



# Forecasting medical cost inflation rates: A model comparison approach

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## ABSTRACT

Due to healthcare costs rising faster than overall cost of living, decision makers (i.e., households, businesses, and governments) must cut back on healthcare utilization or spending elsewhere to be fiscally responsible. Accurate forecasts of future medical costs are critical for efficient planning, budgeting and operating decisions at all levels. This research compares the accuracy of the linear autoregressive moving average (ARMA) model and the nonlinear neural network model in producing forecasts of medical cost inflation rates. The analysis focuses on twelve monthly measures of medical costs including the overall medical care price index and eleven (disaggregated) subsectors of medical costs. In addition to standard symmetric measures of forecast accuracy, we utilize two asymmetric error measures designed to capture and penalize preferences for under- and overprediction in model selection. The findings indicate that the neural network model outperforms the univariate ARMA in both 1-step and 12-step ahead forecasts. A number of important practical implications are discussed, such as the use of accurate forecasts in contract negotiations, budgeting and planning.

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## 1. Introduction

Health care spending continues to grow faster than the economy. According to the Centers for Medicare and Medicaid Services, national health expenditures accounts for 16.2% of gross domestic product in 2008. Increases in demand for healthcare products and services from a growing population, consumer price insensitivity, and technology are just some of the factors that continue to put an upward pressure on prices. Rising prices often make operating and budgetary decisions more difficult as the share of these health expenditures relative to the rest of the budget increases. As such, decision makers (i.e., households, businesses, and governments) must cut back on healthcare utilization or spending on other products or services elsewhere. Hence, accurate forecasts of future medical costs are critical for efficient planning, budgeting and operating decisions at all levels (i.e., household, firm, and government). For instance, while many consumers at the household level have some form of insurance, a substantial amount of medical payments are made out-of-pocket. Consequently, many households participate in health savings accounts (HSA). Knowledge about future changes in medical costs would assist households in optimally determining the amount to allocate to their respective HSAs.<sup>1</sup>

Budget analysts and financial managers require accurate forecasts of the rate of medical price increases. Medical cost inflation plays a major role in planning future budget obligations or liabilities such as pension plans. In addition, understanding the time series behavior of medical costs provides nonhealth-related firms as well as health-care providers with information to negotiate with insurance companies on health plans. Financial managers and health care administrators use forecasts to prepare and evaluate their budget positions, premiums, and capitation rates [13]. Payors and providers may also negotiate multi-year contracts. In doing so, both parties may arrange fee schedules to some cost of living adjustment. Likewise, payors may be more inclined to underpredict medical cost inflation whereas providers may be more inclined to overpredict. The prices for different medical sectors or specialties may behave differently, thus understanding and modeling price changes disaggregated by medical sector could be beneficial for use in business valuations, industry benchmarking, planning and budgeting, and negotiating insurance contracts.

With respect to state and federal governments, the sustainability of public programs (e.g., Medicare and Medicaid) requires accurate forecasts of medical cost inflation. Budget and legislative analysts use forecasts to impose premium caps, payment rates, and global expenditure limits. In fact, accurate forecasts are vital to the legislative process when future public programs are being proposed for policy evaluation and comparison of various health-related programs. For example, the Congressional Budget Office provides cost estimates on proposed legislation while state budget agencies often provide cost estimates for state-level legislation. Accurate forecasts are critical for determining the costs and benefits of health-related programs when taxpayers will be responsible for meeting future government

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<sup>1</sup> For example, throughout the year, households allocate a portion of their budget to known health expenditures through some sort of health savings accounts. These accounts are often setup to benefit the household the closer they are to actual out-of-pocket expenses incurred. Excess money set aside may result in forgone income for other non-medical purchases, while too little money allocated in these accounts may result in less savings. See Remler and Glied [24] for detail discussion on cost sharing and health savings accounts.

obligations. However, it is possible that taxpayers as well as budget analysts may prefer that changes in medical costs be overpredicted as opposed to underpredicted if the costs of making a forecast mistake are higher for the latter. This might be the case if budget deficits are more costly than the equivalent surplus to the taxpayer, especially if there is an increase in taxes to make up the budget shortfall from underpredicting changes in medical costs. Alternatively, budget analysts may have a similar view with respect to deficits and making spending cuts due to underpredicting changes in medical costs relative to the case of overpredicting and an accompanying surplus. Thus, while having the most accurate forecast is certainly preferred, the loss associated with the forecasting errors may actually be asymmetric. Along with traditional symmetric error measures, our paper evaluates the medical cost forecasting models using asymmetric error measures that penalize the respective model for over- or underpredicting the actual rate of medical cost inflation.

Improved forecasts of medical cost inflation can yield better decisions for individuals, businesses, and government. While specific industry models are proprietary, insurers, actuaries and other health care analysts typically utilize variations of autoregressive (AR) and

moving average (MA) methods to conduct stochastic trend analysis; thus, our comparator method is the general class of autoregressive-moving average (ARMA) models. However, the use of traditional time series forecasting models that assume linear relationships between past observations and subsequent forecasts may be problematic and lead to poor forecasts if the data actually exhibit nonlinear patterns as evident in Fig. 1. Seeking to achieve greater levels of accuracy, forecasters are always looking for new quantitative forecasting methods to compare to those they currently use. Since there are few studies that have specifically forecasted medical cost inflation rates [11,26], we choose to compare the traditional linear time series model (e.g., ARMA models) against an artificial neural network (NN) model. NN models are based on previous research that indicates the human brain relies on dense connections between information nodes and a nonlinear, parallel structure to process information [15]. NN models then attempt to replicate these characteristics through mathematical formulas that link input and output variables. Furthermore, NN models have an amazing ability to recognize patterns. Thus, NN-type models tend to outperform other nonlinear approaches [17,22,27,33,34].

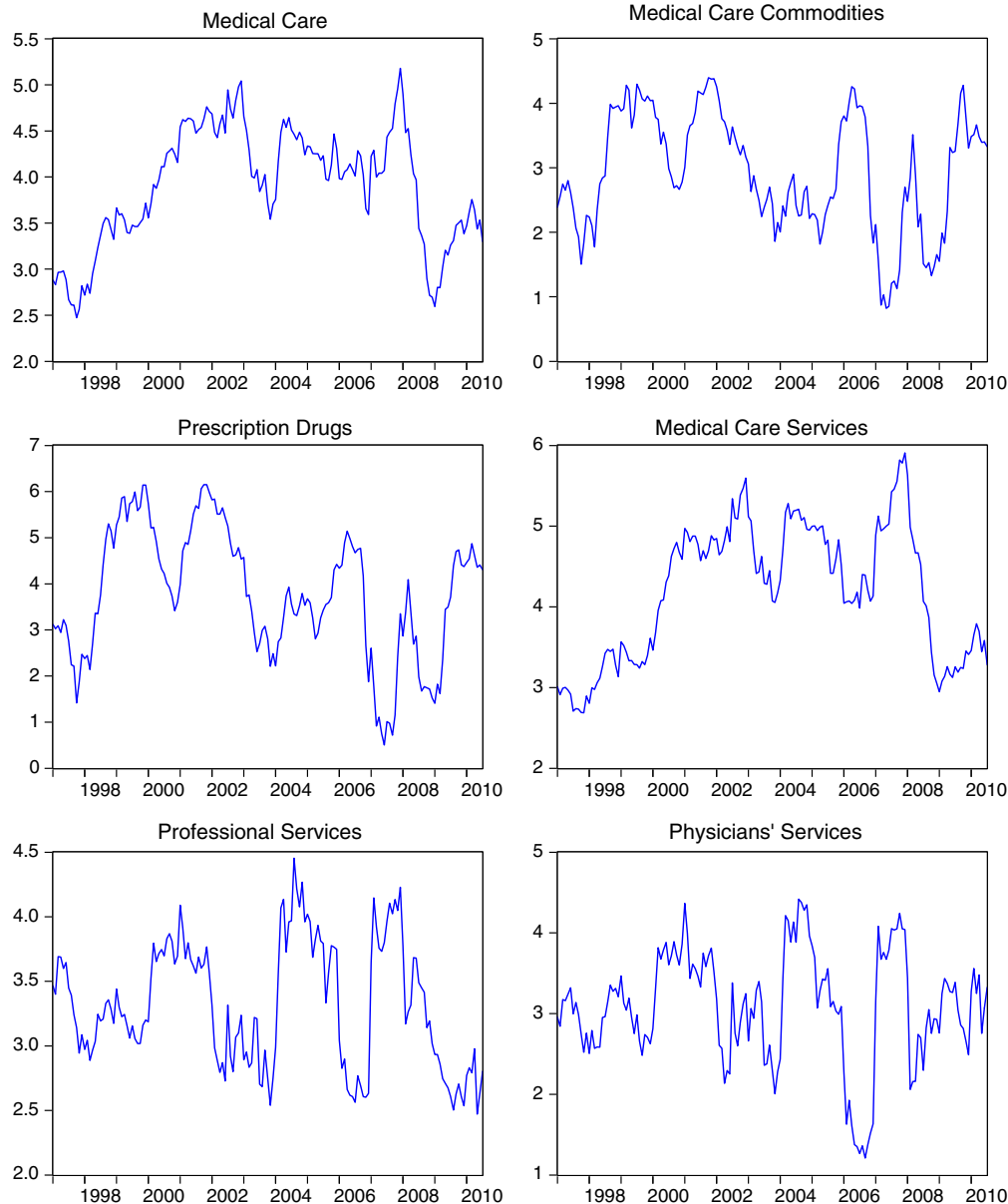


Fig. 1. Medical cost inflation rates.

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