A forecast of charitable giving

Stephen Carnagua

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Introduction

Giving USA produces an annual report with estimates of charitable giving by individuals, corporations, and foundations. This report is relied upon by nonprofit practitioners, academics, policymakers, and the media as the authoritative measure of U.S. giving ("About Giving USA"). Because the data used to create the estimates in the report is only available with a significant lag (up to several years for certain variables), current or recent past giving totals are estimated using time series regression models and later updated (Deb et al., 2003, and Brown et al., 2004). In this project, I generalized and extended these "nowcasting" models to create step ahead forecasts.

My approach was to build upon methodology already in place for Giving USA. I created time series forecasts, using the current methodology as a template, then revised the models and cross-validated using ex-post forecasting. I produced several forecasts, with a certain measure of giving modeled as a function of covariates such as tax rates, GDP, or income. Ultimately, predictions were made for individual and corporate itemized giving, complete with confidence intervals and various scenario analyses. It is my hope and belief that these forecasts will be instructive in planning, and that future researchers will be able to further extend my work to develop even more accurate and useful predictions.

Background

For over 50 years, *Giving USA* has reported on charitable giving. Starting in 2000, the Indiana University Lilly Family School of Philanthropy has been responsible for the research upon which the annual report is based. The report estimates "total giving by about 117 million households across America, approximately 12.4 million corporations that claim charitable deductions, an estimated 99,000 estates, and about 76,000 foundations" to "about 1.1 million IRS-registered charities, plus a conservative estimate of 222,000 American religious organizations" ("About Giving USA").

The School of Philanthropy has improved the methodology for giving estimates over the years. Deb et al. (2003) and Brown et al. (2004) set forth the procedures used to select the models currently in use for estimating individual and corporate charitable giving, respectively. For editions of *Giving USA*, the School has used time series regressions to predict recent past values of individual itemized giving and corporate giving. These values were added to foundation giving estimates, provided by the Foundation Center, and bequest giving estimates, which have an estimated component and a component which comes from tax return data (see Brown et al., 2005). Individual, corporate, foundation, and bequest giving sum to form our aggregate giving estimate. More accurate data on those values comes in a couple years later, so *Giving USA* updates the values as data becomes available, on a rolling basis. Brown et al. (2002) contains a complete description of the methodology.

The variables used to predict corporate giving were as follows: the S&P 500 aggregate annual price index, corporate pretax profits, corporate tax rate, and GDP. The variables used to predict individual itemized giving were as follows: personal consumption, the S&P 500 index (plus a squared term), personal tax rate, and a lag of the dependent variable.

Data

Data were available from primarily from government sources. The dependent variables, itemized individual and corporate giving, came from IRS.gov ("Statistics of Income"), which reports total deductions each year, with a lag of two or three years. Data was available for itemized giving through 2010. Note that although a significant amount of giving by individuals comes from small donors who do *not* itemize, I decided to only model the itemized portion, because it is possible to validate (as the IRS estimates come in later).

Information on corporate pretax profits, GDP, personal consumption, and personal income came from the Bureau of Economic Analysis website ("U.S. Economic Accounts"). The BEA measure of personal income captures all sources of income "associated with current production" ("Fundamental Concepts"). Consumption is a measure of all goods and services bought by US households ("Personal Consumption Expenditures,"). Individual and corporate maximum tax rates come from bankrate.com ("Tax Brackets") and groco.com ("Tax Rate Guide"), respectively.

Measures of the S&P 500, consumer sentiment, potential GDP, and recession probability came from the St. Louis Fed website. The S&P index variable measures aggregate price ("Federal Reserve Economic Data"). Consumer sentiment is developed from a survey administered by Thomson Reuters and the University of Michigan ("Survey Information"). Potential GDP "is the CBO's estimate of the output the economy would produce with a high rate of use of its capital and labor resources" ("Federal Reserve Economic Data"). Recession probability was calculated by Marcel Chauvet (1998), and was used in predictions in place of the dummy variable for recession (see below).

All dollar values were converted to real terms (in 2012 dollars) and rescaled, if necessary, so that all variables reported billions of dollars. Measures of giving are specified as growth rates (changes in logarithmic values), as are corporate profits, personal income, the S&P index, and GDP. Tax rates and consumer sentiment enter the models as first differences. All independent variables were available through at least 2012. All dependent and independent variables went back to at least 1953, meaning 57 complete observations were available[1].

[1] This number is reduced when growth rates are used as the independent variable, because an observation relies on the value of the past observation.

Model Specification

Our forecast models are time series regressions, with individual and corporate charitable deductions as the dependent variables. In the individual giving model, the growth rate of individual charitable deductions is a function of the change in the personal tax rate, growth rate of personal consumption, growth of the S&P 500, growth of S&P squared and a lag of the growth rate of individual deductions. For the corporate model, the growth rate of corporate charitable deductions is a function of the change in the corporate tax rate, growth rate of corporate income, growth rate of the S&P 500, and growth rate of GDP.

In order to forecast future values of giving, it was necessary to first forecast values of the exogenous variables. First, I visually examined autocorrelation and partial autocorrelation functions for each of the variables. For nearly all variables, a clear pattern of slowly fading ACs and PACs which cut off quickly after one lag, so I simply created AR(1) models and used the predicted values to simulate observations past the year 2012, with a few exceptions. The recession indicator variable was replaced by the recession probability variable in 2012 and 2013 observations, and assumed to be zero after 2013. The corporate and individual tax rates were assumed to remain constant after 2013.[2]

In the individual model (see Appendix II), tax rate, consumption, the S&P and the lag of individual deductions were all significant, with the expected coefficient signs. In the corporate model (Appendix I), income, tax rate, GDP, and S&P were significant. Again, the variables had the expected sign. Various other models were tried as well (also in Appendices I and II). These fitted regression models were employed, along with the projected exogenous variables, to come up with forecasts for 2013-2015. I also checked to see if longer lag lengths were significant for independent variables, and they were not.

Results

The model predicted growth rates for individual charitable deductions of 1.61% in 2014 and 1.03% in 2015, and 4.04% in 2014 and 3.98% in 2015 for corporate deductions (see Appendix III). In level values, the predicted amount of individual charitable giving is $201.4 billion in 2014 and $202.7 billion in 2015, and predicted corporate giving is $19.9 billion in 2014 and $20.7 billion in 2015. Findings across the many models I created, including those shown in Appendices I and II, were robust.

[2] Note that ultimately a more sophisticated methodology was employed to estimate covariates. All variables besides recession and tax rates were modeled as functions of the other independent variables' past values, and those models were used to forecast covariate values for 2013 and beyond.

In order to evaluate the forecasts, I employed several techniques. The first was a test of serial correlation in residuals. After running the regressions, I saved the residuals. I examined the autocorrelation function and calculated the Durbin-Watson statistics. I also used Stata's *wntestq* command to run portmanteau tests for white noise forecast residuals. None of these checks suggested serial correlation.

Next, I used Dr. Bivin's *actfit* command to compute Mincer-Zarnowitz regressions, Theil's U statistics, and MAP/MAPE/MAE/RMSE measures of forecast accuracy. The output from these commands can be found in Appendix IV. In both MZ regressions, the null hypothesis that the line's slope is unity cannot be rejected, although the p-value of .081 on the individual giving forecast is a little suspect. In both models, the constant is close to 0, which is the desired outcome.[3]

Conclusion

Using the methodology in place which *Giving USA* researchers use to predict recent past values of individual or corporate charitable deductions, I have built a foundation for forecasting those deductions into the indefinite future. The methods set forth here can be applied to other aspects of giving forecasting, including bequest giving, foundation giving, or even a complete measure of aggregate giving. It is likely that forecast models of giving by geographic region or charity sector will be created as well.

Next steps include continuing to update data as it becomes available and continuing to look for alternate data sources. New data can be used to both improve forecasts and evaluate the models already in place. Other variables to consider using in the forecasts include housing prices, capital gains tax rates, and preliminary IRS giving estimates. Also, quarterly data is available for many of the variables used, so quarterly forecasts are a natural extension.

[3] See the log file for forecast evaluation (*an_006*) procedures to see all models' diagnostics compared.

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Appendix I: Corporate Giving Models

	(1)	(2)	(3)	(4)	(5)
	Real growth rate of itemized corporate giving				
Real S&P growth rate	0.126**	0.128**	0.132**	0.120*	0.113*
	(0.057)	(0.060)	(0.064)	(0.060)	(0.059)
Difference in corporate marginal tax rate	1.924***	1.920***	1.906***	1.923***	1.867***
	(0.547)	(0.553)	(0.557)	(0.557)	(0.557)
Real corporate income growth rate	0.350***	0.356***	0.352***	0.349***	0.331***
	(0.104)	(0.111)	(0.106)	(0.106)	(0.109)
Real GDP growth rate	1.258**	1.300**	1.287**	1.140**	1.287**
	(0.499)	(0.569)	(0.519)	(0.543)	(0.560)
Recession indicator		0.005			
		(0.031)			
Real S&P growth rate squared			0.060		
			(0.254)		
Lag of real corporate giving				0.004	
				(0.101)	
Lag of real GDP growth rate					-0.270
					(0.416)
Constant	-0.010	-0.013	-0.013	-0.008	-0.004
	(0.016)	(0.025)	(0.020)	(0.016)	(0.017)
Observations	56	56	56	55	55
R^2	0.587	0.587	0.587	0.551	0.555
Adjusted R^2	0.554	0.546	0.546	0.506	0.510
AIC	-129.410	-127.439	-127.472	-124.922	-125.391

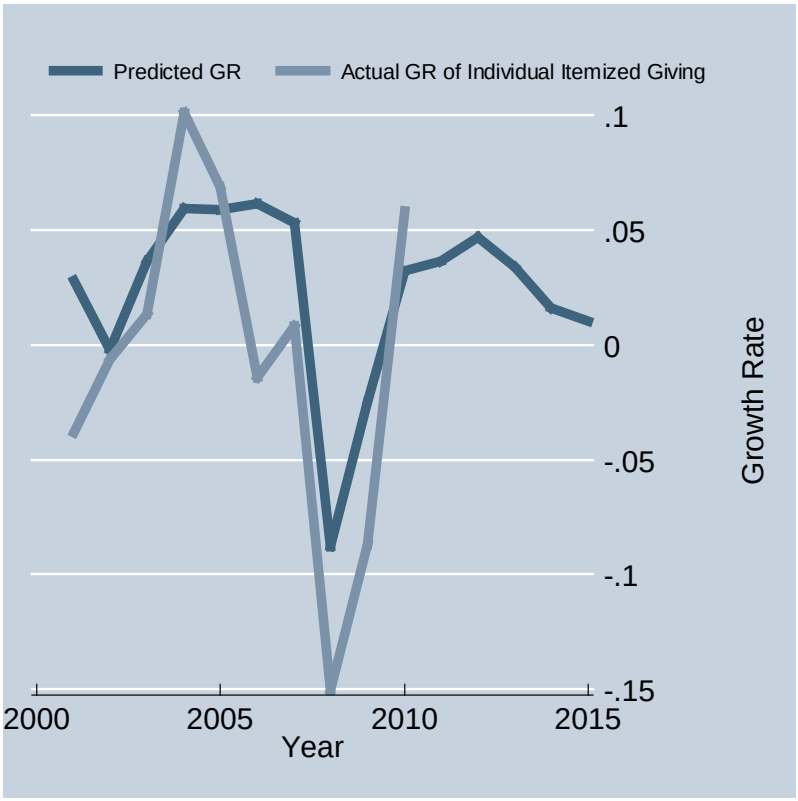
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

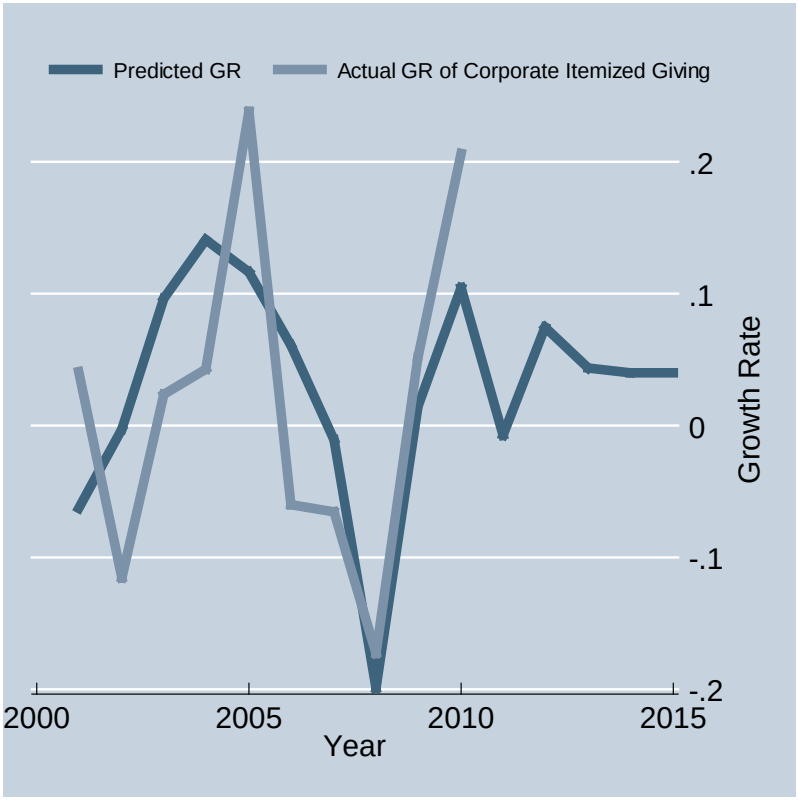
Appendix II: Individual Giving Models

	(1)	(2)	(3)	(4)	(5)
	Real growth rate of itemized individual giving				
Difference in real personal consumption	0.000**	0.000**	0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Differnece in top individual marginal tax rate	0.302**	0.284**	0.288**	0.302**	0.300**
	(0.138)	(0.138)	(0.141)	(0.140)	(0.139)
Real S&P growth rate	0.100**	0.119***	0.102**	0.100**	0.091**
	(0.038)	(0.034)	(0.038)	(0.039)	(0.039)
Real S&P growth rate squared	-0.173		-0.157	-0.173	-0.176
	(0.148)		(0.151)	(0.149)	(0.148)
Lag of real individual giving	0.325***	0.337***	0.326**	0.325***	0.271**
	(0.106)	(0.105)	(0.122)	(0.107)	(0.119)
Second lag of real individual giving			-0.054		
			(0.120)		
Recession indicator				-0.001	
				(0.017)	
Index of Consumer Sentiment (Average)					0.001
					(0.001)
Constant	0.008	-0.001	0.007	0.008	-0.053
	(0.012)	(0.009)	(0.013)	(0.017)	(0.063)
Observations	55	55	54	55	55
R^2	0.478	0.464	0.476	0.478	0.488
Adjusted R^2	0.425	0.421	0.409	0.413	0.425
AIC	-185.943	-186.425	-180.408	-183.944	-185.035

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Appendix III: Predicted Growth Rates





Appendix IV: Forecast Evaluation

Individual Giving Forecast

MEASURES OF FORECAST PERFORMANCE

Number of Obs = 55

Corr. Cof. = .93880156

MSE = .00041915

RMSE = .02047324

MAPE = .30829066

MAE = .00758553

Bias = .00475695

Theil U (Level) = .33480087

Theil U (Percent) = .4114111

THEIL DECOMPOSITION OF MSE

Fraction of MSE due to Bias =.05398638

Fraction of MSE due to different Variation =.16782592

Fraction of MSE due to difference Covariation =.7781877

THEIL ALTERNATIVE DECOMPOSITION OF MSE

Fraction of MSE due to Bias =.05398638

Fraction of MSE due to Difference of Beta from one =.07722319

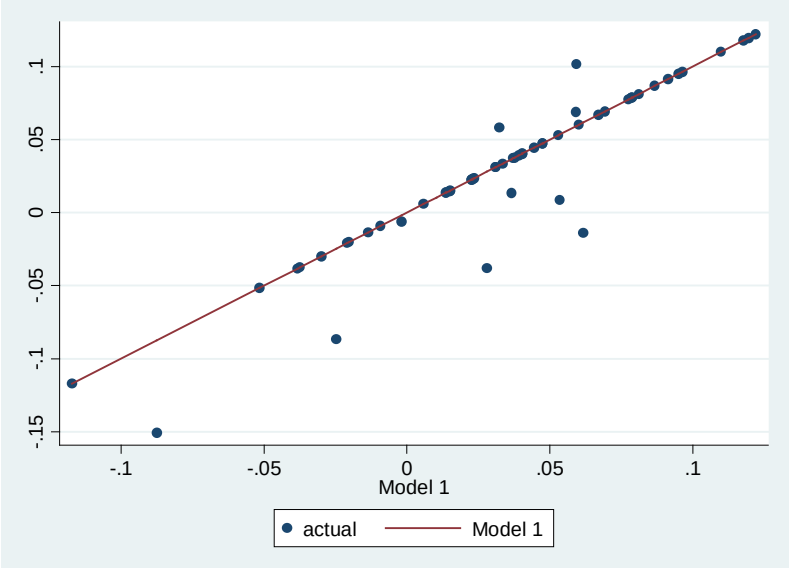
Fraction of MSE due to Residual Variance =.86879042

Mincer-Zarnowitz Regression

Constant = -.00731606

Slope = 1.0761165

two-tailed p-value for slope=1.00 = .08122251



Corporate Giving Forecast

MEASURES OF FORECAST PERFORMANCE

Number of Obs = 55

Corr. Cof. = .93490371

MSE = .0015122

RMSE = .03888708

MAPE = .24720077

MAE = .01544422

Bias = .00124078

Theil U (Level) = .27038026

Theil U (Percent) = .06093089

THEIL DECOMPOSITION OF MSE

Fraction of MSE due to Bias =.00101807

Fraction of MSE due to different Variation =.11505838

Fraction of MSE due to difference Covariation =.88392355

THEIL ALTERNATIVE DECOMPOSITION OF MSE

Fraction of MSE due to Bias =.00101807

Fraction of MSE due to Difference of Beta from one =.09737207

Fraction of MSE due to Residual Variance =.90160986

Mincer-Zarnowitz Regression

Constant = -.00056574

Slope = .98100437

two-tailed p-value for slope=1.00 = .35463995