to one’s church. Clain and Zech (1999) further examined the simultaneous relationship between church attendance, time volunteered, and financial contributions to one’s church. This question was also reexamined by Gruber (2004) focusing on the effect of tax subsidies for charitable giving. Gruber and Hungerman (2006) analyze the effects of secular competition on church attendance, church contributions, church expenditures, and health behaviors via an analysis of the effect of the repeal of restrictions of retail activity on Sundays in U.S. states. Gruber (2005) also examined the relationship of state-level religious density and ancestral density on church attendance and various economic indicators. He found that state-level religious density positively influenced attendance at religious services. Cameron (1999) simultaneously estimated attendance at religious services with intensity of religious belief.

The above literature suggests that a fully specified model of prayer should include age, wages, non-wage income, measures of religious upbringing, and measures of the religious density of the area in which an individual lives. No study to date has incorporated each of these aspects into a single model. These aspects are incorporated both theoretically and empirically below.

3. Theoretical model

In this section, a demand for spiritual health model is presented based on Grossman’s (1972) model of the demand for physical health as interpreted by Nocera and Zweifel (1998) and Zweifel and Breyer (1997). Muurinen (1982) also presents a generalized version of the Grossman model. A demand for health model is an appropriate analogy for spiritual health defined as the perception of being

strongly connected to God. Both physical health and spiritual health will depreciate over time without continued investment in practices which maintain health. In the case of physical health, relevant investments include such physical health practices as good dietary and exercise habits, not smoking, using alcohol in moderation, and obtaining needed medical care. In the case of spiritual health, a key investment is the spiritual practice of prayer. Note that this model only applies to self-identified religious individuals.

Individuals maximize their lifetime utility

$$\int_0^T e^{-\rho t} U[(s(R(t)), Z(t))] \quad (1)$$

where T is total life expectancy, t is time, ρ is a time discount factor, U is utility, s is spiritually “sick” time, R is religious/spiritual health, and Z is a composite consumption commodity. Religious/spiritual health is defined as the perception of being strongly connected to God which increases utility for religious individuals. Spiritual “sick” time is assumed to occur when an individual is slack in the spiritual practice of regular prayer, a practice which all three of the Western monotheistic traditions enjoin. Spiritually “sick” time occurs when an individual perceives that they are not sufficiently connected to God, which causes disutility. The composite commodity Z increases utility. The first derivatives of the utility function are thus as follows:¹

$$\frac{\delta U(t)}{\delta s(t)} < 0, \quad \frac{\delta U(t)}{\delta R(t)} > 0, \quad \frac{\delta U(t)}{\delta Z(t)} > 0 \quad (2)$$

In addition, religious/spiritual health reduces spiritually “sick” time

$$\frac{\delta s(t)}{\delta R(t)} < 0$$

An individual starts with a zero stock of spiritual health capital, which changes over time

$$\dot{R}(t) = C(t) - \delta(t, X(t))R(t) \quad (3)$$

where participating in the spiritual activity of prayer is $C(t)$. This can counteract the depreciation, δ , of spiritual health capital that occurs throughout one’s life. As noted above, spiritual health capital is defined as the perception of being strongly connected to God. $X(t)$ are past and present environmental characteristics that may affect the depreciation of spiritual capital such as one’s religious upbringing and exposure to higher densities of religiosity in the larger geographical environment. These environmental factors reinforce the closeness that one may feel to God, keeping this perception of closeness from depreciating over time.²

Spiritual disinterest will happen when spiritual health capital dips below a minimum point. Since most religious individuals do not believe that death is the cessation of existence, they will tend to behave in a way such that T is considered to be very long if they invest sufficiently in $C(t)$. A critical point is that it is assumed that while religious individuals may believe in eternal existence, they behave as if their future existence is finite (although very long). The

¹ Cross-partial restrictions are as follows: $\delta^2 U(t)/\delta s(t)\delta Z(t) > 0$, $\delta^2 U(t)/\delta R(t)\delta Z(t) > 0$ which states that utility increases as the composite good increases regardless of the amount of religious sick time or the level of religious health. In other words, the composite good unambiguously increases utility in all states of the world.

² While religious upbringing and exposure to higher densities of religiosity in the larger environment may not always reinforce the closeness that one may feel to God (and may even have the opposite effect), it is assumed that most religious upbringing and exposure to religiosity in the larger environment are positive rather than negative experiences.

Table 1
Results of studies: attendance at religious services or allocation of time to religious activities

Variables of interest	Azzi and Ehrenberg (1975)	Long and Settle (1977)	Ehrenberg (1977)	Ulbrich and Wallace (1983)	Neuman (1986) (allocation of time)	Sullivan (1985)	Sawkins et al. (1997)	Clain and Zech (1999)	Cameron (1999)	Branas-Garza and Neuman (2004)	Gruber (2004)	Gruber (2005)	Gruber and Hungerman (2006)
Age	+ signif	Not signif	+ signif ^a	+signif ^a	+ signif ^b	– signif ^c	+ signif ^d	Not signif	Not signif N/A	+ signif	N/A	N/A	Not signif
Spouse of same religion	+ signif ^e	+ signif	+ signif	+signif	+ signif	N/A	N/A	N/A	N/A	+ signif ^e	N/A	N/A	N/A
Spouse's religious commitment	N/A	N/A	N/A	N/A	+ signif	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mother's religious commitment	N/A	Not signif	N/A	N/A	Not signif	N/A	N/A	N/A	+ signif ^f	+ signif ^d	N/A	N/A	N/A
Father's religious commitment	N/A	Not signif	N/A	N/A	Not signif	N/A	N/A	N/A	+ signif ^f	+ signif	N/A	N/A	N/A
Percent of people in area of same religion	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	+ signif	N/A
Hourly wage (Hourly wage) ²	N/A	N/A	N/A	Not signif	N/A	N/A	+ signif	N/A	N/A	N/A	N/A	N/A	N/A
Income	N/A	N/A	N/A	N/A	N/A	N/A	– signif ^g	N/A	N/A	N/A	N/A	N/A	N/A
Education	+ signif ^h	+ signif ⁱ	+ signif ^j	Not signif	– signif ^k	– signif ^l	N/A	Not signif	N/A	N/A	+ signif	N/A	N/A
	+ signif ^m	N/A	+ signif ⁿ	+ signif ^o	– signif	N/A	+ signif	Not signif	+ signif	Not signif	+ signif	N/A	+ signif

+ signif = positive and statistically significant. – signif = negative and statistically significant. not signif = not statistically significant.

^a Positive and statistically significant or statistically insignificant. Negative and statistically significant among Jews in Ehrenberg (1977).

^b Positive and statistically significant or U-shaped and statistically significant or statistically insignificant.

^c U-shaped and statistically significant for males, statistically insignificant for females.

^d Statistically insignificant for males and positive and statistically significant for females.

^e Positive and statistically significant for males, statistically insignificant for females.

^f Estimated for parents as a group, not estimated separately for mother and father.

^g Statistically significant at the 10% level for males only, statistically insignificant for females.

^h This parameter was positive and statistically significant or positive and statistically insignificant depending on the specification used.

ⁱ For husbands, this parameter was negative and statistically significant or negative and statistically insignificant depending on the specification used. For wives this parameter was positive and statistically significant or negative and statistically significant.

^j Christians: For females, this parameter was positive and statistically significant or statistically insignificant on the specification used. For males this parameter was positive and statistically significant, negative and statistically significant, or simply statistically insignificant. Jews: statistically insignificant.

^k Negative and statistically significant or statistically insignificant.

^l Negative and statistically significant for women. Insufficient information for men to determine statistical significance for partial derivative with respect to income.

^m In a footnote, it was reported that equations with education were estimated showing statistically significant and positive results for the respondent and statistically significant and negative results for a spouse (male and female were not differentiated).

ⁿ Christians: positive and statistically significant, or statistically insignificant. Jews: statistically insignificant.

^o Positive and statistically significant or statistically insignificant.

assumption of a degree of myopia in decision making is reasonable and is also necessary in order to solve the optimal control problem.

$$T = \min\{t : \bar{R}(t) \leq R(t)\} \quad (4)$$

Asset accumulation is given by

$$\dot{A}(t) = rA(t) + Y[s(R(t), t)] - \pi^C(t)C(t) - \pi^Z(t)Z(t) \quad (5)$$

The stock of financial assets changes over time according to the difference between income, which comes from interest, $rA(t)$, and market work, $Y(t)$; and expenditures on $C(t)$, spiritual investment goods, and $Z(t)$, consumption goods. Since the value of one's own time is the main opportunity cost of spiritual investment goods, the price of such goods are valued at the market wage rate, $w(t) : \pi^C(t) = w(t)$. The price of consumption goods is $\pi^Z(t)$.

The relationship of income from market work and spiritual "sick" time is as follows:

$$\frac{\delta Y(t)}{\delta s(t)} \geq 0 \quad (6)$$

More spiritual "sick" time is associated with higher income or similar income (depending on the circumstances of an individual's job). In other words, better spiritual health is associated with a lower income since the more spiritual a person becomes (oriented towards existence after death) the less time they spend in income-generating activities and the more time they spend in religious activities (Lipford and Tollison, 2003) such as prayer. Note that is not at variance with the concept of the Protestant work ethic: the idea that ceaseless secular work is the highest form of asceticism and the strongest evidence of genuine faith.³ It more simply states that there is a trade-off between time spent in prayer, which does not generate income, and secular activities that do generate income.

The individual must choose time paths for $R(t)$ and $Z(t)$ subject to the constraints (3)–(5). The solution to this problem yields the following optimality condition:

$$\left[\frac{\delta U(t)/\delta s(t)}{\lambda(0)} e^{-(\rho-r)t} \right] \frac{\delta s(t)}{\delta R(t)} = \left[r + \delta(t) - \frac{\delta \pi^C(t)}{\delta \pi^C(t)} \right] \pi^C(t) - \frac{\delta Y(t)}{\delta s(t)} \frac{\delta s(t)}{\delta R(t)} \quad (7)$$

where $\lambda(0)$ is the marginal effect of relaxing the asset constraint (5). The optimality condition (7) states that the marginal benefits of spiritual health must equal the marginal cost of procuring it. The left-hand side represents the utility of better spiritual health and is made up of the increased utility that spiritual health brings. The first part of the right hand side is made up of the forgone interest on the alternative use of funds, the depreciation that must be made up for by expenditures, and $\delta \pi^C(t)/\delta \pi^C(t)$ stands for the change in the value of spiritual health in monetary terms. The last term represents the potentially decreased level of income that is a cost of spiritual health.

In this paper, the pure consumption model is of primary interest, that is, the situation where $\delta Y(t)/\delta s(t) = 0$. This model describes how much spiritual health people demand when there is no decrease in income from participation in prayer (holding income constant). By

³ As noted by Miller and Woehr (2002), Weber (1958, p. 272) states "The religious valuation of restless, continuous, systematic work in a worldly calling, as the highest means to asceticism, and at the same time the surest and most evident proof of rebirth and genuine faith, must have been the most powerful conceivable lever for the expansion of that attitude toward life which we have here called the spirit of capitalism".

taking logarithms of both sides the following equation is derived:

$$\ln \left[\frac{\delta U(t)}{\delta s(t)} \frac{\delta s(t)}{\delta R(t)} \right] - \ln \lambda(0) - (\rho - r)t = \ln \delta(t) + \ln \pi^C(t) - \ln \psi(t) \quad (8)$$

where $\ln \psi(t) = \delta(t)/[r + \delta(t) - \dot{\pi}^C(t)/\pi^C(t)]$. In order to transform (8) into an equation that can be estimated the functional forms of $s(\cdot)$, $\delta(\cdot)$, $C(\cdot)$, and $\pi(\cdot)$ must be determined. To do so, it is assumed that spiritually sick days are produced according to the following production function (following Wagstaff, 1986)

$$s_i(t) = \beta_1 R_i(t)^{-\beta_2} \quad (9)$$

where $\beta_1, \beta_2 > 0$. This states that the spiritually "sick" days are an inverse function of spiritual health. Depreciation of spiritual health is defined as (following Nocera and Zweifel, 1998)

$$\ln \delta_i(t) = \ln \delta_0 + \beta_3 t + \beta_4 X \quad (10)$$

where X is vector of environmental variables such as the density of religiosity in one's larger geographical environment and one's early religious upbringing. The parameter β_3 will be negative since the older an individual is, the more aware they are of life after death and the more importance it holds for them. The parameter β_4 will be negative because religious upbringing and the density of religiosity in one's larger geographical environment both work to keep an individual thinking about spiritual things and feeling connected to God, thus keeping the increase in spiritual capital that occurs when individuals participate in prayer from declining as rapidly as would otherwise be the case.

$C(t)$ is assumed to be produced by a combination of one's own time and religious events (prayer can occur in both private and public contexts). If a Cobb–Douglas constant returns-to-scale production function can describe the production of $C(t)$, it will correspond to the following marginal cost function:

$$\ln \pi^C(t) = (1 - \beta_5) \ln w_i(t) + \beta_5 \ln P_i^R(t) + \beta_6 E_i \quad (11)$$

where $w_i(t)$ is the opportunity cost of one's time, measured by implicit wages, $P_i^R(t)$ is the price of religious participation, defined as 10% of one's income (the traditional tithe of both Judaism and Christianity—this will be an overstatement for adherents of Islam, whose traditional Zakat is only 2.5%) and E_i is education, which allows individuals to more efficiently invest in their spiritual health (it reduces the level of technical inefficiency).⁴ It is thus assumed that $0 < \beta_5 < 1$, and that $\beta_6 < 0$.

The utility function is assumed to be of the form

$$U_i(t) = \beta_7 s_i(t)^{\beta_8} + g(Z(t)) \quad (12)$$

where $\beta_7 < 0$ and $0 < \beta_8 < 0$ and $g(\cdot)$ is a function. It is also assumed that $\ln \psi(t) = \beta_9 t$ and $\beta_9 > 0$ which basically says that the expression $\delta(t)/[r + \delta(t) - \dot{\pi}^C(t)/\pi^C(t)]$ rises over time.

Using (8), (9), and (12), the following pure consumption model demand-for-spiritual-health equation can be derived, which holds $\lambda(0)$ constant.

$$\ln R_i(t) = \beta_{11} + \gamma \ln \lambda_i(0) - (1 - \beta_5) \gamma \ln w_i(t) - \beta_5 \gamma \ln P_i^R(t) - [(\beta_3 - \beta_9) + (\rho - r)] \gamma t - \beta_6 \gamma E_i - \beta_4 \gamma X_i + u_{2i} \quad (13)$$

where $\beta_{11} = \gamma \{ \ln[-\beta_7 \beta_8] + \beta_8 \ln \beta_1, u_{2i} = \gamma \ln \delta_0, \text{ and } \gamma = 1/[1 + \beta_2 \beta_8] \}$ is the elasticity of spiritual capital.

⁴ Although most individuals may not pay tithe or the Zakat, it is nevertheless the traditional price.

Using (3) and the cost-minimizing condition for health investment (8), the structural demand for prayer can be derived

$$\ln C_i(t) = \beta_{12} + \ln R_i(t) - (1 - \beta_5) \ln w_i(t) - (1 - \beta_5) \ln P_i^R(t) + \beta_3 t + \beta_6 E_i + \beta_4 X_i + u_{3i} \quad (14)$$

where $\beta_{12} = -(1 - \beta_5) \ln[(1 - \beta_5)/\beta_5]$, and $u_{3i} = \gamma \ln \delta_0 + \ln[R(t)/\delta_i(t)]$.

Finally since spiritual health, $R(t)$, is unobservable, (13) can be substituted into (14) to derive the reduced-form version of the demand for prayer to be estimated:

$$\ln C_i(t) = \beta_{12} + \beta_{11} + \gamma \ln \lambda_i(0) - 2(1 - \beta_5) \gamma \ln w_i(t) + \beta_3(1 - \gamma)t + \beta_9 \gamma t - (\rho - r) \gamma t - (1 - \beta_5(1 + \gamma)) \ln P_i^R(t) + \beta_3 t + \beta_6(1 - \gamma)E_i + \beta_4(1 - \gamma)X_i + u_{4i} \quad (15)$$

where $u_{4i} = u_{2i} + u_{3i}$. For purposes of estimation this analysis follows Muurinen (1982) and assumes that $\lambda_i(0)$ can be approximated by current non-wage income.

The reduced-form model of the demand for prayer makes the following five predictions with respect to the frequency of prayer. First, wages will negatively correlate with the frequency of prayer (due to the opportunity cost of time). Second, age will correlate positively with the frequency of prayer. Third, education will positively correlate with the frequency of prayer (due to the improved ability to lower the depreciation rate by choosing baskets of activities that more effectively promote spiritual health). Fourth, environmental factors that are supportive of religious activity will correlate positively with the frequency of prayer. Fifth, the price of spiritual goods (which is proportionate to income—tithe or Zakat) will correlate negatively with the frequency of prayer. Finally, the effect of the asset constraint will be positive. However, because relaxing the asset constraint necessarily causes the price of spiritual participation to rise by the same amount as the degree of relaxation of the asset constraint (due to the ad valorem nature of the price of spiritual practices)

$$\ln P_i^R(t, Y) = \ln \lambda_i(0) \quad (16)$$

it is not possible to estimate the price of spiritual goods separately from the effect of relaxing the income constraint and the price of spiritual goods will dominate:

$$|-(1 - \beta_5(1 + \gamma)) \ln P_i^R(t, Y)| > |(1 - \beta_5(1 + \gamma)) \ln \lambda_i(0)| \quad (17)$$

if $(1 - \beta_5(1 + \gamma)) > \gamma$. This will be the case if β_5 is between 0.5 and unity.

4. Data and econometrics

The data used in this analysis is repeated cross-sectional data from the General Social Survey (GSS) administered to adults 18 years of age and older in the U.S. by the National Opinion Research Center. The 1996, 1998, 2000, 2002, 2004 waves of the survey are used. In each wave, a random subsample of the GSS is asked about their frequency of prayer. Data was only used for individuals who self-identified as religious persons. A small number of individuals who self-identified as adherents of Eastern or Native American religions are included because it was not possible to omit all of them. They are estimated to make up less than 1.3% of the sample.

Other data used include state-level data from County Business Patterns to measure the religious portion of the Petris Social Capital Index (PSCI). The religious portion of the PSCI is a proxy for the density of religiosity in a given state and has been used in other types of economic analysis (Brown et al., 2006). The religious portion of the PSCI is constructed by dividing the total number of individuals employed in North American Industry Classification System code

8131 (Religious Organizations) by the state population. This quotient is then multiplied by 100 to derive a percentage measure. The state is the lowest feasible geographical level of analysis possible using the GSS due to its relatively small sample size.

The equation to be estimated is the operationalization of Eq. (15) above:

$$\text{PRAYFREQ} = \theta_0 + D'\theta_1 + E'\theta_2 + Y'\theta_3 + R'\theta_4 + S'\theta_5 + F'\theta_6 + \varepsilon \quad (18)$$

The dependent variable is the frequency of prayer. The frequency of prayer, PRAYFREQ, is reported using six intervals: never, less than once a week, once a week, several times a week, once a day, and several times per day. The question about prayer is asked of approximately half of the sample. PRAYFREQ is transformed to numerical form by transforming never and less than once a week to zero, once a week to 1, several times a week to 3, once a day to 7, and several times a day to 21, making frequency of prayer the number of times a person prays per week.

The independent variables are as follows: \mathbf{D} is a vector of variables including sex, age and the square of age, race/ethnicity (White, Black, and other race), and marital status (not married, married, divorced/separated, and widowed). The vector \mathbf{E} is educational level (less than high school, high school, associate's degree, bachelor's degree, and graduate degree). The vector \mathbf{Y} includes earnings per hour (in 2004 dollars) and its square, non-wage income (in 2004 dollars), and employment status (employed and non-employed). The vector \mathbf{R} includes the religion in which the respondent was raised as a child (Catholic, Jewish, Protestant, other, and none), and how fundamentalist the religion was in which the respondent was raised at age 16 (fundamentalist, moderate, and liberal).⁵ The category "other" includes all religious groups who are not Catholic, Jewish, or Protestant. The vector \mathbf{S} includes whether a respondent lives in the same state as they did when they were aged 16 and the religious portion of the PSCI. The religious portion of the PSCI is lagged by two years in order to give a reasonable time period for changes in the religious portion of the PSCI to affect the praying behavior of individuals. The vector \mathbf{F} contains year dummies (1998, 2000, 2002, and 2004) and state-level fixed effects. The state-level fixed effects are included to control for omitted variable bias at the state level and thus control for such things as culture, weather, etc. Finally, ε is the error term. The reference group includes individuals who are male, white, unemployed, not raised in any particular religious faith or raised in a liberal fashion with regard to religion, do not live in the same state as they did at age 16, are unmarried, have less than a high school education, and are responding in the year 1996.

To construct earnings per hour, the following approach is used. Earnings per hour are constructed by dividing each respondent's inflation-adjusted annual income (2004 dollars, before taxes and deductions) by the product of usual hours worked per week and weeks worked per year. Earnings per hour is set to zero if an individual is not employed and a dichotomous variable is set to one (the indicator is set to zero if an individual is working) following Plotnik (1983), and Hutchens (1981) and similar to the procedure used by Saffer (2008) with GSS data.

Non-wage income for each respondent is constructed by subtracting the respondent's annual income from family income. Table 2 presents descriptive statistics for all variables.

All equations are estimated using generalized least squares, are corrected for heteroscedasticity, and are probability weighted in

⁵ Responses of "no answer" with regard to how fundamentalist, moderate, or liberal the religion was in which a respondent was raised in were simply coded as zeros. Such answers were approximately 3% of the sample.

Table 2
Descriptive statistics

Variables	Value
Frequency of prayer per week (mean/S.D.) ^a	8.87/8.15
Earnings per hour (2004 dollars: mean/S.D.)	13.70/43.52 ^b
Non-wage income (2004 dollars: mean/S.D.)	30,966.35/46,467.89
Religious community-level social capital (% of population; mean/std)	0.53/0.12
Age (mean/S.D.)	46.05/17.23
Raised Catholic (proportion)	0.31
Raised Protestant (proportion)	0.57
Raised Jewish (proportion)	0.02
Raised other religion (proportion)	0.24
Raised fundamentalist (proportion)	0.31
Raised moderate (proportion)	0.41
Raised liberal (proportion)	0.21
Live in same state as when aged 16 (proportion)	0.65
Employed (proportion)	0.68
Female (proportion)	0.54
Married (proportion)	0.57
Widowed (proportion)	0.06
Divorced/separated (proportion)	0.14
Black (proportion)	0.13
Other race/ethnicity (proportion)	0.07
High school graduate (proportion)	0.54
Associate's degree (proportion)	0.07
Bachelor's degree (proportion)	0.17
Graduate degree (proportion)	0.08

^a S.D. = standard deviation.

^b Earnings per hour includes a large number of individuals who are unemployed and earn zero dollars per hour.

order to estimate correct parameter values. Stata 9.2 was used to estimate all equations.

5. Results

Since PRAYFREQ is an ordinal variable transformed to cardinal form, it is now measured with error. However, this error is essentially random and while it will result in the equation being estimated with less efficiency, there will be no bias to the estimated coefficients (Green, 2000). Data was insufficient for five states and therefore the results exclude these states (Nebraska, Nevada, New Hampshire, Rhode Island, and Utah). A Chow (1960) test indicated that the equation should be estimated separately for females and males ($F = 1.59, p < 0.01$).

Table 3 reports the final equations for the frequency of prayer for both females and males. Consistent with the predictions of the theoretical model, earnings per hour are negatively correlated with the frequency of prayer for both males and females; however this relationship does turn positive for both sexes when earnings per hour are high enough. For females, the standard formula for computing a turning point, the parameter on earnings per hour divided by twice the parameter on the square of earnings per hour (after transforming both parameters into \$1s: $-0.0229652/(2 \cdot 0.0000119)$) yields a turning point of \$964.07 ($t = -3.09, p < 0.01$).⁶ For males the turning point is \$572.61 ($t = -5.18, p < 0.01$) ($-0.0220879/(2 \cdot 0.0000193)$). This corresponds to individual annual earnings of \$1.9 million and \$1.1 million, respectively, assuming 2000 hours of work per year. In other words, this turning point will occur only for the very highest earners in the U.S. population.

In order for a female to reduce their frequency of prayer by one prayer per week, earnings per hour must reach \$43.58 ($t = -2.55, p = 0.01$). For males, earnings per hour must reach \$45.35 ($t = -2.63, p < 0.01$). This is \$87,160 and \$90,700 in terms of annual earnings,

respectively, assuming 2000 hours of work per year. This suggests that only those at the top of the U.S. income distribution are likely to reduce their frequency of prayer in response to increases in their earnings per hour.

The situation is similar for non-wage earnings, but occurs only for females. In order for the frequency of prayer to be reduced by one prayer per week for females, annual non-wage earnings on must reach \$80,177 ($t = 2.08, p = 0.038$).

Age is also important with respect to frequency of prayer, but only for females. For females, prayer becomes more frequent with age. Although it does increase at a diminishing rate as age increases, it never reaches an actual turning point during a person's lifetime (the turning point in the model occurs at age 170.67 ($t = -5.20, p < 0.01$)). Females increase their frequency of prayer by one prayer per week at approximately 5-year age intervals (4.93, $t = 3.81, p < 0.01$).

Relatively to those who were not raised in religious homes, only those raised in Jewish homes pray less frequently, with females praying approximately four fewer prayers per week ($-3.64, t = 2.85, p < 0.01$) and males praying approximately five fewer prayers per week ($-5.24, t = 3.83, p < 0.01$). In contrast, relative to those raised in religiously liberal homes, females raised in moderately religious homes pray approximately 1.6 more times per week (1.63, $t = 2.63, p < 0.01$), and females raised in fundamentalist religious homes pray approximately 2.3 more times per week (2.26, $t = 4.63, p < 0.01$). For males these figures are much lower, with no difference detected between those raised in moderately religious homes relative to those raised in religiously liberal homes, while those raised in

Table 3
Frequency of weekly prayer

Variables	Females	Males
Earnings per hour (\$10s) ^a	-0.230** (0.090)	-0.221*** (0.084)
(Earnings per hour) ² (\$1000s) ^a	0.0119 (0.0085)	0.0193** (0.0077)
Not employed	0.679* (0.39)	0.202 (0.52)
Non-wage income (\$10,000s)	-0.0725** (0.035)	-0.0428 (0.043)
Age	0.205*** (0.054)	0.0423 (0.063)
(Age) ² /100	-0.120** (0.053)	0.00447 (0.062)
Raised Catholic	-0.974 (1.05)	-1.197 (1.23)
Raised Protestant	-0.231 (0.89)	-1.051 (1.10)
Raised Jewish	-3.639*** (1.28)	-5.240*** (1.37)
Raised other religion	-0.201 (0.18)	-0.0120 (0.28)
Raised fundamentalist	2.258*** (0.49)	1.658*** (0.56)
Raised moderate	1.632*** (0.62)	0.398 (0.65)
Live in same state as when aged 16	-0.568* (0.34)	-0.204 (0.39)
State-level employment in religious organizations (% of population)	15.46* (8.33)	-0.402 (9.53)
Married	1.173** (0.48)	1.789*** (0.49)
Widowed	1.194* (0.72)	1.441* (0.86)
Divorced/separated	0.379 (0.53)	-0.142 (0.58)
High school graduate	0.519 (0.47)	0.126 (0.54)
Associate's degree	1.365* (0.72)	2.153** (0.91)
Bachelor's degree	1.811*** (0.61)	1.075 (0.66)
Graduate degree	1.356* (0.76)	1.908** (0.80)
Black	3.269*** (0.48)	3.091*** (0.62)
Other race/ethnicity	1.379** (0.70)	-0.588 (0.72)
Year 1998	-0.708 (0.60)	-1.178* (0.67)
Year 2000	-0.672 (0.64)	-0.239 (0.73)
Year 2002	-0.661 (0.85)	-1.466 (0.89)
Year 2004	0.0913 (0.92)	-0.392 (1.05)
Constant	-9.724 (6.47)	6.706 (7.54)
F-statistic	23.30***	5.98***
R ²	0.1404	0.1320
Observations	2978	2283

State-level fixed effects included, but not shown. Standard errors are in parentheses.

*** \leq 1% statistical significance (two-tailed test). ** \geq 1% and \leq 5% statistical significance (two-tailed test). * \geq 5% and \leq 10% statistical significance (two-tailed test).

^a Earnings and income are expressed in 2004 dollars.

⁶ This was calculated using the "nlcom" command in Stata 9.2.

fundamentalist homes pray about 1.6 more times per week (1.66, $t = 2.98$, $p < 0.01$).

Education also strongly affects the frequency of prayer. Relative to those with less than a high school education, females with an associate's degree pray approximately one more time per week (1.36, $t = 1.89$, $p = 0.06$), females with a bachelor's degree pray approximately two more times per week (1.81, $t = 2.95$, $p < 0.01$), and females with a graduate degree pray approximately one more time per week (1.36, $t = 1.79$, $p = 0.07$). In other words, for females education exhibits an inverted-U shape with respect to the frequency of prayer. Relative to those with a high school education, males with an associate's degree pray approximately two more times per week (2.15, $t = 2.36$, $p = 0.02$), males with a bachelor's degree pray approximately one more time per week (1.08, $t = 1.62$, $p = 0.10$), and males with a graduate degree pray approximately two more times per week (1.91, $t = 2.39$, $p = 0.02$). In other words, in contrast to females, for males education exhibits a U-shape with respect to the frequency of prayer.

There is no association between living in the same state at age 16 and the frequency of prayer. However, for females there is an association between the religious portion of the PSCI (a proxy for the density of religiosity in a state) and the frequency of prayer. Because the estimation includes state-level fixed effects, this parameter should be interpreted as the change in the percentage of the population employed in religious organizations 2 years prior. Specifically, for females to increase their frequency of prayer by one prayer per week, the percentage of the population employed in religious organizations 2 years prior must have increased by 0.065 ($t = 1.85$, $p = 0.06$). To put this into perspective, the range of the lagged change in the percentage of the population employed in religious organizations was $[-0.818, 0.313]$ with a mean of -0.0006426 and a standard deviation of 0.128. In other words, this magnitude of change is relatively common over a 2-year period. This change is equivalent to the addition of only 6.5 additional religious employees per 100,000 population (most of whom would work in churches). There is no effect for males.

Married and widowed females pray about once more per week (married: 1.17, $t = 2.42$, $p < 0.01$; widowed: 1.19, $t = 1.66$, $p = 0.10$) relative to unmarried females, while married males pray about twice more per week (1.79, $t = 3.54$, $p < 0.01$) and widowers pray about once more per week (1.44, $t = 1.68$, $p = 0.09$) relative to unmarried males. Divorced or separated individuals do not pray more than single individuals.

Finally, African-Americans, both females and males, pray about three times more per week relative to Caucasians (females: 3.27, $t = 6.79$, $p < 0.01$; males: 3.09, $t = 4.97$, $p < 0.01$). Females from other non-Caucasian, non-African-American racial groups also pray about one time more per week relative to Caucasians (1.38, $t = 1.97$, $p = 0.05$).

6. Discussion

The above model of the demand for spiritual health focused on the demand for prayer since prayer is a practice that is often private and thus unlikely to be performed much by individuals who do not have much credence in their religious tradition. It is thus a relatively pure form of spiritual practice and the best available candidate to test the theoretical model developed here. The model predicted a number of patterns with regard to the frequency of prayer including (1) earnings per hour will negatively correlate with the frequency of prayer, (2) age will correlate positively with the frequency of prayer, (3) education will positively correlate with the frequency of prayer, (4) environmental factors that are supportive of religious activity will correlate positively with the frequency of prayer, and (5) the

price of spiritual participation (which is proportionate to income) will correlate negatively with the frequency of prayer.

Each of these predictions was supported for females with the exception of education which exhibited an inverted-U shape with respect to the frequency of prayer. However, males did not behave in keeping with the predictions about age, non-wage income, and state-level environmental factors. This is not surprising. Female-male differences are consistently found in the literature. Branas-Garza and Neuman (2004) also performed separate analyses on females and males with respect to the frequency of prayer and found important differences by sex. In the literature on attending religious services separate analyses for females and males have also been performed and important differences by sex have also been noted (Azzi and Ehrenberg, 1975; Ehrenberg, 1977; Sullivan, 1985; Sawkins et al., 1997; Branas-Garza and Neuman, 2004). It is not clear what the specific reasons for these differences are at this time.

The practice of prayer clearly increases utility to those involved, but a key question is why? Do individuals pray primarily out of duty? Do individuals pray because prayer improves their emotional state, reducing mental distress and/or increasing happiness? Of course, additional reasons are possible. An understanding of the potential reasons why people pray and whether these differ by sex is an important topic for future research.

References

- Azzi, C., Ehrenberg, R., 1975. Household allocation of time and church attendance. *Journal of Political Economy* 83, 27–56.
- Branas-Garza, P., Neuman, S., 2004. Analyzing religiosity within an economic framework: the case of Spanish Catholics. *Review of Economics of the Household* 2, 5–22.
- Brown, T., Scheffler, R., Seo, S., Reed, M., 2006. The empirical relationship between community social capital and the demand for cigarettes. *Health Economics* 15, 1159–1172.
- Cameron, S., 1999. Faith, frequency, and the allocation of time: a micro level study of religious capital and participation. *Journal of Socio-Economics* 28, 439–456.
- Chow, G., 1960. Tests of equality between sets of coefficients in two linear regressions. *Econometrica* 28, 591–605.
- Clain, S.H., Zech, C.E., 1999. A household production analysis of religious and charitable activity. *Journal of Economics and Sociology* 58, 923–946.
- Daniels, P., 2005. Economic systems and the Buddhist world view: the 21st century nexus. *Journal of Socio-Economics* 34, 245–268.
- Ehrenberg, R.G., 1977. Household allocation of time and religiosity, replication and extension. *Journal of Political Economy* 85, 415–423.
- Green, W., 2000. *Econometric Analysis*, 4th edition. Prentice Hall.
- Grossman, M., 1972. On the concept of health capital and the demand for health. *Journal of Political Economy* 80, 223–255.
- Gruber, J., Hungerman, D.H., 2006. The church vs. the mall, what happens when religion faces increased secular competition? NBER Working Paper Series, No. 12410.
- Gruber, J., 2004. Pay or pray? The impact of charitable subsidies on religious attendance. *Journal of Public Economics* 88, 2635–2655.
- Gruber, J., 2005. religious market structure, religious participation, and outcomes, is religion good for you? *Advances in Economic Analysis & Policy* 5, 1–30.
- Hull, B., Bold, F., 1989. Towards an economic theory of the church. *International Journal of Social Economics* 16, 5–15.
- Hutchens, R.M., 1981. Entry and exit transitions in a government transfer program, the case of aid to families with dependent children. *Journal of Human Resources* 16, 217–237.
- Iannaccone, L., 1990. Religious practice: a human capital approach. *Journal for the Scientific Study of Religion* 29, 297–314.
- Iannaccone, L., 1997. Skewness explained: a rational choice model of religious giving. *Journal for the Scientific Study of Religion* 36, 141–157.
- Iannaccone, L., 1998. Introduction to the economics of religion. *Journal of Economic Literature* 36, 1465–1495.
- Lipford, J.W., Tollison, R.D., 2003. Religious participation and income. *Journal of Economic Behavior & Organization* 51, 249–260.
- Long, S.H., Settle, R.F., 1977. Household allocation of time and church attendance, some additional evidence. *Journal of Political Economy* 85, 409–413.
- Miller, M., Woehr, D., 2002. The meaning and measurement of work ethic: construction and initial validation of a multidimensional inventory. *Journal of Vocational Behavior* 60, 451–489.
- Muurinen, J.M., 1982. The demand for health, a generalised Grossman model. *Journal of Health Economics* 1, 5–28.

- Neuman, S., 1986. Religious observance within a human capital framework, theory and application. *Applied Economics* 18, 1193–1202.
- Nocera, S., Zweifel, P., 1998. The demand for health, an empirical test of the grossman model using panel data. In: Zweifel, P. (Ed.), *Health, The Medical Profession, and Regulation*. Kluwer Academic Publishers, Boston.
- Plotnik, R., 1983. Turnover in the AFDC population, an event history analysis. *Journal of Human Resources* 18, 65–81.
- Saffer, H., 2008. The demand for social interaction. *Journal of Socio-Economics* 37, 1047–1060.
- Sawkins, J.W., Seaman, P.T., Williams, H.C.S., 1997. Church attendance in Great Britain: an ordered logit approach. *Applied Economics* 29, 125–134.
- Sullivan, D.H., 1985. Simultaneous determinants of church contributions and church attendance. *Economic Inquiry* 23, 309–320.
- Ulbrich, H., Wallace, M., 1983. Church attendance, age, and belief in the afterlife: some additional evidence. *Atlantic Economic Journal* 11, 44–51.
- Wagstaff, A., 1986. The demand for health: some new empirical evidence. *Journal of Health Economics*, 195–233.
- Weber, M., 1958. *The Protestant Ethic and the spirit of capitalism* (T. Parsons, Trans.). New York: Scribners [Original work published 1904–1905].
- Zweifel, P., Breyer, F., 1997. *Health Economics*. Oxford University Press, New York.