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BUSINESS CYCLES AND HEALTHCARE EMPLOYMENT

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ABSTRACT

Is healthcare employment recession proof? We examine the hypothesis that healthcare employment is stable across the business cycle. We explicitly distinguish between a negative aggregate demand and supply shock in studying how healthcare employment responds to recessions, and show that this response depends largely on the type of the exogenous shock triggering the recession. We find that aggregate healthcare employment responds procyclically during demand-induced recessions but remains stable during supply-induced recessions. Further, there is significant heterogeneity in the employment responses of the healthcare sub-sectors. While healthcare employment in most sub-sectors responds procyclically during recessions caused by both negative demand and supply shocks, that in nursing dominant sectors responds countercyclically. However, the procyclical response of sub-sectors and countercyclical response of nursing dominant sectors are both relatively weaker during recessions caused by a negative aggregate supply shock than a demand shock, thus balancing out and contributing to an overall null employment response of the aggregate healthcare sector during recessions caused by a supply shock. More generally, by isolating the recessionary impact of the negative aggregate demand shock from supply shock on healthcare employment, we provide new empirical evidence that healthcare employment in general is not recession proof.

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I. Introduction

The simple scatter plots of national unemployment rate (U-3) and healthcare employment over the period 1990-2019 in the U.S. in Figure 1 show null or small negative co-movements. Does this indicate that healthcare employment remains stable during recessions? Does the healthcare sector enjoy insulation from the factors that cause other sectors to experience expansions and contractions? These questions are important, yet untapped in the literature. Although the business cycle literature confirms that employment across industries in general exhibit procyclical behavior during economic downturns, there is limited evidence on how employment in the healthcare industry react to economic downturns.[1] Understanding how healthcare employment responds to macroeconomic conditions is important because staffing arrangements can affect the quality and cost of care (Cohen and Spector, 1996; Needleman et al., 2006, 2011; Lin, 2014; Antwi and Bowblis, 2018), an issue that was explicitly magnified during the COVID-19 health crisis.

In this paper, we study the impact of recessions on healthcare employment caused by two fundamental sources of business cycle fluctuations: aggregate demand shocks and aggregate supply shocks.[2] We explicitly distinguish between an exogenous negative aggregate demand shock and negative aggregate supply shock in studying how healthcare employment responds to recessions, and show that this response is heterogeneous across sub-sectors depending on the type of the exogenous shock hitting the economy. More importantly, we find evidence that employment in healthcare sub-sectors is procyclical,

[1] The amplitude and duration of the labor market response during business cycles vary across industries, demographic sub-groups, and geographies due to different degrees of labor market frictions and adjustment (Clark and Summers, 1980; Greenwald and Stiglitz, 1993; Kose, 2002; Wall and Zoega, 2003; Hoynes, Miller, and Schaller, 2012; Boz, Durdu, and Li, 2015; Bredemeier and Winkler, 2017; Bredemeier, Juessen, and Winkler, 2020; De et al., 2021).

[2] To make these shocks clear, examples of exogenous "aggregate demand shocks" include unexpected changes in income, consumer or producer sentiment/expectations, residential markets investment, or credit standards, while exogenous "aggregate supply shocks" can include things such as extreme weather shocks, war, labor strikes, productivity shocks, oil shocks, or any shock that affects the economy's contemporaneous ability to produce goods and services. The COVID-19 pandemic can be understood as an exogenous negative *Keynesian aggregate supply shock* on impact, with negative spillover effects on aggregate demand in other sectors overtime in the presence of incomplete markets and liquidity constraints (Guerrieri et al., 2020; Smith, 2020). Brinca, Duarte, and Faria-e-Castro (2020) further argue that the COVID-19 outbreak features a negative labor supply shock, and can therefore be interpreted as a negative aggregate (output) supply shock.

except nursing dominant sectors.

Since the seminal work by Ruhm (2000), an extensive literature has studied the relationship between macroeconomic conditions and different health outcomes as well as health behavior (Ruhm, 2005, 2015; Tekin, McClellan, and Minyard, 2018; Peng, Chen, and Guo, 2022; Hollingsworth, Ruhm, and Simon, 2017; Currie, Duque, and Garfinkel, 2015; Carpenter, McClellan, and Rees, 2017; Charles and DeCicca, 2008; Lindo, 2015). However, a very small number of studies have explored the relationship between macroeconomic conditions and healthcare employment, in particular, the impact of recessions on healthcare employment (see, e.g., Dillender et al., 2021). This could be owing to the inherent complexities of the healthcare sector that can generate mixed responses during recessions. On the one hand, economic downturns and job losses as well as falling financial resources is expected to reduce the demand for healthcare (just like any other normal good) and lead to decrease in healthcare employment. This is in conformity with a procyclical response of employment in the healthcare sector (similar to other sectors of the economy) to business cycles. On the other hand, there are several features typical to the healthcare sector alone, which hold the ability to insulate the sector from business cycle fluctuations.

First, the healthcare labor market overall features extensive licensing that makes substitution of healthcare workers in response to cost pressures more difficult (Garber and Skinner, 2008). Second, in certain sectors like nursing, prior studies have shown evidence of labor substitution towards less skilled forms of labor or "downskilling" (Konetzka et al., 2018; Alameddine et al., 2012; Zabalegui and Cabrera, 2010; Heitlinger, 2003). Third, prior studies also document evidence that economic downturns can have negative effects on health outcomes such as mental health for certain sub-groups of the population (Charles and DeCicca, 2008; Tefft, 2011; Bradford and Lastrapes, 2014; Cutler and Sportiche, 2022), which might also increase demand for healthcare workers during recessions, especially in psychiatric or substance abuse treatment hospitals. Moreover, health insurance paying for a large fraction of the patients' out-of-pocket healthcare cost (a feature again typical of the healthcare industry) also makes their healthcare demand

less price sensitive, though it might vary largely across different income groups (Manning et al., 1987). Even if individuals lose private insurance coverage during economic downturns, they can be eligible for public health insurance. These features can possibly explain why healthcare sector might react differently during recessions compared to other sectors. Ex ante, it is not clear whether employment in the healthcare sector should exhibit procyclical, countercyclical or acyclical response during business cycles.

We are aware of only five studies in the literature that investigate the impact of business cycles on healthcare employment (Dillender et al., 2021; Konetzka et al., 2018; Chen, Sasso, and Richards, 2018; Stevens et al., 2015; Huang and Bowblis, 2019). These studies focus either on certain sub-sectors of the healthcare industry or a specific group of healthcare workers such as nurses or physicians. Further, all these studies do so using multivariate regression models with variation in unemployment rates as their primary measure of recession.[3] Specifically, these models regress the share of employment in the healthcare sector on the local unemployment rate, after controlling for unit (often state or county) and year fixed effects, and find no effect (and in some cases positive effect) of recession on healthcare employment.[4] Although existing studies only establish association but not causality, an important yet unanswered question is what drives the underlying correlation and how to formally interpret it.

Our study makes a number of important and novel contributions to the literature on recessions and U.S. healthcare employment. Business cycles have pervasive effects throughout the economy including output, employment, prices and other macroeconomic variables in response to different types of aggregate macroeconomic disturbances: demand shocks, supply shocks, monetary policy shocks, credit shocks, etc. Therefore, a novel contribution of our paper is the use of the structural factor-augmented vector autoregression

[3]This is also a conventional method in the papers that use health and health behaviors as an outcome.

[4]The existing approach relies on the assumption that variation in unemployment rate is an exogenous predictor of healthcare employment. This assumption might be restrictive in the context of business cycles because first, there is limited information available from a single reported historical time series, and second, labor market indicators (for example healthcare employment) may be strongly correlated with a number of omitted variables (Domash and Summers, 2022). Further, there could be regional or other unit-level time-varying shocks that simultaneously affect healthcare employment and the unemployment rate. Including unit and time fixed effects alone is not typically sufficient to account for endogeneity (see, e.g., Antwi and Bowblis 2018).

(FAVAR) model of Bernanke, Boivin, and Eliasz (2005) and Stock and Watson (2016) to conduct our analysis, which allows us to jointly model the interaction between healthcare employment and U.S. macroeconomic conditions (from over a 100 variables reflecting economic activity, prices, and monetary policy) in studying the impact of recessions on healthcare employment. A key step in investigating the impact of recessions on healthcare employment lies in identifying structural macroeconomic shocks plausibly. We identify two fundamental sources of business cycle fluctuations: a negative aggregate demand shock and a negative aggregate supply shock using the pure sign restrictions approach.

Our methodological framework fills the gap in the literature by explicitly identifying the type of exogenous structural shock causing the economic downturn, and consequently the impact of this shock on healthcare employment. By conditioning our analysis on the broad information set in one large dynamic common factor model, the impulse response functions are able to accurately track the dynamic effects of a negative aggregate demand and supply shock separately on healthcare employment.[5] To the best of our understanding, our paper is the first in the literature to study the impact of recessions on healthcare employment using a macro-econometric structural FAVAR framework.

We show that the response of employment in overall healthcare industry, as well as the different sectors and sub-sectors of healthcare industry, to recession is significantly different from those found in the few previous studies, and depends largely on the type of the shock hitting the economy. This reinforces the importance of first identifying the type of macroeconomic shock correctly and second conditioning the analysis on the broad information set, thereby accounting for the full interaction between the healthcare employment and U.S. macroeconomic conditions when studying the impact of recessions on healthcare employment. Further, through variance decomposition we are also able to assess the quantitative importance of demand and supply shocks in explaining movements in U.S. healthcare employment.

[5]Impulse response functions are commonly used to study the impact of different kinds of macroeconomics shocks such as negative demand and supply shocks on economic variables in VAR and more recent FAVAR systems (Bernanke, Boivin, and Eliasz, 2005; Bradford and Lastrapes, 2014; Peersman, 2005; Stock and Watson, 2016; Uhlig, 2005). Thus, impulse responses in our study allow us to track the response of healthcare employment to a negative aggregate demand and a negative aggregate supply shock.

Previewing our results, we find that healthcare employment is procyclical and declines significantly during recessions caused by a negative aggregate demand shock. This is a novel finding in this literature which documents healthcare employment to be stable during recessions. In exploring potential mechanisms behind our findings, we find that personal healthcare expenditures go down during recessions.[6] Our findings imply that reductions in demand for healthcare during such economic downturns contributes to the decline in healthcare employment. The procyclical response of healthcare employment during recession caused by the negative aggregate demand shock appears to be driven by the procyclical response of healthcare utilization.

Additionally, we find strong heterogeneity in employment responses across different healthcare sub-industries (ambulatory healthcare services, hospitals, and nursing and residential care facilities as well as other sub-sectors) in terms of the magnitude as well as the direction of the impact. Employment goes down during recessions caused by an adverse demand shock in most sub-sectors. Specifically, general medical and surgical hospitals experience the largest decline in employment followed by physicians' offices. In contrast, home healthcare services, outpatient care centers, and nursing care facilities experience an increase in employment during such recessions.

We next discuss our findings for healthcare employment during economic downturns caused by a negative aggregate supply shock. Similar to those found for the negative aggregate demand shock, we conclude that employment is procyclical for most sub-sectors, but countercyclical for home healthcare services and nursing care facilities. However, the magnitude of the response is relatively smaller during recessions caused by a negative aggregate supply shock compared to a negative aggregate demand shock. Consequently when hit by a negative aggregate supply shock, the procyclical employment response of the sub-sectors balance out the countercyclical employment response of nursing dominant sectors contributing to an overall null employment response of aggregate healthcare sector.[7] More generally, we do find that the healthcare industry as a whole enjoys some

[6] As we discuss later in footnote 12, hospital and physician services constitute the largest share of personal health expenditures among all categories.

[7] The decline in employment in most healthcare sub-sectors and the increase in employment in home healthcare and nursing care facilities is relatively smaller during recessions caused by a negative aggregate

insulation from supply-induced recessions. Our results for a stable response of aggregate healthcare employment during recessions in this scenario complement prior studies.

Our study fills the gap in the literature of business cycles and healthcare employment by disentangling the effects of demand-induced recessions from supply-induced recessions on healthcare employment. While previous studies find a null effect of recessions on healthcare employment, we show that aggregate healthcare employment goes down significantly during demand-induced recessions but does show a null response during supply-induced recessions. Further, healthcare employment in most sub-sectors respond procyclically to both negative aggregate demand and supply shocks. The only exceptions are nursing dominant sectors (home healthcare facilities and nursing care facilities) which respond countercyclically to both negative demand and supply shocks. The impact of recession on healthcare employment and the consequent mechanisms at play, both depend largely on the type of the exogenous shock triggering the recession. To the best of our knowledge, our study is the first in the literature to show that healthcare employment in general is *not* recession proof. This is the primary contribution of our study, and comprises a novel finding in the literature of business cycles and healthcare employment.

II. Data

Our dataset consists of monthly time series data for 131 macroeconomic variables from 1990:01 to 2019:12.[8] Out of the 131 variables, 118 are macroeconomic indicators for the U.S. economy that assist in identifying the structural macroeconomic shocks, and 13 are labor market indicators for the U.S. healthcare industry that are our primary variables of interest.[9] For the 118 U.S. macroeconomic indicators, we rely on St. Louis Federal Reserve Economics Data (FRED) and Institute for Supply Management (ISM).

supply shock compared to a negative aggregate demand shock. Therefore, during recessions caused by a negative aggregate supply shock, the procyclical employment response of the sub-sectors balance out the countercyclical employment response of the nursing dominant sectors contributing to an overall null employment response of the aggregate healthcare sector.

[8]In our benchmark analysis, we use data up to the pre-COVID-19 period. However, we extend the data to also cover the pandemic period, i.e., 1990:01 to 2021:07, as a robustness check.

[9]We select the sample period based on the availability of all 131 time series indicators, though note that this does provide an extensive sample of 367 months of data (i.e., 30 years of data).

The variables are similar to those used in Bernanke, Boivin, and Eliasz (2005) as well as Stock and Watson (2016). We seasonally adjust all data prior to use and transform the variables to first differences of the logarithm in order to induce stationarity (except for those reported in percent which we use directly) and standardize them.[10] Next, we describe the labor market indicators for the U.S. healthcare industry below.

Healthcare employment The data on healthcare employment come from the Current Employment Statistics (CES) program, which is a monthly survey conducted by the U.S. Bureau of Labor Statistics. We obtain the seasonally adjusted number of employees in healthcare services per thousands of individuals at a monthly frequency. In our analysis, we take the natural log of this measure. We further disaggregate healthcare employment into sub-industry sectors using the North American Industry Classification System (NAICS) codes.[11] The first set of sub-industries we use in our empirical framework include ambulatory health care services (NAICS 621), hospitals (NAICS 622), and nursing and residential care facilities (NAICS 623). While previous studies stratify health services into a few sub-sectors within the healthcare industry (see, e.g., Dillender et al., 2021), our empirical design has the advantage of including all the major sub-sectors for which data are available. More granular and comprehensive information about the healthcare industry allows us to formally explore heterogeneity across sub-sectors, as well as within broad industry categories such as ambulatory health care services, hospitals, and nursing and residential care facilities. Specifically, we focus on the sub-sectors of the healthcare industry displayed in Table 1.

We plot the annualized growth rate of employment in healthcare sectors as well as the major sub-sectors over our sample period 1990:01-2019:12 in Figure 2. Note that in most cases employment growth shows a declining trend overall, and even turns negative

[10] We follow Bernanke, Boivin, and Eliasz (2005) for choice of series and their transformations. The macroeconomic indicators, their transformation codes, as well as the matrix of factor loading is reported in Appendix Tables A1-A4.

[11] Another alternative outcome variable is the unemployment rate from the Current Population Survey (CPS). However, we intentionally do not use the unemployment data from the CPS. The main reason is the break in series due to the switch from the Standard Industrial Classification (SIC)- to NAICS-based classification of industries in 2000. While the CES program have revised their data backwards over time to create comparable series, the CPS does not provide comparable unemployment data by industry.

for nursing care facilities towards the end of the sample period, indicating declining levels of nursing home staffing and increasing capacity constraints.

Personal consumption expenditures We use real personal consumption expenditures for healthcare as a proxy for healthcare demand and utilization. We test whether economic downturns reduce demand for healthcare due to falling financial resources. We obtain the seasonally adjusted series from the Bureau of Economics Analysis at a monthly frequency for the sample period 1990-2019.[12]

III. Empirical Framework

III.A. The FAVAR Model

The purpose of our study is to investigate the impact of a negative aggregate demand and supply shock on employment in healthcare industry as well as the sectors and sub-sectors of healthcare industry. To achieve our objective, we make use of a structural factor-augmented vector autoregression model (Bernanke, Boivin, and Eliasz, 2005; Stock and Watson, 2016). Our primary motivation in using a factor-augmented vector autoregression (FAVAR) model is its multiple distinct advantages over traditional low-dimensional VARs. The relatively small scale of traditional VAR models poses a question of whether all relevant information about the economy has been included in measuring business cycles. It is well known that informationally deficient VARs can lead to bias in the transmission of shocks. For example, "economic activity", "price level", "interest rate and monetary conditions" are not perfectly observable and likewise cannot be captured by a single reported data series (as in traditional VARs) (Bernanke, Boivin, and Eliasz, 2005; Stock and Watson, 2016; Forni and Gambetti, 2014). Many alternative measures of these concepts may be informative and the FAVAR framework provides one integrated

[12]Personal health expenditures include outpatient services (e.g., physician and dental services), paramedical services (e.g., home healthcare services), hospital and nursing home services, as well as spending on pharmaceutical and medical products. We can only observe these spending categories annually (i.e., not reported in the monthly data). Nonetheless, on average, more than half of health expenditures come particularly from hospital and physician services based on the annual data.

approach for combining multiple data series through factor analysis.

The richer information set in the FAVAR model provides superior estimates of economic concepts over using any single reported data series, more closely reflects the true information set used by policymakers, and assists in more accurate measurement of structural macroeconomic shocks (Bernanke, Boivin, and Eliasz, 2005; Forni and Gambetti, 2014; Bahadir and Lastrapes, 2015). We therefore use the FAVAR framework, allowing us to condition our investigation of macroeconomic shocks on healthcare employment using a richer information set without giving up the statistical merits of traditional VARs.[13] Our model is detailed below.

Let X_t be a n-dimensional vector stochastic process for a set of "informational" U.S. macroeconomic variables, and F_t be a q-dimensional vector of common latent factors. Λ is a $n \times q$ matrix of "factor loadings". The informational variables are primarily used to extract the common latent factors. Given a time series realization of X_t and the observable subset of Z_t, we estimate the following FAVAR model of Bernanke, Boivin, and Eliasz (2005); Stock and Watson (2016) in Equations (1) and (2):

$$X_t = \Lambda F_t + \upsilon_{xt} \tag{1}$$

$$\begin{bmatrix} Y_t \end{bmatrix} = \begin{bmatrix} F_t \\ Z_t \end{bmatrix} = B(L) \begin{bmatrix} F_{t-1} \\ Z_{t-1} \end{bmatrix} + \epsilon_t, \tag{2}$$

where Y_t follows the following linear dynamic process

$$Y_t = B_1 Y_{t-1} + ...B_p Y_{t-p} + \epsilon_t, \tag{3}$$

where Y_t is a $m \times 1$ vector of data at date $t = 1, ..., T$, B_i are coefficient matrices of size $m \times m$ and ϵ_t is the one-step ahead prediction error with variance-covariance matrix Σ.

[13] We conduct a robustness check of our findings using a simple structural sign-identified VAR model for a system of variables including standard measurements of economic activity (national unemployment rate), price level (consumer price index), interest rate (federal funds rate), money supply (M2 money supply), and healthcare employment. Overall, qualitatively our robustness results support our main findings. However, quantitatively the magnitude and persistence of the responses we find differ between the FAVAR and VAR model. To conserve space, the robustness results from the simple structural sign-identified VAR model are available upon request.

The system in Eq. (3) is the reduced form obtained from a dynamic structural model. We are not interested in the reduced form shocks, but rather identifying how the variables in Y_t respond to aggregate structural shocks. The structural counterpart to Eq. (3) in moving average form is given by:

$$Y_t = (I - B_y L)^{-1} D_y u_t \tag{4}$$

$$Y_t = (D_0 + D_1 L + D_2 L^2 + ...) u_t, \tag{5}$$

where u_t is a vector of aggregate structural shocks, $E\left(u_t u_t^{'}\right)$ is normalized to be the identity matrix. The mapping from the reduced form to the structural form imposes restrictions on the covariance structure:

$$\Sigma = E\left(\epsilon_t \epsilon_t^{'}\right) = D_y E\left(u_t u_t^{'}\right) D_y^{'} = D_y D_y^{'} \tag{6}$$

Once we identify the $m \times m$ matrix D_y from this mapping, we obtain the dynamic multipliers of interest from Eq. (3) using (4) and (5).[14] We provide details on our model specification (factors and observables entering Y_t) and identification in sub-section III.B. In particular, we utilize the sign restrictions approach to identify the structural macroeconomic demand and supply shock.

III.B. Model Specification, Identification, and Estimation

We use the two-step principal component estimation approach in which we estimate the factors using principal component analysis prior to estimating the FAVAR model (Bernanke, Boivin, and Eliasz, 2005; Stock and Watson, 2016; Bahadir and Lastrapes, 2015; De and Sun, 2019; De et al., 2021).

[14]Note that we need not fully identify D_y because we are solely interested in two types of structural macroeconomic disturbances impacting the economy: a negative aggregate demand shock and a negative aggregate supply shock. We therefore need to impose identifying restrictions only to columns of matrix D_y that correspond to the two structural shocks above.

1. Model Specification

The first step is to extract the common latent factors F_t. The observable set X_t in Eq. (1) consists of monthly time series of 118 macroeconomic indicators for the U.S. economy over the sample period 1990-2021.[15] We partition X_t into four subsets of broad economic concepts required to identify macroeconomic shocks, $X_{st}, s \in (1,4)$: economic activity, price level, interest rate, monetary aggregate; and extract a static factor $\hat{F_{st}}$ from each of the four subsets. For each subset s, that is, we estimate $\hat{F_{st}}$ as the first principal component of X_{st}: $\hat{F_{st}} = \left(\frac{1}{n}\right) \hat{\Lambda}' X_{st}$, where $\hat{\Lambda}$ contains the eigenvectors of X_{st}, normalized so that $\left(\frac{1}{n}\right) \Lambda'\Lambda = I$. The "U.S. economic activity factor" is loaded with 74 indicators broadly reflecting the U.S. macroeconomic environment – industrial production, employment, income, labor earnings, capacity utilization, consumption, business and residential investment, ISM manufacturing, consumer sentiment, housing sales, and trade indicators in the U.S. The "U.S. price factor" is loaded with 28 different consumer and producer prices as well as import and export prices, stock prices and oil prices for the U.S. The "U.S. interest rate factor" is loaded with 9 treasury interest rates of different maturities as well as the bank prime loan rate, and mortgage rates for the U.S. The "U.S. money supply factor" is loaded with 6 measures of US monetary aggregates. Thus, $\left[\hat{F_{1t}}, \hat{F_{2t}}, \hat{F_{3t}}, \hat{F_{4t}}\right]$ are the estimated common latent factors that serve as a proxy respectively for economic activity, price level, interest rate, and money supply in the U.S. These factors comprise the macroeconomic sub-system F_t in Eq. (2), and assist in identification of the structural macroeconomic shocks.[16] The observable subset Z_t in Eq. (2) includes the employment in the healthcare industry, the variable of primary interest to us.

The FAVAR $[Y_t]$ given by Eq. (2) now reduces to a standard VAR augmented with the latent factors from the first step, and the observable employment in healthcare industry. In the second step, we proceed to identifying structural shocks within this framework using sign restrictions, and estimating the model. We also estimate FAVAR models

[15] The rest of the variables reflecting healthcare employment enter our baseline model directly as observables.

[16] A detailed description of the entire dataset that has been used to construct the respective factors, and the matrix of factor loading is reported in Appendix Tables A1-A4.

separately for the different healthcare sectors and sub-sectors, such that the the observable subset Z_t in Eq. (2) includes healthcare employment of the different sectors and sub-sectors.[17]

2. Identification: Demand and Supply Shock

We use the popular sign restriction strategy of Peersman (2005) and others to identify the structural macroeconomic aggregate demand and supply shock in our work. The primary advantage of using sign restriction is that shocks are identified not based on zero restrictions on the contemporaneous matrix, but rather the direction of their impact on the variables in the system (which makes it less restrictive than Cholesky decomposition or long-run identification restrictions); see, for example, Arias, Caldara, and Rubio-Ramirez (2019); Mumtaz, Pinter, and Theodoridis (2018); Abdallah and Lastrapes (2013); Rubio-Ramirez, Waggoner, and Zha (2010); Scholl and Uhlig (2008); Dedola and Neri (2007); Farrant and Peersman (2006).[18] Further, the sign restrictions identification strategy eliminates any kind of puzzling responses, which are often regarded as failures in identification; see, for example, Christiano, Eichenbaum, and Evans (1999) and Uhlig (2005). Table 2 summarizes the sign restrictions used to identify the structural shocks in our model. These widely accepted restrictions are based on standard IS-LM and AD-AS models. After a negative aggregate demand shock, the response of economic activity and price is not positive, and there is not an immediate increase in the interest rate. Following a negative aggregate supply shock, economic activity does not increase and prices do not fall over a selected horizon.[19] It is important to note here that no restrictions are

[17] We estimate 13 different model specifications for the whole healthcare industry, sub-industries, and sub-sectors of those sub-industries. These sub-industries include ambulatory health care services, hospitals, and nursing and residential care facilities, as well as the sub-sectors of these sub-industries explained in Table 1. Each FAVAR model includes economic activity, price level, interest rate, and money supply in the the macro sub-system F_t; and employment in the specific healthcare sub-sector in Z_t.

[18] Mumtaz, Pinter, and Theodoridis (2018) find that structural vector autoregression (SVAR) with sign restrictions deliver the best performance, producing impulse responses that match those from the dynamic stochastic general equilibrium (DSGE) model.

[19] Farrant and Peersman (2006) argue that a restriction on interest rate to identify supply shock is not necessary. There is no strong rationale for monetary policy tightening in response to a negative supply shock. To the extent that an adverse supply shock is both recessionary and inflationary at the same time, it would not be obvious that the appropriate monetary policy response on balance would be to raise the interest rate. Therefore, we stay agnostic about the interest rate response to a negative supply

imposed on employment in the healthcare industry; we are agnostic about the variables under investigation.[20]

3. Estimation

We fit the FAVAR model (with four factors and one observable) in Equations (2)-(3) with 7 lags in first differences of the logarithm of the variables except those reported in percentages, which we use directly (interest rate).[21] We also add a constant and a time trend to Eq. (3). To identify the structural shocks, we impose the sign restrictions on $k = 2$ months (including the initial impact period of the shock). We use Bayesian methods to estimate the posterior densities of the parameters of interest, conditional on observing the sample data for the baseline model and alternatives to check for robustness of different model specification.[22] Following the sign restrictions literature, we report the median along with the 16% and 84% quantiles for the sample of impulse responses. To quantify the relative importance of the structural shocks, we also report the forecast error variance decomposition.

shock, and leave it unrestricted.

[20]Even though the sign-restriction approach has many advantages over alternative just identifying schemes and has seen widespread acceptance, it does not completely lack for criticism (Fry and Pagan, 2011; Baumeister and Hamilton, 2020). Note that we do not attempt to separately identify the specific sources of aggregate demand shocks (such as those caused by credit shocks, monetary policy shocks or housing demand shocks etc., see footnote 2). While a more refined identification strategy is interesting and feasible, this refinement is not necessary for our purpose. Ultimately, we want to study the impact of recessions on healthcare employment with an eye towards distinguishing broadly the effects caused by exogenous economy-wide negative aggregate demand shocks from exogenous economy-wide negative aggregate supply shocks, not between particular types of demand-supply shocks. Therefore, the sign restrictions approach based on standard theory of IS-LM and AD-AS models is sufficient for our purpose to identify and disentangle the structural system-wide aggregate demand and supply shocks.

[21]We follow Bernanke, Boivin, and Eliasz (2005) for choice of series and their transformations.

[22]For complete details of the algorithm refer to Rubio-Ramirez, Waggoner, and Zha (2010).
To check for robustness, we estimate our model with 12 lags and k=3,6 respectively. Our results are robust to changes in lag length.

IV. Empirical Results

IV.A. Effects of Negative Aggregate Demand Shock on the U.S. Healthcare Employment

We first consider the effects of a negative aggregate demand shock on healthcare employment. The impulse responses of the macroeconomic sub-system and the employment in the healthcare industry to a one standard deviation negative aggregate demand shock are reported in Figure 3. An "Impulse Response Function" (IRF) describes the reaction of endogenous macroeconomic variables in a VAR and FAVAR system to a macroeconomic shock. Period zero refers to the time of the shock, and the impact can be measured contemporaneously (at period zero) as well as over subsequent periods in time. Subsequent periods represent months in our paper. We plot the response of all variables from period zero (at the time of the shock) to period 96 (96 months or 8 years post the shock). This helps us gauge both the magnitude and persistence of the impact of the a shock on healthcare employment.

In response to a one standard deviation negative aggregate demand shock, economic activity declines by 0.60% on impact, and by 1% over a two month horizon before slowly increasing, and reaching its long-run normal level at the end of fifteen months. Prices fall by 1.30% over a ten month horizon, and continue to remain permanently low at 1.10%. The adverse demand shock prompts an expansionary monetary policy in the form of lower interest rates and higher money supply. Note that following an adverse demand shock, economic activity, prices, and interest rates fall, lending justification to our identification scheme discussed in Table 2, and suggesting reliability in the result for healthcare employment.

The main focus of our paper is the response of healthcare employment to this adverse demand shock. We find that a one standard deviation negative aggregate demand shock in the U.S. economy leads to a significant and fairly permanent decline in healthcare employment by 1.50%. Overall healthcare employment responds procyclically during a

recession caused by a negative aggregate demand shock. We further explore the mechanism behind this procyclical response. The gist of our analysis is that a drop in healthcare demand, measured by real personal healthcare expenditures, leads to a drop in employment. We will return to our discussion of the mechanism in Section IV.C.

We now turn to the employment responses in different healthcare sub-industries to the negative aggregate demand shock (Figure 4). These sub-industries include ambulatory health care services, hospitals, and nursing and residential care facilities, as well as the sub-sectors of these industries reported in Table 1. There is substantial heterogeneity in the employment responses across these healthcare sub-industries as well as different sub-sectors. An interesting observation is that not all sub-sectors respond negatively to the adverse demand shock. While most sub-sectors of these three healthcare sub-industries witness a drop in employment in the short run, some also witness an increase in employment. Specifically, in our quest for identifying heterogeneous effects across sub-sectors, a striking pattern emerges in sectors that predominantly hire nurses such as home healthcare services, outpatient care centers, and nursing care facilities. We carefully examine later why employment responses are different in these nursing driven sectors, but before doing so we provide an overview of our benchmark findings.

Ambulatory Healthcare Services We find an overall null response of employment to the negative demand shock in ambulatory healthcare services. This is owing to the procyclical response of employment in physicians' and dentists' offices jointly with a countercyclical response of employment in home healthcare services. Specifically, employment declines significantly by 1.50% in physicians' offices and 0.40% in dentists' offices in the long run. In contrast, employment increases significantly by 1.75% in home healthcare services in the long run. We also observe an initial decline followed by a quick and strong recovery of employment in outpatient care centers.

Hospitals Hospitals within the healthcare industry experience the largest decline in employment following the adverse demand shock. Employment declines significantly

and permanently by 2% in hospital sector as well as general medical and surgical hospitals. Strikingly, and in contrast to general medical and surgical hospitals, psychiatric and substance abuse hospitals experience a slight increase in employment following the adverse demand shock, although the response is largely insignificant. This is consistent with the literature showing that mental health and addiction problems as well as drug-related emergency room visits and deaths increase during economic downturns (Carpenter, McClellan, and Rees, 2017; Hollingsworth, Ruhm, and Simon, 2017; Tefft, 2011; Bradford and Lastrapes, 2014). Therefore, we do not necessarily observe a procyclical employment response in psychiatric and substance abuse hospitals since these are special cases where decrease in the demand for healthcare services appears to be limited when economic conditions worsen.

Nursing and Residential Care Facilities We show that employment increases on impact and eventually returns to its long run normal levels in nursing and residential care facilities. The countercyclical response of employment in this aggregate sector is largely driven by the staffing increase in nursing care facilities. Analyzing the sub-sectors, we find that nursing care facilities respond countercyclically to recessions caused by an adverse demand shock, recording a 0.50% rise in employment in the long run.

This response in nursing care facilities is not unique to an adverse demand shock. We show later that a similar response also emerges in the case of an adverse supply shock. Other residential care facilities, on the other hand, respond procyclically and reduce employment in response to the negative aggregate demand shock.

Taken together, our findings show that first, there is a significant and permanent decline in employment pertaining to aggregate healthcare industry during recessions caused by a negative aggregate demand shock. Aggregate healthcare employment is strongly procyclical during recessions caused by a negative demand shock (Figure 3). Second, there is strong heterogeneity in the employment responses faced by different healthcare subindustries (ambulatory healthcare services, hospitals, and nursing and residential care facilities as well as sub-sectors of those industries) in terms of the magnitude, direction,

as well as the persistence of the impact. In particular, general medical and surgical hospitals experience by far the largest decline in employment and the decline is significant and permanent, followed by the decline in other residential care facilities, as well as physicians' offices. In contrast, home healthcare services, outpatient care centers, psychiatric and substance abuse hospitals, and nursing care facilities respond countercyclically to recessions caused by the adverse demand shock.

IV.B. Effects of Negative Aggregate Supply Shock on the U.S. Healthcare Employment

We next analyze how healthcare employment responds to a negative aggregate supply shock. The impulse responses of the macroeconomic sub-system and employment in the healthcare industry to a one standard deviation negative aggregate supply shock are reported in Figure 5. In response to a one standard deviation adverse supply shock, economic activity declines by 0.60% in the long run. Prices increase significantly, reaching a peak impact of 1% over a five month horizon, and 0.80% permanently. Note that the response of economic activity and prices to the negative aggregate supply shock is consistent with standard macroeconomic theory and the sign restrictions identification strategy employed in Table 2, suggesting that the supply shock has been plausibly identified.

We find evidence of expansionary monetary policy in the form of an increase in money supply to stabilize some of the recessionary effects of the adverse supply shock. Perhaps more importantly, we do not find evidence that the Federal Reserve tightens monetary policy in response to an unexpected supply disruption, thus subsequently amplifying recessions (Kilian and Lewis, 2011). Finally, our primary interest is the response of employment in the healthcare industry to the adverse supply shock. We find that in response to a one standard deviation negative aggregate supply shock, employment in the healthcare industry remains fairly stable, albeit these results are largely insignificant throughout.

We next examine why the aggregate employment response in healthcare industry shows a null (or very small boom-bust) response to a negative aggregate supply

shock. We do so by investigating the employment responses in different healthcare sub-industries to the negative supply shock. In Figure 6, we observe strong heterogeneity in the employment responses faced by the three major healthcare sub-industries and different sub-sectors. Similar to our previous findings, most sub-sectors show a procyclical employment response, except home healthcare and nursing care facilities that show a countercyclical employment response to the negative aggregate supply shock.

Ambulatory Healthcare Services In response to the adverse supply shock, employment remains stable in overall ambulatory healthcare services, however the response is insignificant throughout. Following the adverse supply shock, we find evidence of a decline in employment in all sub-sectors of ambulatory healthcare services, except home healthcare services. Home healthcare services need a particular mention as this sector experiences a significant and permanent increase in employment to both negative demand and supply shocks. It is important to highlight that home healthcare services is a nursing dominant sub-sector, which exhibits a consistent employment pattern throughout our analysis. For instance, existing studies show that immigrants are likely to be employed in this sub-sector as nursing aides (Lowell and Gerova, 2004).

Hospitals In response to the negative aggregate supply shock, employment goes down by 0.50% in hospitals as well as general medical and surgical hospitals in the long run. We find that employment responses to negative aggregate demand and supply shocks in overall hospitals as well as general medical and surgical hospitals are qualitatively similar. We further show that the response of employment to the negative aggregate supply shock is fairly stable in psychiatric and substance abuse hospitals, which is also consistent with our previous analysis showing that the employment response is not procyclical in this sub-sector.

Nursing and Residential Care Facilities The estimated effects suggest a significant and permanent increase in employment in nursing and residential care facilities in re-

sponse to the negative aggregate supply shock. Employment in nursing care facilities increases by 0.30% in the long run, driving much of the increase in employment in overall nursing and residential care facilities. In contrast to nursing care facilities, employment in other residential care facilities falls by 0.35% in the long run.

Similar to those found for the negative demand shock, we conclude that employment is procyclical for most healthcare sub-industries, but countercyclical for home healthcare services and nursing care facilities. Because the procyclical employment response of the sub sectors and countercyclical employment response of nursing dominant sectors are both weaker during recessions caused by a negative aggregate supply shock than a demand shock, so on average for the aggregate healthcare sector we observe a very small or null employment response in case of a negative aggregate supply shock (i.e, the procyclical response of the sub-sectors balance out the countercyclical response of nursing dominant sectors in case of a negative aggregate supply shock). In sum, employment in aggregate healthcare industry does not change much during recessions caused by a negative supply shock. Our findings reiterate the importance of taking into account the heterogeneous employment responses with respect to different types of shocks.

IV.C. Establishing Mechanisms

An important yet unanswered question so far is what mechanisms are driving these employment responses during recessions caused by the adverse demand and supply shock? We investigate *a priori* hypothesis in the health economics literature that the reductions in demand for healthcare during economic downturns could be limited (Dillender et al., 2021). The main reasoning is that although individuals may lose access to private insurance coverage during recessions, public health insurance (e.g., Medicaid or Medicare) or other alternative forms of insurance coverage such as subsidized health insurance may weaken the linkages between personal financial constraints and the demand for healthcare.

On the one hand, the strand of literature analyzing healthcare utilization during economic downturns is relatively underdeveloped and the findings are largely mixed (McIn-

erney and Mellor, 2012; Peng, Chen, and Guo, 2022). On the other hand, there is a vast literature exploring the relationship between business cycles and health outcomes. In fact, a large number of studies report a procyclical pattern in health and health behaviors during recessions, particularly mortality (Ruhm, 2000; Stevens et al., 2015), drinking (Ruhm and Black, 2002; Ruhm, 2005; Cotti, Dunn, and Tefft, 2015), and other health-compromising behaviors (Ásgeirsdóttir et al., 2016), which in turn can yield procyclical patterns in healthcare utilization.[23]

Taking these into account, we find it natural to investigate how personal consumption expenditures (PCE) for health respond during economic downturns. If individuals increase demand for healthcare during economic downturns, there could be a countercyclical response (or an increase) of personal health expenditures. We explain below in detail that we do not find supporting evidence for this hypothesis, rather we find reductions in healthcare expenditures resulting from recessions, which serve as a potential mechanism through which overall healthcare employment declines.[24]

Negative Aggregate Demand Shock: Falling personal financial resources during an economic downturn would be expected to reduce demand for formal healthcare and healthcare employment. As discussed above, however, Medicaid and other forms of public insurance could dampen the effects of private insurance loss that accompanies unemployment, which could partially mitigate reductions in demand for formal healthcare. For that reason, one might be tempted to claim that the reductions in demand for formal healthcare would be limited during economic downturns because of access to public health insurance. This claim would be premature mainly because it does not take into considera-

[23]The literature shows that these findings can be sensitive to the level of geographic aggregation, as well as socioeconomic and demographic characteristics of the sub-population, and further that the procyclical response of mortality become smaller and statistically insignificant over time (Charles and DeCicca, 2008; Lindo, 2015; Tekin, McClellan, and Minyard, 2018; Ruhm, 2015).

[24]We are only able to study the response of real personal consumption healthcare expenditures (PCE) for the aggregate healthcare industry. Due to unavailability of time series data at a monthly frequency, we cannot test the patterns of healthcare expenditures for individual sub-industries during recessions. While it is possible that healthcare demand and expenditures in certain sub-industries exhibit countercyclical behavior, it may not necessarily be significant enough to have a large effect. Our results show that for the aggregate healthcare industry healthcare expenditures behave procyclically during recessions. Further, note that hospitals and physician services which constitute the largest share of healthcare expenditures exhibit procyclical employment behavior during recessions.

tion the potential substitution of informal care for formal care during economic downturns (which can play a significant role in reducing demand for formal healthcare). Moreover, aside from its implications on demand for care, Aslim (2022) shows that access to public health insurance also reduces full-time employment, particularly among females through income effect.

We study if changes in healthcare utilization can act as a potential mechanism to explain the decline in healthcare employment. To investigate this mechanism, we employ a basic exercise in which we proxy real personal healthcare expenditures for healthcare demand and re-run the FAVAR model. We report our findings in Figure 7. In response to a one standard deviation negative aggregate demand shock, personal healthcare expenditures decline by 0.50% over a 0-24 month horizon, leading to a significant decline in healthcare employment by 1.50% in the long run. Our results provide supporting evidence that the decline in healthcare demand during such recessions is contributing to the decline in healthcare employment. Our mechanism complements the findings in the literature that economic downturns may be associated with increases in the availability of informal care and declines in revenues in the healthcare sector (Costa-Font, Karlsson, and Øien, 2016; Konetzka et al., 2018).

Negative Aggregate Supply Shock: Figure 8 presents the impulse responses of personal healthcare expenditures as well as healthcare employment to a one standard deviation negative aggregate supply shock. Consistent with previous findings, personal healthcare expenditures drop by 0.50% in the long run. This indicates that demand for healthcare goes down during supply-induced recessions as well. Still we observe that overall healthcare employment does not go down during supply-induced recessions. A natural question is why? This is because while employment in most sub-industries of the healthcare sector is going down (which could potentially be explained by a drop in their healthcare utilization), that in home healthcare and nursing care facilities is going up. The countercyclical response of nursing dominant sectors appears to be balancing out the procyclical response of other sub-sectors during recession caused by the supply

shock, leading to an overall null (or small) response of aggregate healthcare employment on average.

Interestingly, another pattern we observe in our results is that the employment response of the healthcare sub-sectors to a negative aggregate supply shock (which is inflationary in nature) is relatively smaller compared to a negative aggregate demand shock. One potential reason could be that our sample period (1990-2019) largely witnessed recessions caused by negative aggregate demand shocks.[25] However, we do provide additional potential explanations from the macro-labor literature as to why employment responses might be different across shocks.[26]

A potential explanation relates to elevated inflationary pressures stemming from negative aggregate supply shocks which can impact labor demand and labor supply choices respectively. Negative aggregate supply shocks can lead to future increases in hiring costs when the recession is over and the economy enters the expansionary phase of the business cycle (during which healthcare workers have alternative job options).[27] An increase in hiring and labor costs during upswings may potentially dampen the procyclical response of employment during recessions (or downswings) caused by a negative supply shock, i.e., firms putting more weight on future profits may tend to show evidence of labor hoarding during these types of economic downturns (Burnside, Eichenbaum, and Rebelo, 1993; Guerrieri et al., 2020).[28] Our findings seem

[25]Our sample period (1990-2019) witnessed more negative aggregate demand shocks. Therefore, the magnitude of one standard deviation negative aggregate demand shock can be different from one standard deviation negative aggregate supply shock over our sample period. So for comparison purpose, we additionally check the degree of responsiveness of change in employment to change in economic activity following a one standard deviation shock in each case $\left(\frac{\Delta Healthcare\ Employment}{\Delta Economic\ Activity}\right)$. We find that the degree of sensitivity of change in employment to change in economic activity (or elasticity) is higher for a negative aggregate demand shock.

[26]It is worth noting that although VAR and FAVAR models are a reduced form approach and are valuable in establishing a general set of facts about the relevant data and the overall impact, it does not enable us to formalize all specific channels and transmission mechanisms. A richer calibrated job search and match model with labor market frictions could provide a more precise understanding of the transmission mechanisms during different types macroeconomic shocks; see, for example, Uhlig (2004); Mandelman and Zanetti (2014). However, this is beyond the scope of our current paper and forms a novel avenue of future research.

[27]During upswings, the tightening of labor market pulls workers out of their matches increasing quits. Quits trigger vacancies, which in turn beget other vacancies through replacement hiring (Faberman, 2009; Mercan and Schoefer, 2020; Domash and Summers, 2022).

[28]Features of labor hoarding can also be prevalent during recession caused by a negative aggregate demand shock, though cost pressures get more amplified during a negative aggregate supply shock, which might make labor hoarding more salient during a supply-driven recession.

consistent with this theory. Specifically, we find that most sub-sectors of the healthcare sub-industries witness a smaller decline in employment during a negative aggregate supply shock compared to a negative aggregate demand shock, providing supporting evidence of some labor hoarding during an adverse supply shock.

Nursing Dominant Sectors A unique finding of our study is that employment in nursing care facilities (a sub-sector of nursing and residential care facilities) or other nursing dominant sectors such as home healthcare services experience an increase in employment following economic downturns caused by both the negative aggregate demand and supply shock. This could be attributed to several factors, some of which we already discuss above (e.g., labor hoarding or precautionary supply of labor input). We nonetheless expound on potential reasons behind the countercyclical employment response of nursing dominant sectors from the health economics and nursing literature.

Because of the unattractive work environment, compensation, and benefits offered by nursing homes, the staffing in nursing homes is likely to be sensitive to economic expansions and recessions (Scanlon, 2001; Huang and Bowblis, 2019). Skilled nurses such as RNs (registered nurses) are often paid lower wages in nursing homes than other health care setting (Antwi and Bowblis, 2018). CNAs (certified nursing assistants) are often paid wages comparable to similar skill-level jobs in retail and tourism where the jobs do not require additional emotional and physical strains of caring for individuals that need around-the-clock care (Wunderlich, Sloan, and Davis, 1996). But during recessions when the labor market deteriorates and these alternative jobs are limited, working at a nursing home may become a more attractive option than it would during economic expansions. Further, many nurses and nurse aides are secondary wage earners and may be more likely to enter the labor force during a recession or when the primary wage earner in a household loses a job, triggering an *added worker effect* during recessions (Konetzka et al., 2018; Buerhaus and Auerbach, 2011; William, 2006; Yamada, 2002). Using data primarily from California, Konetzka et al. (2018) document that when unemployment rates rise, higher paid registered nurses (RNs) are replaced with licensed practical nurses

(LPNs) in nursing homes.

Another strand of literature argues that financial resources and revenues of nursing homes may decline during recessions, although it may not be significant enough to have a large effect on staffing (Konetzka et al., 2018; Bowblis, 2011). First, many states have minimum nursing staff requirements and nursing homes may not be able to reduce overall staffing levels (Bowblis, 2011). Second, nursing homes may not need to increase wages or offer additional benefits to attract workers during a recession, offsetting some of the revenue declines. Taken together, this implies that the business cycle is likely to affect the ability of nursing care facilities to retain and hire employees with the net effect of a recession resulting in higher nursing staff levels, lower turnover, and better retention of existing employees.

In essence, the financial burden of hiring and maintaining a skilled workforce in nursing sector has become an increasing challenge. Recent literature argues that without sufficient increases in Medicaid and Medicare reimbursement rates, it will be difficult for nursing homes to employ and maintain a capable and stable workforce especially when labor costs rise during economic expansions.[29]

IV.D. Comparison: Pre- and Post-COVID-19 Period

In our benchmark analysis, we find that both negative aggregate demand and supply shocks lead to a decline in healthcare employment in all the sub-sectors, except nursing care facilities and home healthcare facilities. An important question is what happens to our results if we extend our analysis to also include the COVID-19 period. To answer this, we conduct our study by extending our sample period to 2021 (including data for the periods 1990-2021). The full set of IRFs is reported in Appendix Figures A1-A6.

Figure 9 compares the impulse responses from FAVAR model over the extended COVID-19 period (1990-2021) versus the benchmark period (1990-2019) to a one standard deviation negative aggregate demand shock. Consistent with our benchmark period, we find that employment in aggregate healthcare industry and sub-industries is procycli-

[29]This challenge is only going to exacerbate further by policy initiatives such as increase in minimum wages.

cal and responds negatively to the negative aggregate demand shock over the extended COVID-19 period, although the negative responses are relatively weaker compared to our baseline results. We further explore whether countercyclical employment responses in nursing care facilities, outpatient care centers, home healthcare, as well as psychiatric and substance abuse hospitals to an adverse demand shock persist over the extended COVID-19 period. The answer is affirmative. We do find that this countercyclical response of employment in these sub-sectors is robust to changes in sample period.[30]

Figure 10 provides a similar analysis comparing the employment responses between the extended COVID-19 period and the benchmark period to a one standard deviation negative aggregate supply shock. Compared to our baseline finding of an average null (or small boom-bust) healthcare employment response, the extended COVID-19 period experiences a stronger positive aggregate healthcare employment response to the negative supply shock. In contrast to our benchmark findings, the healthcare sub-industries and their sub-sectors: ambulatory healthcare services, hospitals, and nursing and residential care facilities all respond positively to the negative aggregate supply shock. In Figure A4, most of these sub-sectors experience a strong initial spike in employment and subsequent smoothing.

IV.E. How Important are Demand and Supply Shocks in Explaining Healthcare Employment?

In this section, we consider the extent to which macroeconomic shocks can account for labor market dynamics in the U.S. healthcare industry. That is, we now turn to the question of assessing the quantitative importance of this relationship, whereas the previous sections focus on characterizing whether macroeconomic shocks affect the employment in the healthcare industry and sub-industries. Variance decomposition report what fraction of the movement in the variables can be accounted for by the structural shocks. If a shock explains a large fraction of the variation in a reported variable, then the shock is an important driver of movements in the variable. This measure provides one metric of the

[30] We do note a lag in the countercyclical employment response though in nursing care facilities.

extent to which demand and supply shocks are quantitatively important in driving labor market dynamics in the healthcare industry. Table 3 reports the variance decomposition results for employment in the healthcare industry and sub-industries to the structural demand and supply shock. We first discuss the variance decomposition results for demand shocks followed by supply shocks.

Demand shocks explain up to 11% of the movement in the U.S. healthcare employment, up to 20% of the variation in hospital employment and up to 19% of the variation in office of physicians over a 5-year horizon. Further, we note that demand shocks account for 12-16% of the variation in employment in nursing care facilities and other residential care facilities over a 5-year horizon, suggesting that these shocks play a non-trivial role in accounting for movements in healthcare employment. The forecast error variance decomposition suggests that the contribution of demand shocks to fluctuations in healthcare employment is of a similar order of magnitude as the contribution of these shocks to other macroeconomic factors such as economic activity and inflation, indicating that these shocks are important and should be taken into account by policymakers.[31]

Supply shocks, on the other hand, explain only about 2-3% of the movement in overall U.S. healthcare employment over a 5-year horizon. Additionally, supply shocks account for about 7-8% of the employment movement in outpatient care centers, and about 5% in nursing care facilities and other residential care facilities over a 5-year horizon. Our variance decomposition results show that aggregate supply shocks explain a lower fraction of variation in healthcare employment compared to aggregate demand shocks, indicating that aggregate demand shocks are more important drivers of healthcare employment.

V. Conclusion

In this paper, we attempt to answer an important yet untapped question in the literature of business cycles and healthcare employment: how do recessions affect U.S. healthcare employment? We study the impact of recessions on U.S. healthcare employment caused by

[31] To save space, the full set of variance decomposition results (i.e., for economic activity, price, money supply, and interest rate) are not reported here, but can be made available upon request.

two fundamental sources of business cycle fluctuations: an aggregate demand shock and an aggregate supply shock. We utilize a factor augmented vector autoregression framework with 131 macroeconomic variables from 1990:01 to 2019:12, and sign restrictions to conduct our study. Our methodological framework allows us to explicitly distinguish the effects of a negative aggregate demand shock from a negative aggregate supply shock, when examining the impact of recession on healthcare employment.

We find that employment in aggregate healthcare industry is procyclical and declines significantly in response to recessions caused by a negative aggregate demand shock. Additionally, we find strong heterogeneity in employment responses across different healthcare sub-sectors. In particular, general medical and surgical hospitals experience the largest decline in employment followed by physicians' offices. Home healthcare, outpatient care centers and nursing care facilities, on the other hand, experience an increase in employment in response to the negative aggregate demand shock.

Next, we find that employment in the aggregate healthcare industry shows little or null response during economic downturns caused by a negative aggregate supply shock. While most sub-sectors witness a decline in employment in response to the negative supply shock, nursing dominant sectors (home health care and nursing care facilities) experience an increase in employment contributing to the stable response of overall aggregate healthcare employment during a supply-induced recession. Specifically, we do find that the healthcare sector enjoys some insulation from supply-induced recessions, which complements prior studies.

Finally, aggregate demand shocks account for a significant fraction of the variation in healthcare employment and are more important drivers of healthcare employment relative to aggregate supply shocks. From a broader perspective, the novelty of our paper is that we provide new robust evidence that U.S. healthcare employment in general is *not* recession proof. This is a novel finding in the literature of business cycles and healthcare employment, and comprise the primary contribution of our study.

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Table 1. Selected Sub-Sectors of Healthcare Services

Healthcare Services		
Ambulatory Health Care Services	Hospitals	Nursing and Residential Care Facilities
Offices of physicians (NAICS 6211)	General medical and surgical hospitals (NAICS 6221)	Nursing care facilities (NAICS 6231)
Offices of dentists (NAICS 6212)	Psychiatric and substance abuse hospitals (NAICS 6222)	Other residential care facilities (NAICS 6239)
Outpatient care centers (NAICS 6214)		
Home health care services (NAICS 6216)		
Offices of other health practitioners (NAICS 6213)		

Notes: The sub-sectors that do not have available monthly data from 1990 to 2021 are excluded from the analysis. These sub-sectors are as follows: offices of other health practitioners (NAICS 6213), specialty hospitals, except psychiatric and substance abuse (NAICS 6223), residential mental retardation, mental health and substance abuse facilities (NAICS 6232), and community care facilities for the elderly (NAICS 6233).

Table 2. Sign Restrictions

Structural Shocks	Economic Activity (factor)	Price Level (factor)	Interest Rate (factor)	Money supply (factor)	Employment Healthcare (observable)
Negative Aggregate Demand Shock	≤ 0	≤ 0	≤ 0	?	?
Negative Aggregate Supply Shock	≤ 0	≥ 0	?	?	?

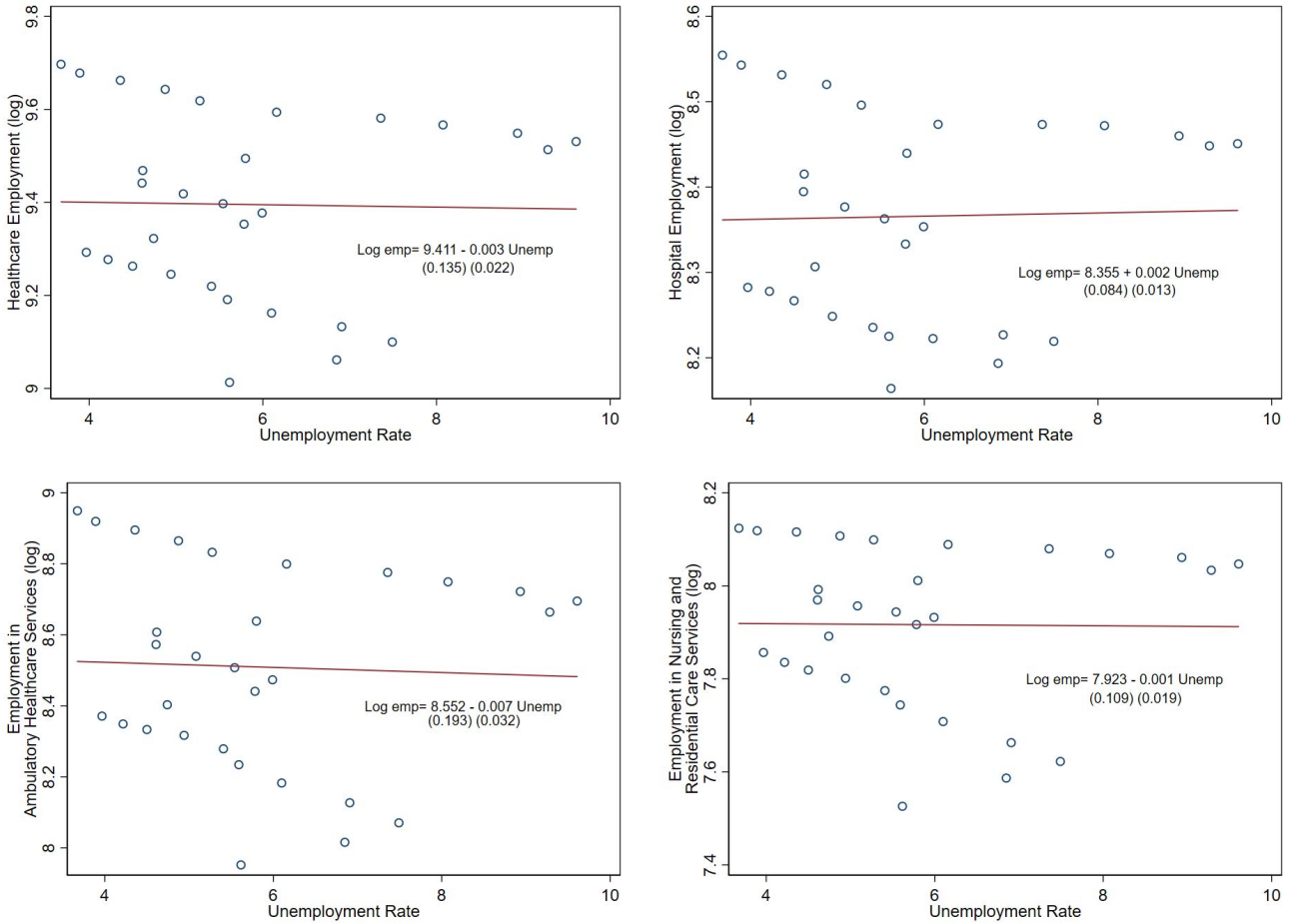
Notes: This table summarizes the sign restrictions used to identify the structural macroeconomic demand and supply shock. The time period over which we impose sign restrictions to identify the structural shocks is $k = 2$ months, including the impact period of the shock. Note that no restrictions are imposed on employment in the healthcare industry; here we are agnostic about the variables under investigation.

Table 3. K-step ahead forecast error variance that can be explained by the structural shocks (in %)

Factors/Observables	Demand Shock	Supply Shock
Healthcare	10.57	2.44
Ambulatory Health Care	3.15	2.63
Home Health Care	8.02	2.42
Offices of Dentists	6.83	2.31
Offices of Other Health Practitioners	3.43	2.85
Offices of Physicians	19.34	3.49
Outpatient Care Centers	6.20	7.55
Hospitals	20.34	4.14
General Medical and Surgical Hospitals	18.93	3.79
Psychiatric and Substance Abuse Hospitals	3.63	1.91
Nursing and Residential Care Facilities	8.18	3.24
Nursing Care Facilities	11.87	4.57
Other Residential Care Facilities	15.66	4.76

Notes: The numbers show the median estimates of the K-step ahead (5 year) forecast error variance decomposition of the observables/factors explained by the two structural shocks from our model using sign restrictions.

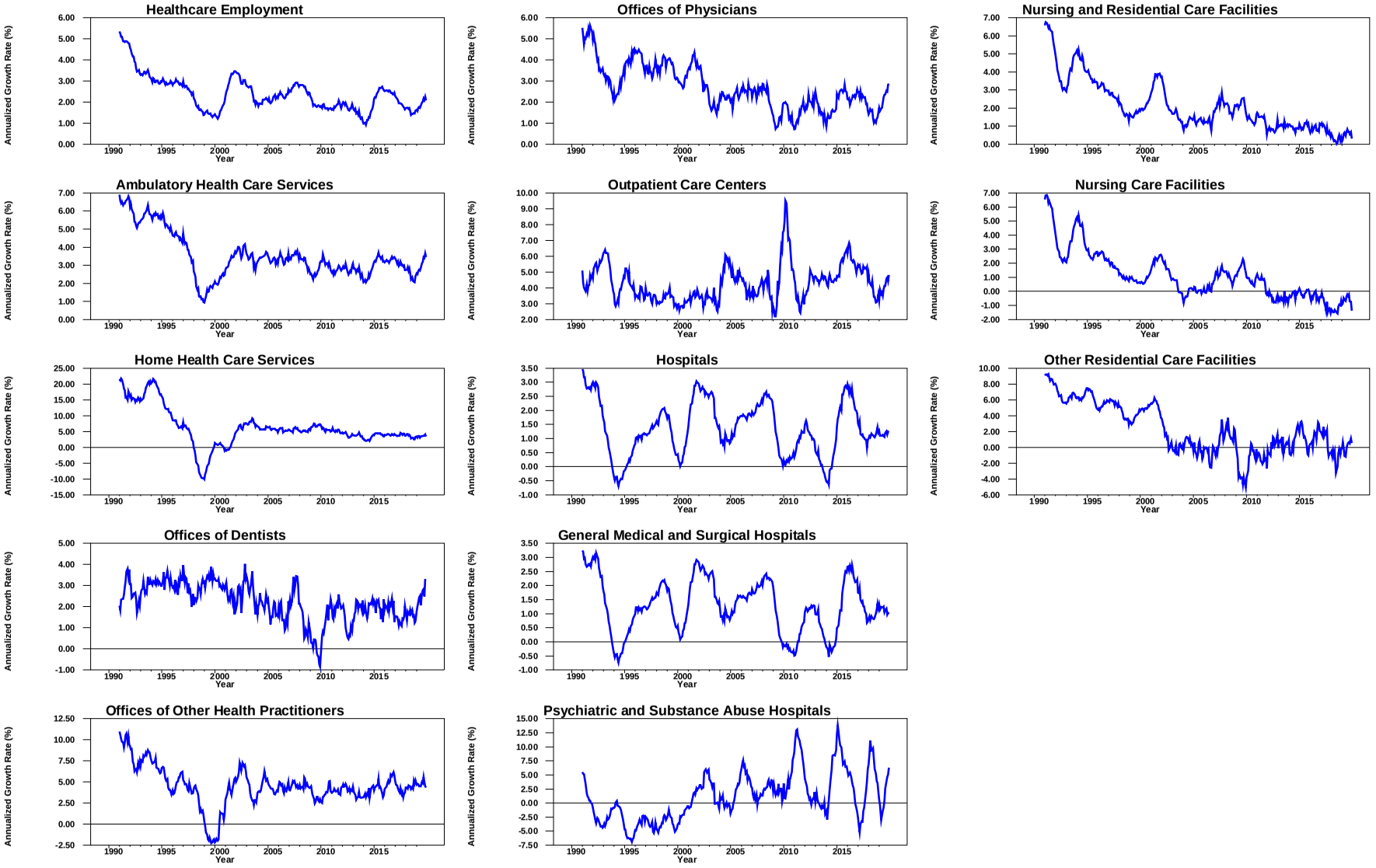
Figure 1. The Relationship Between the Unemployment Rate and Employment in Healthcare Sectors, 1990-2019



Notes: This figure presents the relationship between the unemployment rate and the log of employment in selected healthcare sectors. Circles represent the mean unemployment rate and employment in healthcare sectors from 1990-2019 in the U.S. The red lines are linearly fitted lines. Robust standard errors are in parentheses.

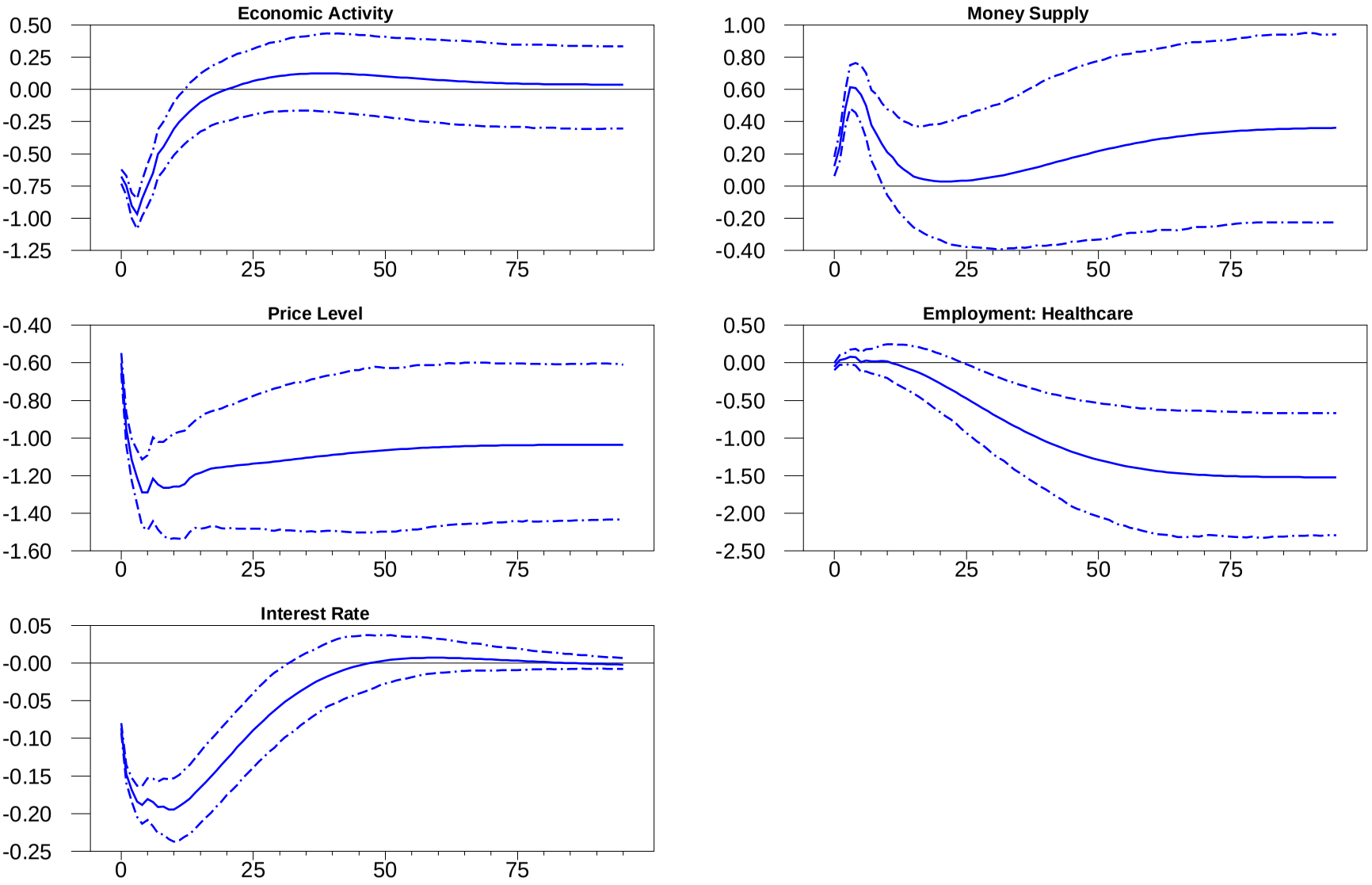
Data Sources: Current Employment Statistics from the U.S. Bureau of Labor Statistics and Federal Reserve Economic Database (FRED) of the St. Louis Fed.

Figure 2. Annualized Growth Rate of Employment in the US Healthcare Industry, 1990-2019



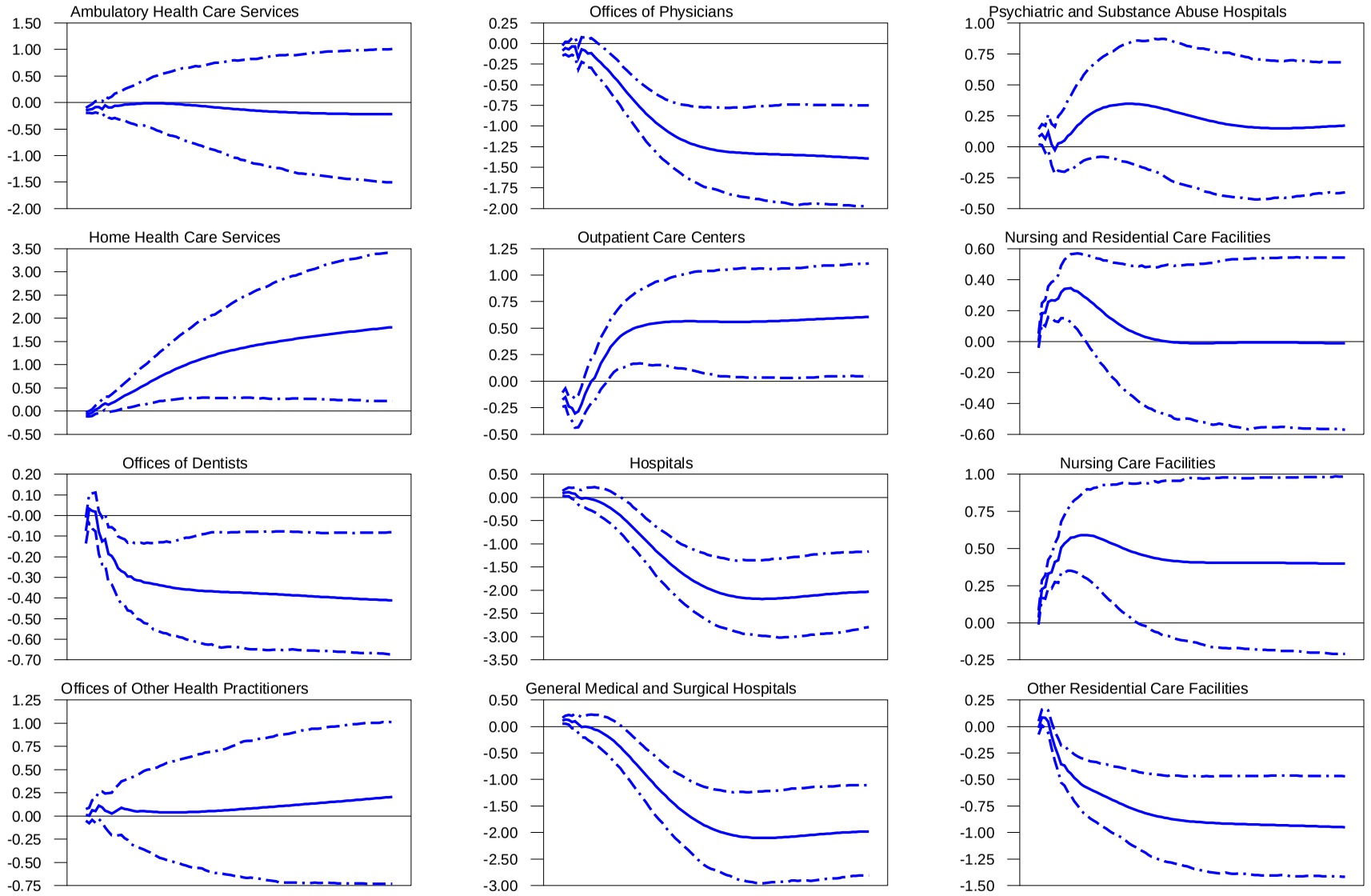
Notes: This figure presents the annualized growth rate of employment in U.S. healthcare sectors over our sample period, 1990-2019.

Figure 3. IRFs of Healthcare Employment to Negative Demand Shock



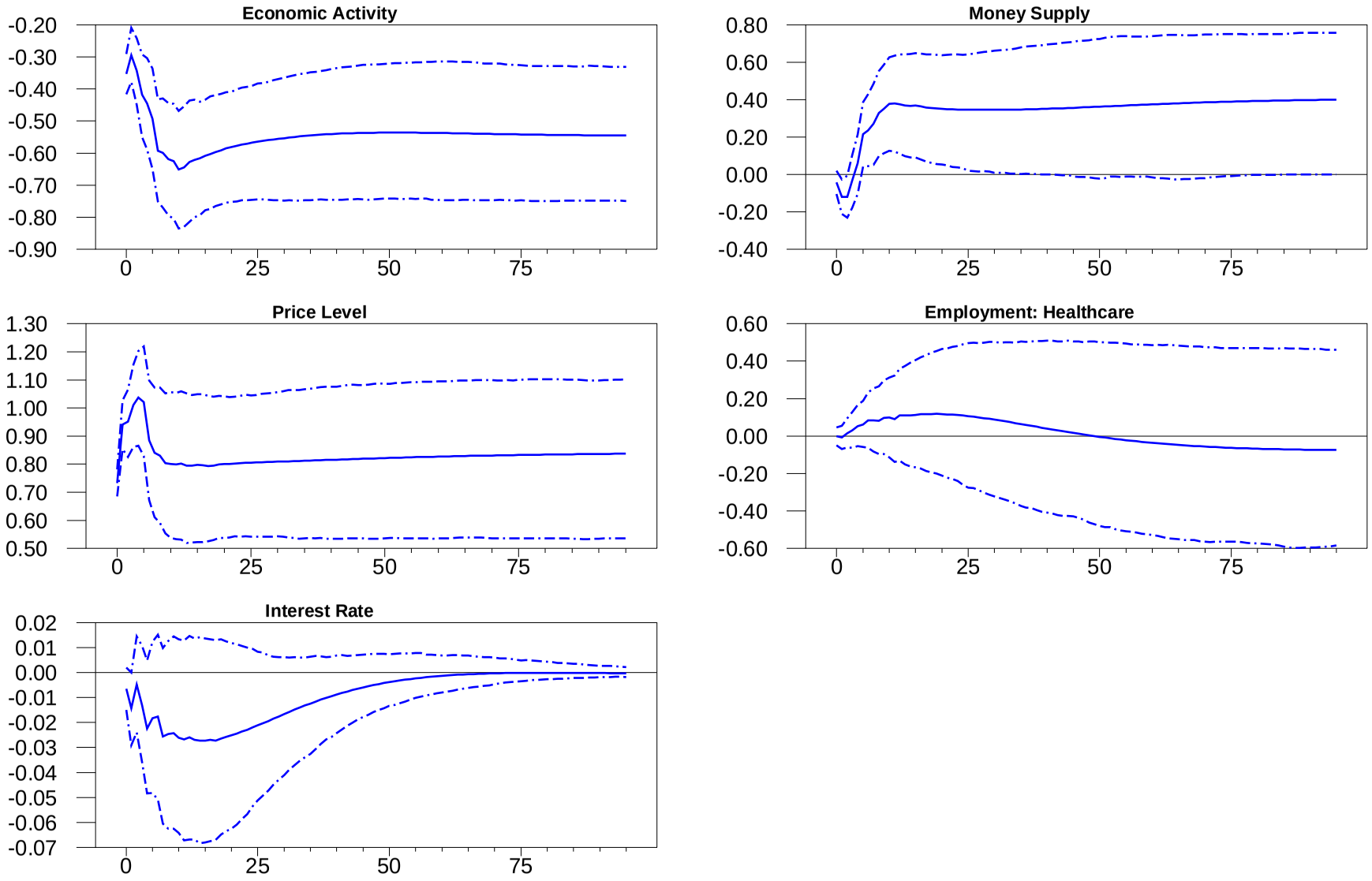
Notes: This figure presents the accumulated impulse responses of the variables/factors to a one standard deviation negative aggregate demand shock using sign restrictions. The sample period is 1990-2019. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 4. Differential Response of Employment in Healthcare Industry to Negative Demand Shock



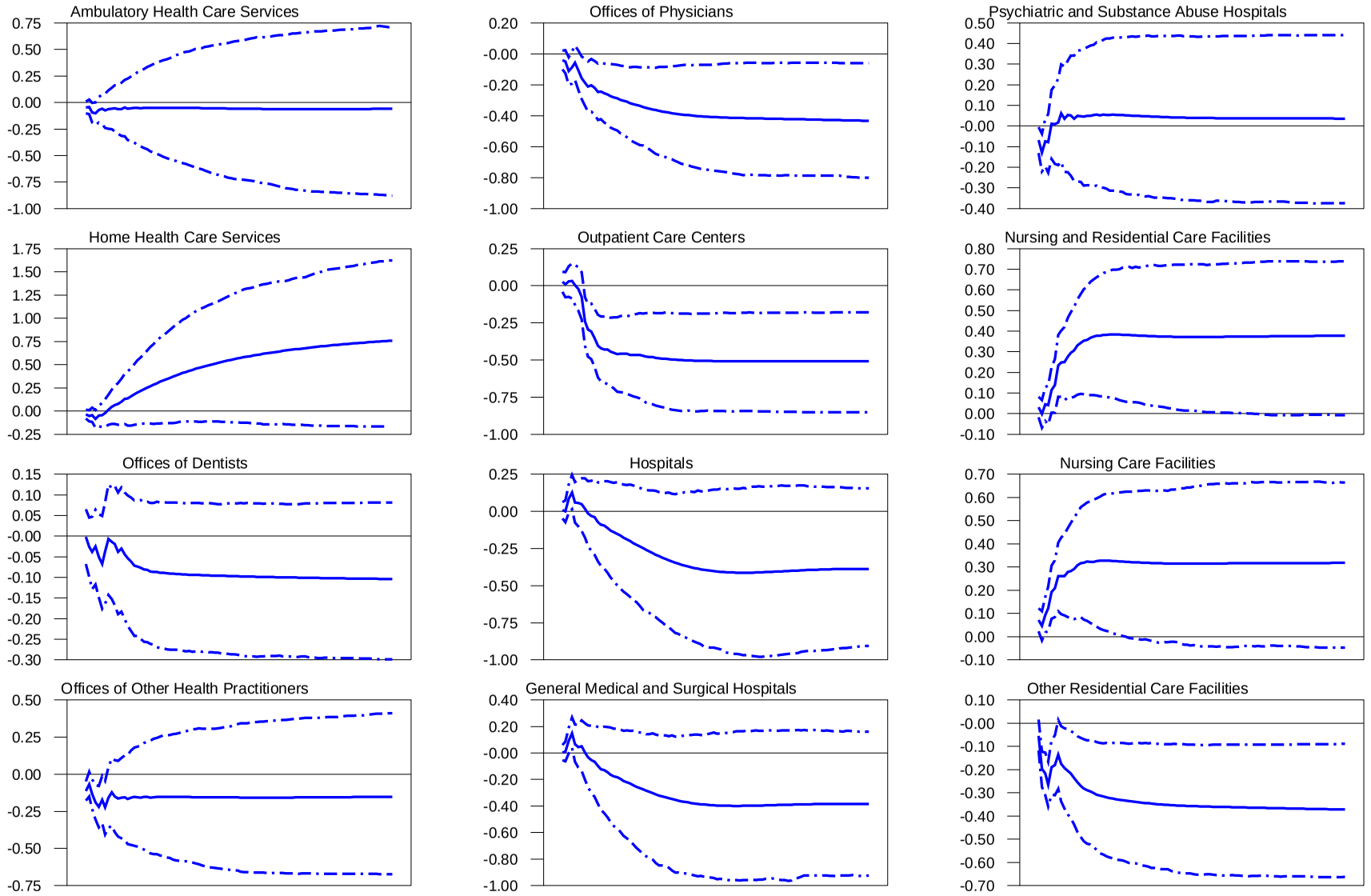
Notes: This figure presents the accumulated impulse responses of employment in the different healthcare sectors to a one standard deviation negative aggregate demand shock using sign restrictions. The sample period is 1990-2019. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 5. IRFs of Healthcare Employment to Negative Supply Shock



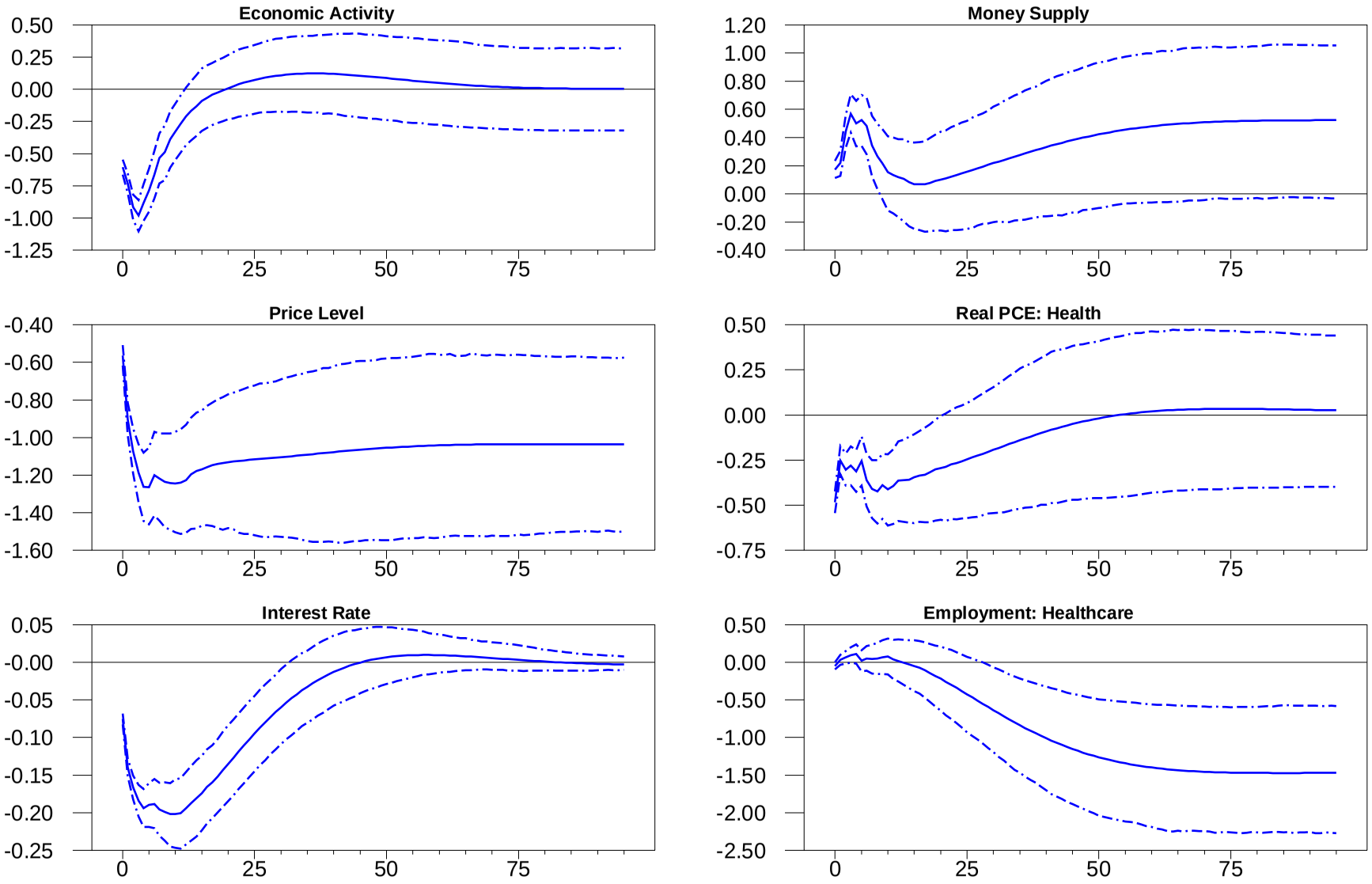
Notes: This figure presents the accumulated impulse responses of variables/factors to a one standard deviation negative aggregate supply shock using sign restrictions. The sample period is 1990-2019. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 6. Differential Response of Employment in Healthcare Industry to Negative Supply Shock



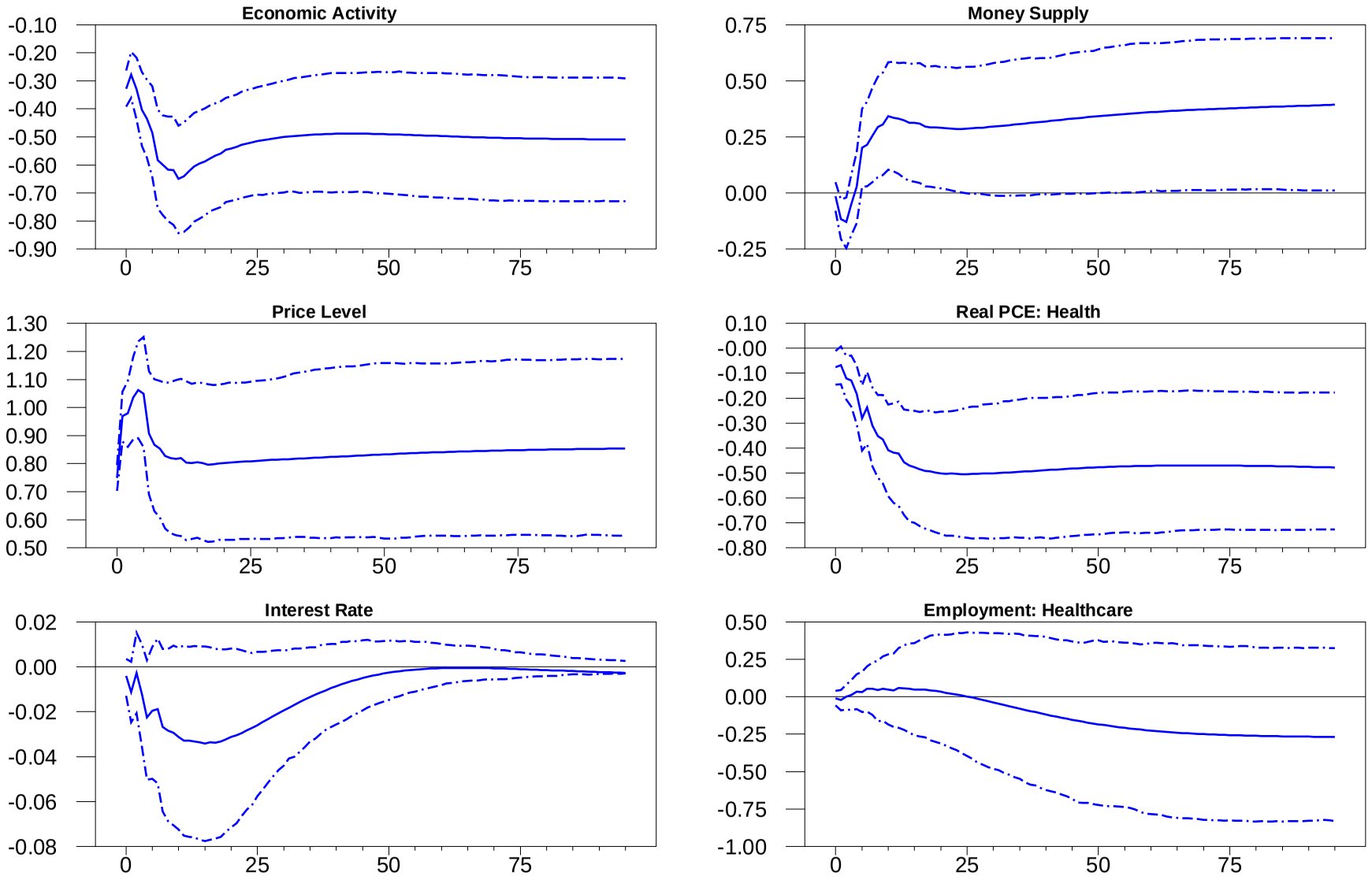
Notes: This figure presents the accumulated impulse responses of employment in the different healthcare sectors to a one standard deviation negative aggregate supply shock using sign restrictions. The sample period is 1990-2019. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 7. Mechanism: Negative Demand Shock and Personal Healthcare Expenditures



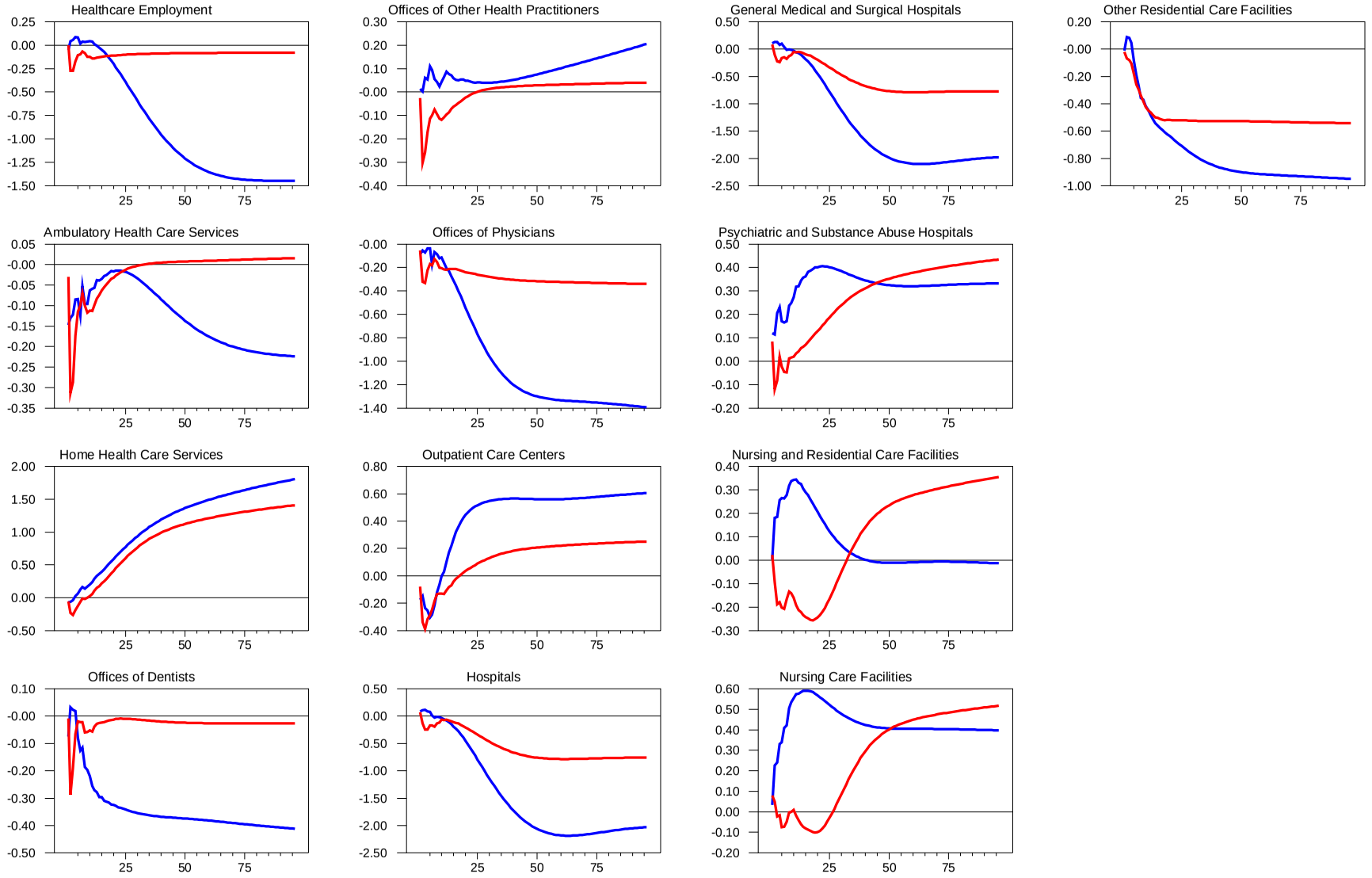
Notes: This figure presents the accumulated impulse responses of the variables/factors to a one standard deviation negative aggregate demand shock using sign restrictions. The sample period is 1990-2019. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 8. Mechanism: Negative Supply Shock and Personal Healthcare Expenditures



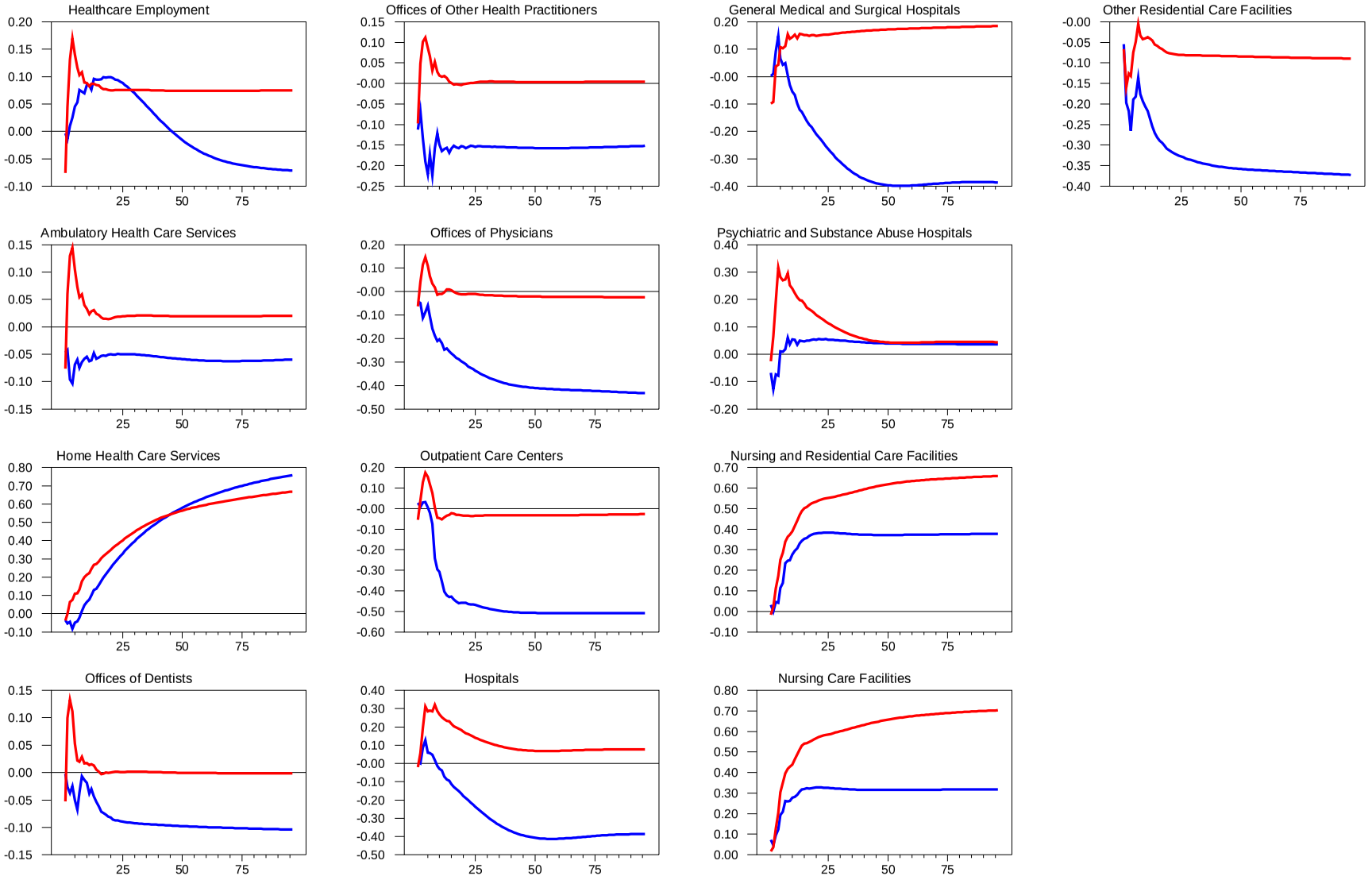
Notes: This figure presents the accumulated impulse responses of the variables/factors to a one standard deviation negative aggregate supply shock using sign restrictions. The sample period is 1990-2019. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 9. Responses of Healthcare Employment to Negative Demand Shock: 1990-2019 vs. 1990-2021



Notes: This figure compares the differential responses of employment in healthcare industry to a one standard deviation negative aggregate demand shock using data over two sample periods: 1990-2019 vs. 1990-2021. The red line reports the responses using 1990-2021 data, while the blue line reports the responses using 1990-2019 data (benchmark period). The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure 10. Responses of Healthcare Employment to Negative Supply Shock: 1990-2019 vs. 1990-2021

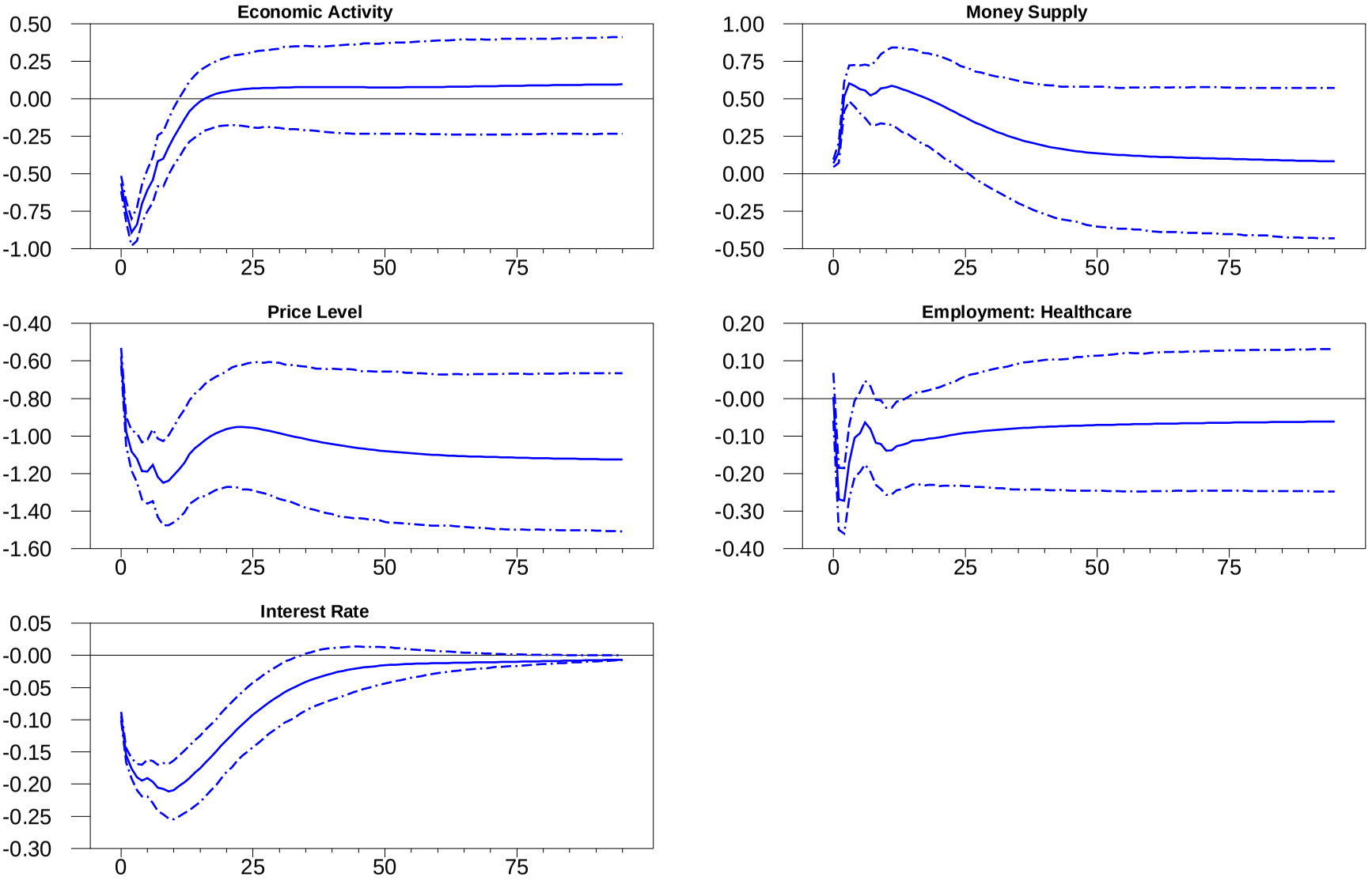


Notes: This figure compares the differential responses of employment in healthcare industry to a one standard deviation negative aggregate supply shock using data over two sample periods: 1990-2019 vs. 1990-2021. The red line reports the responses using 1990-2021 data, while the blue line reports the responses using 1990-2019 data (benchmark period). The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

For Online Publication: Appendix

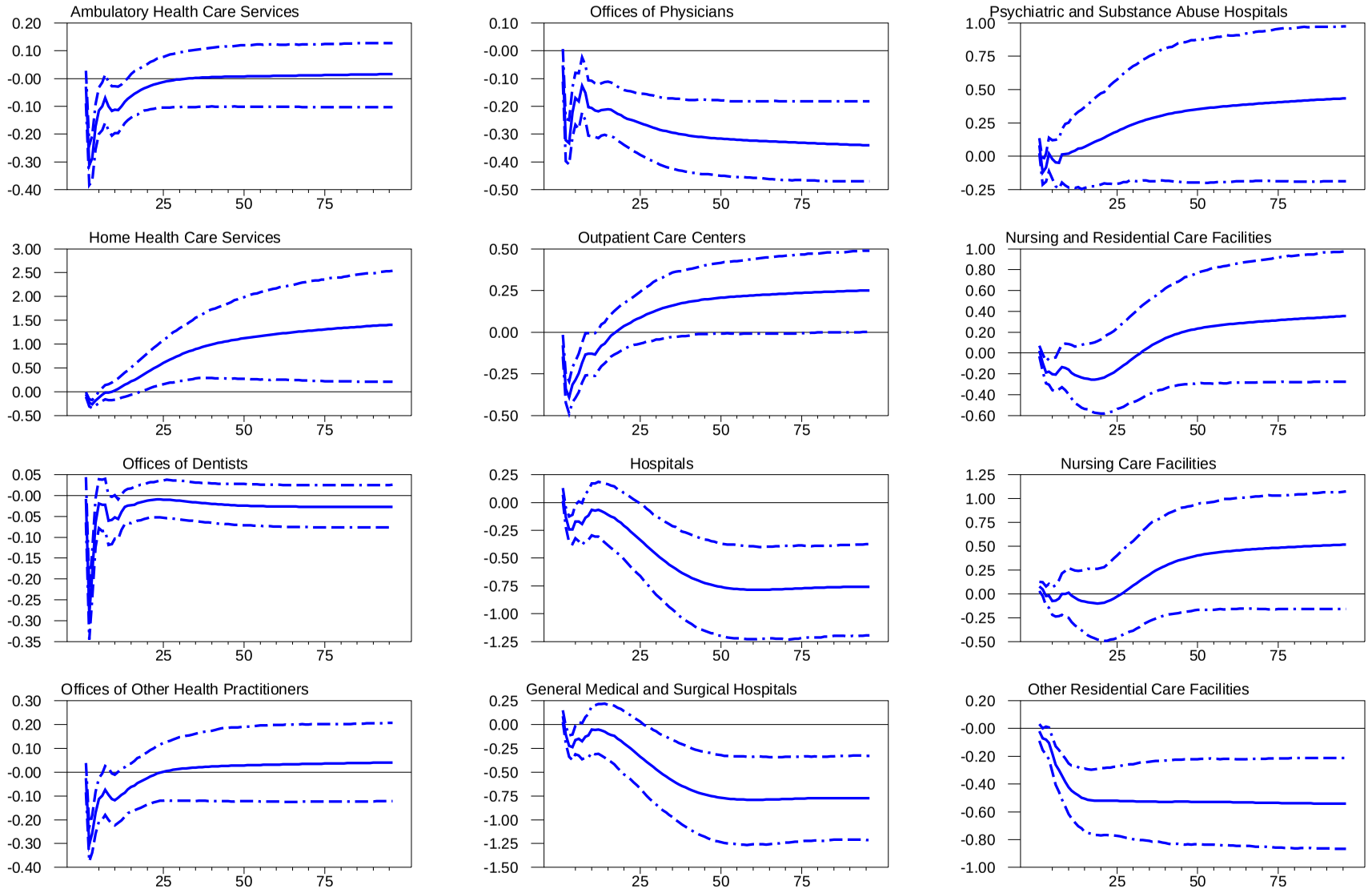
Appendix A. Figures

Figure A1. IRFs of Healthcare Employment to Negative Demand Shock



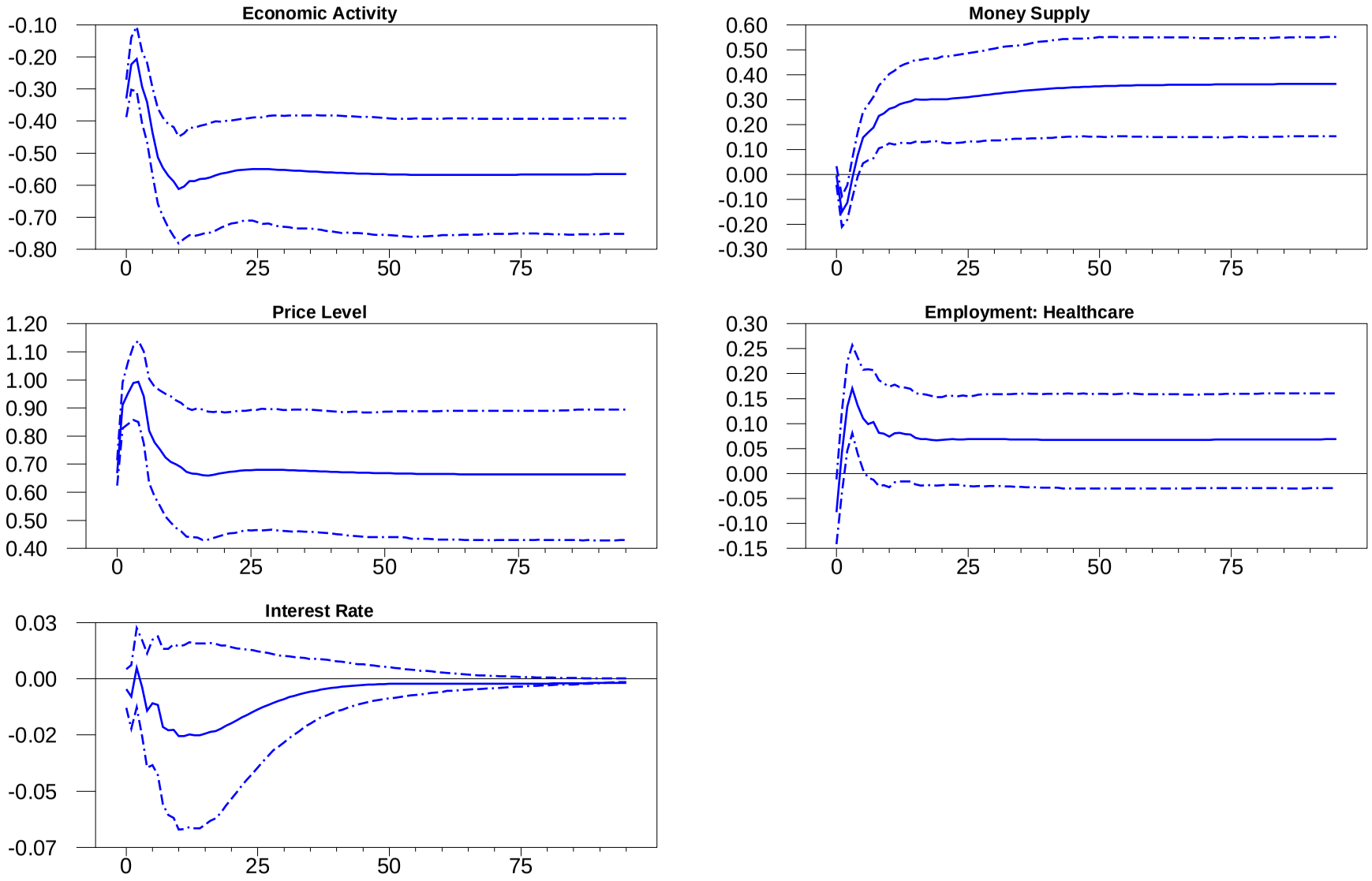
Notes: This figure presents the accumulated impulse responses of the variables/factors to a one standard deviation negative aggregate demand shock using sign restrictions. The sample period is 1990-2021. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure A2. Differential Response of Employment in Healthcare Industry to Negative Demand Shock



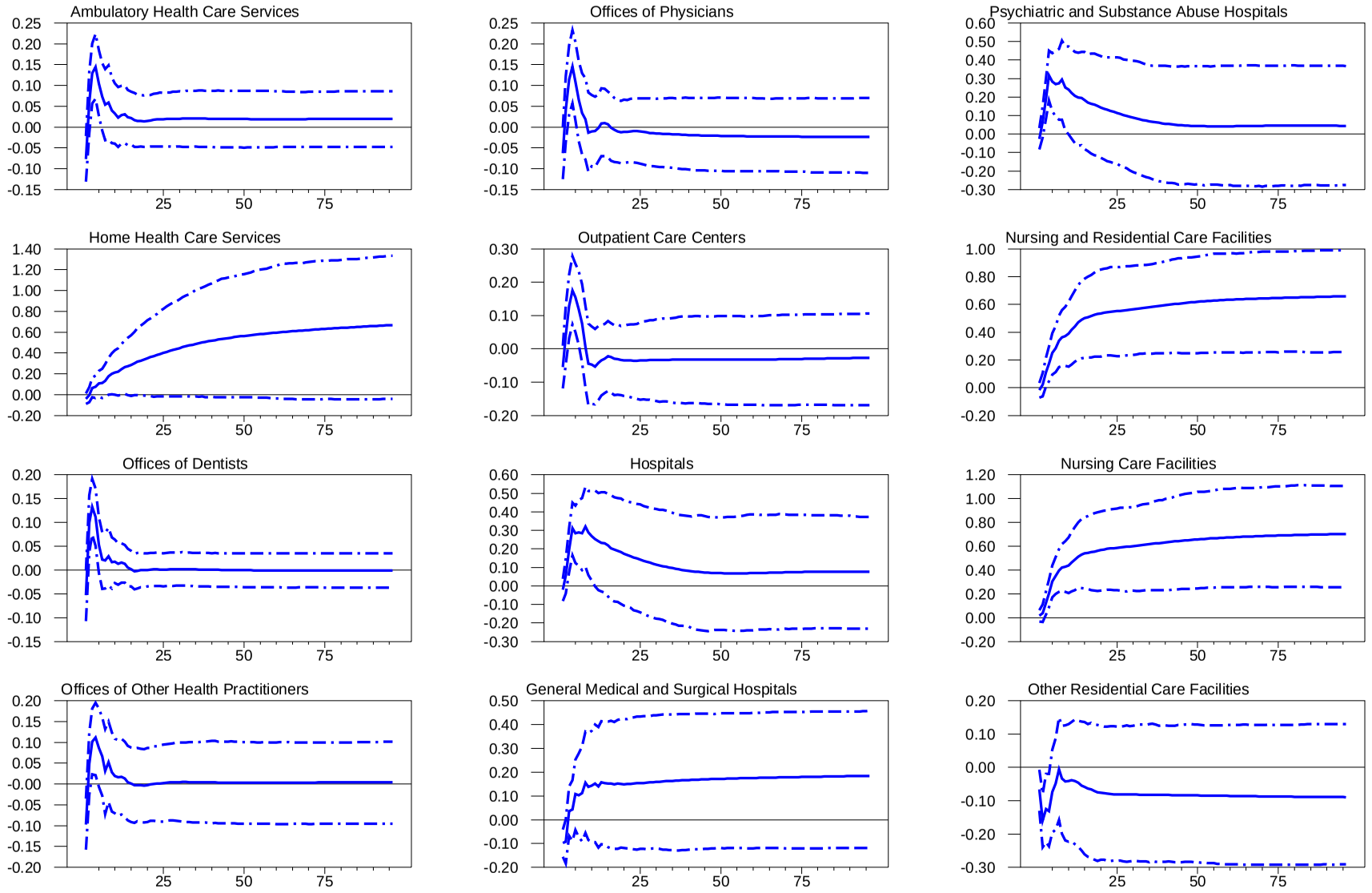
Notes: This figure presents the accumulated impulse responses of employment in the different healthcare sectors to a one standard deviation negative aggregate demand shock using sign restrictions. The sample period is 1990-2021. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure A3. IRFs of Healthcare Employment to Negative Supply Shock



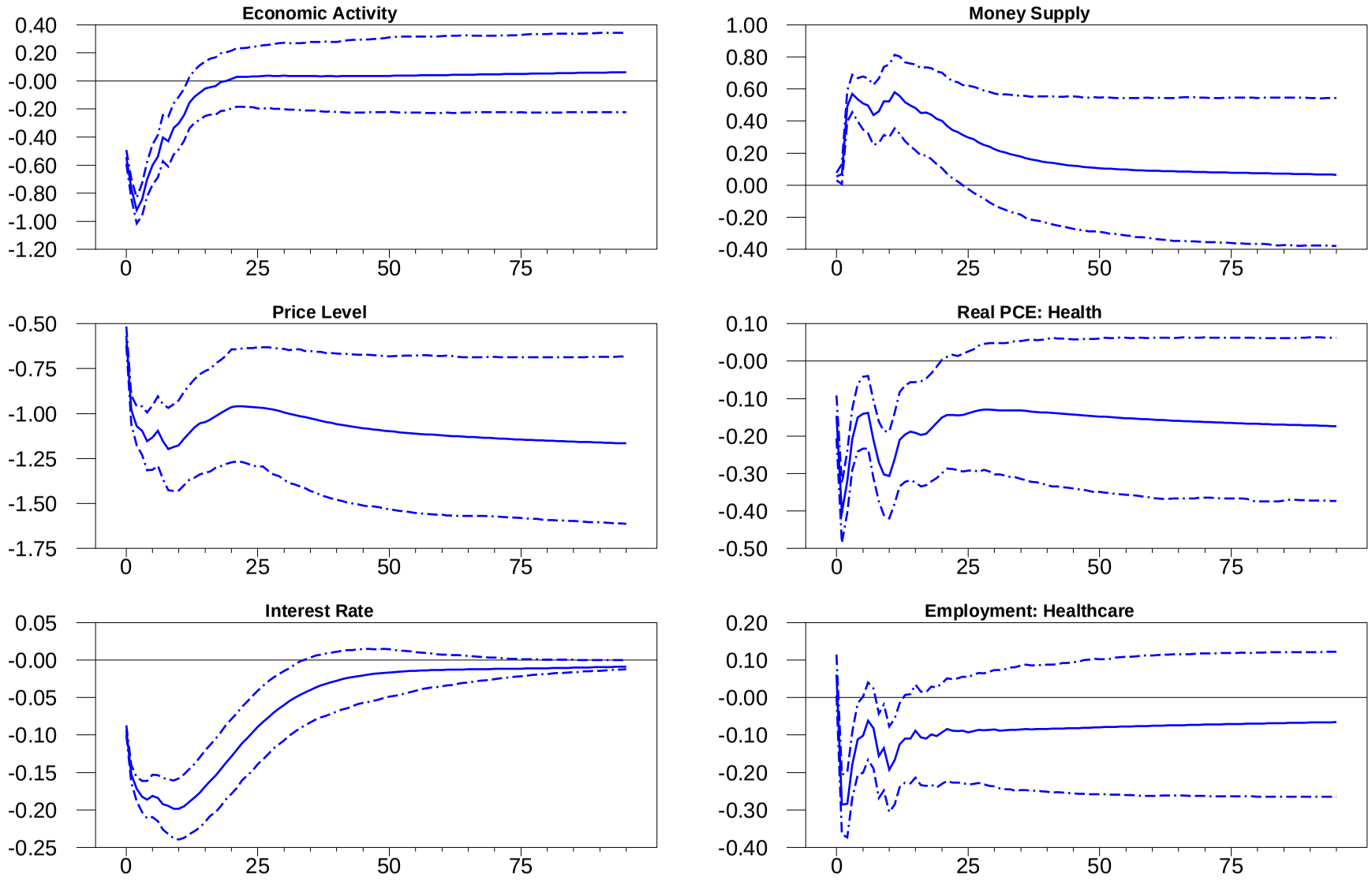
Notes: This figure presents the accumulated impulse responses of employment in the different healthcare sectors to a one standard deviation negative aggregate supply shock using sign restrictions. The sample period is 1990-2021. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure A4. Differential Response of Employment in Healthcare Industry to Negative Supply Shock



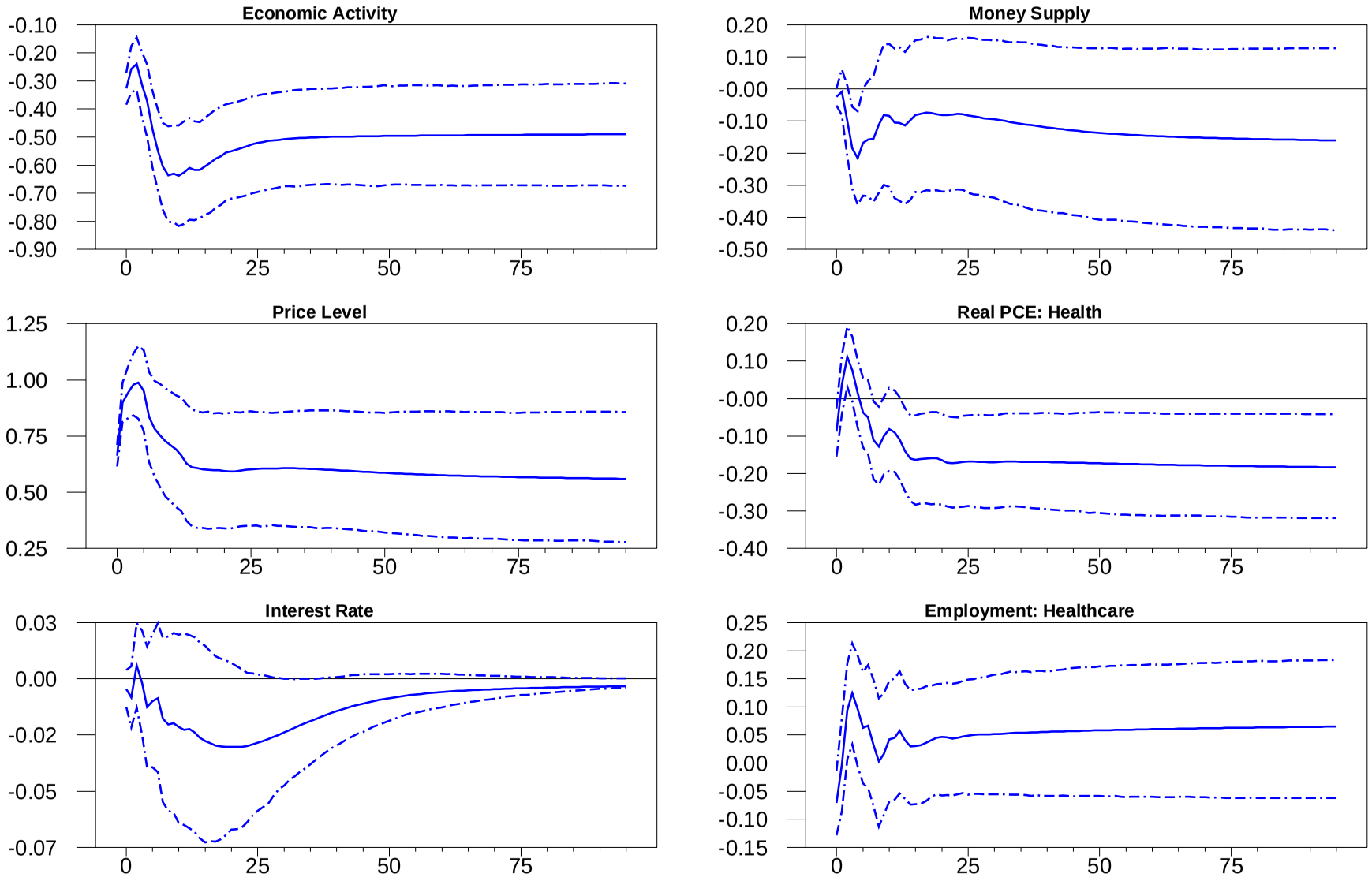
Notes: This figure presents the accumulated impulse responses of employment in the different healthcare sectors to a one standard deviation negative aggregate supply shock using sign restrictions. The sample period is 1990-2021. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure A5. Mechanism: Negative Demand Shock and Personal Healthcare Expenditures



Notes: This figure presents the accumulated impulse responses of the variables/factors to a one standard deviation negative aggregate demand shock using sign restrictions. The sample period is 1990-2021. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Figure A6. Mechanism: Negative Supply Shock and Personal Healthcare Expenditures



Notes: This figure presents the accumulated impulse responses of the variables/factors to a one standard deviation negative aggregate supply shock using sign restrictions. The sample period is 1990-2021. The three lines are 16% quantile, the median and the 16% quantile of the posterior distribution. The vertical axis reports quantitative magnitude of the response (in %), while the horizontal scale reports months.

Supplementary Tables

Data Sources: Federal Reserve Economic Database (FRED) of the St. Louis Fed, IMF International Financial Statistics, and Institute of Supply Management.

Table A1. U.S. Economic Activity Factor and Factor Loading

No.	Variables Constructing U.S. Economic Activity Factor	Transformation Code	Description	Factor Loading (λ)
1	INDPRO	2	Industrial Production Index, Index 2012=100, SA	0.1886
2	IPFINAL	2	Industrial Production: Final Products (Market Group), Index 2012=100, SA	0.1907
3	IPCONGD	2	Industrial Production: Consumer Goods, Index 2012=100, SA	0.1930
4	IPDCONGD	2	Industrial Production: Durable Consumer Goods, Index 2012=100, SA	0.1879
5	IPNCONGD	2	Industrial Production: Nondurable Consumer Goods, Index 2012=100, SA	0.1945
6	IPMAT	2	Industrial Production: Materials, Index 2012=100, SA	0.1856
7	IPDMAT	2	Industrial Production: Durable Materials, Index 2012=100, SA	0.1809
8	IPNMAT	2	Industrial Production: Nondurable Materials, Index 2012=100, SA	0.1956
9	IPMANSICS	2	Industrial Production: Manufacturing (SIC), Index 2012=100, SA	0.1893
10	IPBUSEQ	2	Industrial Production: Business Equipment, Index 2012=100, SA	0.1835
11	IPB53820S	2	Industrial Production: Non-energy materials for intermediate goods producers, Index 2012=100, SA	0.1935

12	IPB562A3CS	2	Industrial Production: Primary and semifinished processing, Index 2012=100, SA	0.1889
13	IPDMAN	2	Industrial Production: Durable Manufacturing (NAICS), Index 2012=100, SA	0.1830
14	IPNMAN	2	Industrial Production: Nondurable Manufacturing (NAICS), Index 2012=100, SA	0.1947
15	IPMINE	2	Industrial Production: Mining, Index 2012=100, SA	0.1894
16	IPG22111S	2	Industrial Production: Utilities: Electric power generation, Index 2012=100, SA	0.1919
17	CAPUTLGMFNS	1	Capacity Utilization: Nondurable manufacturing, Percent of Capacity, SA	3.3118
18	CAPUTLGMFDS	1	Capacity Utilization: Durable manufacturing, Percent of Capacity, SA	3.2003
19	CUMFNS	1	Capacity Utilization: Manufacturing (SIC), Percent of Capacity, SA	3.2491
20	ISMMANPMI	1	ISM Manufacturing: PMI Composite Index, SA (in percent)	2.2171
21	ISMMANPROD	1	ISM Manufacturing: Production Index, SA (in percent)	2.3395
22	ISMMANNEWORDERS	1	ISM Manufacturing: New Order Index, SA (in percent)	2.3380
23	ISMMANEMPL	1	ISM Manufacturing: Employment Index, SA (in percent)	2.0920
24	ISMMANDELIV	1	ISM Manufacturing: Supplies Delivery Index, SA (in percent)	2.2735
25	ISMMANINVENT	1	ISM Manufacturing: Inventories Index, SA (in percent)	1.9562

26	RPI	2	Real Personal Income, Billions of Chained 2012 Dollars, SAAR	0.3953
27	W875RX1	2	Real personal income excluding current transfer receipts, Billions of Chained 2012 Dollars, SAAR	0.3883
28	DPCERA3M086SBEA	2	Real Personal Consumption Expenditures, Index 2012=100, SA	0.1872
29	DDURRA3M086SBEA	2	Real personal consumption expenditures: Durable goods (chain-type quantity index), Index 2012=100, SA	0.1823
30	DNDGRA3M086SBEA	2	Real personal consumption expenditures: Nondurable goods (chain-type quantity index), Index 2012=100, SA	0.1896
31	DSERRA3M086SBEA	2	Real Personal Consumption Expenditures: Services, Index 2012=100, SA	0.1875
32	DPCCRA3M086SBEA	2	Real Personal Consumption Expenditures Excluding Food and Energy, Index 2012=100, SA	0.1864
33	UMCSENT	2	University of Michigan: Consumer Sentiment, Index 1966:Q1=100, NSA	0.1880
34	CSCICP03USM665S	2	Consumer Opinion Surveys: Confidence Indicators: Composite Indicators: OECD Indicator for the United States, Normalised (Normal=100), SA	0.1941
35	CE16OV	2	Civilian Employment Level, Thousands of Persons, SA	0.4985
36	LNS12035019	2	Employment Level: Nonagricultural Industries, Thousands of Persons, SA	0.4977

37	LNS12034560	2	Employment Level: Agriculture and Related Industries, Thousands of Persons, SA	0.3308
38	UNRATE	1	Civilian Unemployment Rate, Percent, SA	-0.2482
39	UEMPMEAN	2	Average (Mean) Duration of Unemployment, Weeks, SA	-0.1265
40	UEMPLT5	2	Number of Civilians Unemployed for Less Than 5 Weeks, Thousands of Persons, SA	-0.3326
41	UEMP5TO14	2	Number of Civilians Unemployed for 5 to 14 Weeks, Thousands of Persons, SA	-0.3279
42	UEMP15OV	2	Number of Civilians Unemployed for 15 Weeks and Over, Thousands of Persons, SA	-0.3373
43	UEMP15T26	2	Number of Civilians Unemployed for 15 to 26 Weeks, Thousands of Persons, SA	-0.2996
44	UEMP27OV	2	Number of Civilians Unemployed for 27 Weeks and Over, Thousands of Persons, SA	-0.3139
45	USPRIV	2	All Employees: Total Private, Thousands of Persons, SA	0.4887
46	PAYEMS	2	All Employees: Total Nonfarm, Thousands of Persons, SA	0.4962
47	USGOOD	2	All Employees: Goods-producing, Thousands of Persons, SA	0.4202
48	USMINE	2	All Employees: Mining and Logging, Thousands of Persons, SA	0.2751
49	USCONS	2	All Employees: Construction, Thousands of Persons, SA	0.3681
50	MANEMP	2	All Employees: Manufacturing, Thousands of Persons, SA	0.4033

51	DMANEMP	2	All Employees: Durable Goods, Thousands of Persons, SA	0.3831
52	NDMANEMP	2	All Employees: Non durable Goods, Thousands of Persons, SA	0.3626
53	SRVPRD	2	All Employees: Service Providing, Thousands of Persons, SA	0.4885
54	USTPU	2	All Employees: Trade, Transportation, and Utilities, Thousands of Persons, SA	0.4271
55	USWTRADE	2	All Employees: Wholesale Trade, Thousands of Persons, SA	0.3636
56	USTRADE	2	All Employees: Retail Trade, Thousands of Persons, SA	0.4043
57	USFIRE	2	All Employees: Financial Activities, Thousands of Persons, SA	0.3773
58	USSERV	2	All Employees: Other Services, Thousands of Persons, SA	0.3602
59	USGOVT	2	All Employees: Government, Thousands of Persons, SA	0.4194
60	CIVPART	2	Civilian Labor Force Participation Rate, Percent, SA	2.7474
61	UNEMPLOY	2	Unemployment Level, Thousands of Persons, SA	-0.3802
62	AWHMAN	2	Average Weekly Hours of Production and Nonsupervisory Employees: Manufacturing, Hours, SA	0.1567
63	AWOTMAN	2	Average Weekly Overtime Hours of Production and Nonsupervisory Employees: Manufacturing, Hours, SA	0.0613
64	CES2000000008	2	Average Hourly Earnings of Production and Nonsupervisory Employees: Construction, 1982-84 Dollars, SA	0.1258

65	CES3000000008	2	Average Hourly Earnings of Production and Nonsupervisory Employees: Manufacturing, 1982-84 Dollars, SA	0.1171
66	AHETPI	2	Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private, 1982-84 Dollars, SA	0.1171
67	CES0600000008	2	Average Hourly Earnings of Production and Nonsupervisory Employees: Goods-producing, 1982-84 Dollars, SA	0.1203
68	CES0800000008	2	Average Hourly Earnings of Production and Nonsupervisory Employees: Private Service-providing, 1982-84 Dollars, SA	0.1161
69	HOUST	2	Housing Starts: Total: New Privately Owned Housing Units Started, Thousands of Units, SAAR	0.3004
70	HOUSTMW	2	Housing Starts in Midwest Census Region, Thousands of Units, SAAR	0.2276
71	HOUSTNE	2	Housing Starts in Northeast Census Region, Thousands of Units, SAAR	0.2024
72	HOUSTS	2	Housing Starts in South Census Region, Thousands of Units, SAAR	0.2690
73	HOUSTW	2	Housing Starts in West Census Region, Thousands of Units, SAAR	0.2404
74	PERMIT	2	New Private Housing Units Authorized by Building Permits, Thousands of Units, SAAR	0.3010

Data Sources: Federal Reserve Economic Database (FRED) of the St. Louis Fed, IMF International Financial Statistics, Bureau of Labour Statistics, and Institute of Supply Management.

Table A2. U.S. Price Factor and Factor Loading

No.	Variables Constructing U.S. Price Factor	Transformation Code	Description	Factor Loading (ζ)
1	WPS141	2	Producer Price Index by Commodity for Transportation Equipment: Motor Vehicles and Equipment, Index 1982=100, SA	0.9764
2	WPSFD4111	2	Producer Price Index by Commodity for Final Demand: Finished Consumer Foods, Index 1982=100, SA	1.0121
3	WPSFD49207	2	Producer Price Index by Commodity for Final Demand: Finished Goods, Index 1982=100, SA	1.0078
4	WPSID62	2	Producer Price Index by Commodity for Intermediate Demand by Commodity Type: Unprocessed Goods for Intermediate Demand, Index 1982=100, SA	1.0022
5	WPSID61	2	Producer Price Index by Commodity for Intermediate Demand by Commodity Type: Processed Goods for Intermediate Demand, Index 1982=100, SA	1.0024
6	WPSID69111	2	Producer Price Index by Commodity for Intermediate Demand by Commodity Type: Processed Materials Less Foods and Feed, Index 1982=100, SA	1.0029

7	WPSID69211	2	Producer Price Index by Commodity for Intermediate Demand by Commodity Type: Unprocessed Materials Less Agricultural Products, Index 1982=100, SA	1.0118
8	PPIACO	2	Producer Price Index for All Commodities, Index 1982=100, NSA	1.0053
9	PPIACO	2	Producer Price Index for All Commodities, Index 1982=100, NSA	0.7357
10	CPIAPPSL	2	Consumer Price Index for All Urban Consumers: Apparel, Index 1982-1984=100, SA	0.9599
11	CPITRNSL	2	Consumer Price Index for All Urban Consumers: Transportation, Index 1982-1984=100, SA	1.0212
12	CPIMEDSL	2	Consumer Price Index for All Urban Consumers: Medical Care, Index 1982-1984=100, SA	1.1464
13	CUSR0000SAC	2	Consumer Price Index for All Urban Consumers: Commodities, Index 1982-1984=100, SA	1.0082
14	CUSR0000SAD	2	Consumer Price Index for All Urban Consumers: Durables, Index 1982-1984=100, SA	0.9433
15	CUSR0000SAS	2	Consumer Price Index for All Urban Consumers: Durables, Index 1982-1984=100, SA	1.0787
16	CPIULFSL	2	Consumer Price Index for All Urban Consumers: All Items Less Food, Index 1982-1984=100, SA	1.0471
17	CUSR0000SA0L2	2	Consumer Price Index for All Urban Consumers: All items less shelter, Index 1982-1984=100, SA	1.0377

18	CPILFESL	2	Consumer Price Index for All Urban Consumers: All Items Less Food and Energy, Index 1982-1984=100, SA	1.0536
19	CUSR0000SA0L5	2	Consumer Price Index for All Urban Consumers: All Items Less Medical Care, Index 1982-1984=100, SA	1.0402
20	CPIENGSL	2	Consumer Price Index for All Urban Consumers: Energy, Index 1982-1984=100, SA	1.0087
21	CPILEGSL	2	Consumer Price Index for All Urban Consumers: All Items Less Energy, Index 1982-1984=100, SA	1.0520
22	CPIUFDSL	2	Consumer Price Index for All Urban Consumers: Food, Index 1982-1984=100, SA	1.0466
23	WTISPLC	2	Spot Crude Oil Prices: West Texas Intermediate (WTI) - Cushing, Oklahoma, Dollars per Barrel, NSA	0.7357
24	CPIAUCSL	2	Consumer Price Index for All Urban Consumers: All Items in U.S. City Average, SA	1.0470
25	CSUSHPISA	2	S&P/Case-Shiller U.S. National Home Price Index, Index Jan 2000=100, SA	1.0713
26	CUSR0000SEHA	2	Consumer Price Index for All Urban Consumers: Rent of primary residence, Index 1982-1984=100, SA	0.9695
27	PXPIX	2	Export Price Index: All Commodities, Index, NSA	0.9373
28	PMPIX	2	Import Price Index: All Commodities, Index, NSA	0.9373

Data Sources: Federal Reserve Economic Database (FRED) of the St. Louis Fed, IMF International Financial Statistics, Bureau of Labour Statistics, and Institute of Supply Management.

Table A3. U.S. Interest Rate Factor and Factor Loading

No.	Variables Constructing the U.S. Interest Rate Factor	Transformation Code	Description	Factor Loadings (η)
1	FEDFUNDS	1	Effective Federal Funds Rate, Percent, NSA	0.7852
2	TB3MS	1	3-Month Treasury Bill: Secondary Market Rate, Percent, NSA	0.7337
3	TB6MS	1	6-Month Treasury Bill: Secondary Market Rate, Percent, NSA	0.7529
4	GS1	1	1-Year Treasury Constant Maturity Rate, Percent, NSA	0.8094
5	GS3	1	3-Year Treasury Constant Maturity Rate, Percent, NSA	0.9087
6	GS5	1	5-Year Treasury Constant Maturity Rate, Percent, NSA	0.9723
7	GS10	1	10-Year Treasury Constant Maturity Rate, Percent, NSA	1.0531
8	MPRIME	1	Bank Prime Loan Rate, Percent, NSA	1.3629
9	MORTGAGE30US	1	30 year Mortgage Rate, Percent, NSA	1.3731

Data Sources: Federal Reserve Economic Database (FRED) of the St. Louis Fed, IMF International Financial Statistics, Bureau of Labour Statistics, and Institute of Supply Management.

Table A4. U.S. Monetary Aggregate Factor and Factor Loading

No.	Variables Constructing the U.S. Monetary Aggregate Factor	Transformation Code	Description	Factor Loading (γ)
1	M1SL	2	M1 Money Stock, Billions of Dollars, SA	0.9474
2	M2SL	2	M2 Money Stock, Billions of Dollars, SA	1.1241
3	NOM1M2	2	Non-M1 Components of M2, Billions of Dollars, SA	1.1025
4	M2MSL	2	M2 Less Small Time Deposits, Billions of Dollars, SA	1.0808
5	BUSLOANS	2	Commercial and Industrial Loans, All Commercial Banks, Billions of U.S. Dollars, SA	0.8979
6	CONSUMER	2	Consumer Loans at All Commercial Banks, Billions of U.S. Dollars, SA	0.8418
7	TOTALSL	2	Total Consumer Credit Owned and Securitized, Outstanding, SA	0.9698