Unequal Unemployment Effects of COVID-19 and Monetary Policy across U.S. States[*]

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Abstract

This paper shows that daily Google trends can be used as an alternative to conventional U.S. data (with alternative frequencies) on unemployment, interest rates, inflation and coronavirus disease 2019 (COVID-19). This information is used to investigate the effects of COVID-19 and the corresponding monetary policy on the U.S. unemployment, both nationally and across U.S. states, by using a structural vector autoregression model. Historical decomposition analyses show that the U.S. unemployment is mostly explained by COVID-19, whereas the contribution of monetary policy is almost none. An investigation based on the U.S. states further suggests that COVID-19 and the corresponding monetary policy conducted based on nationwide economic developments have resulted in unequal changes in state-level unemployment rates, suggesting evidence for distributive effects of national monetary policy.

JEL Classification: J63, F66, I10

Key Words: COVID-19; Coronavirus; Google Trends; Monetary Policy

1 Introduction

The weekly unemployment claims were about 281,000 in the week ending March 14th, 2020 according to the U.S. Department of Labor, reaching its highest level since September 2nd, 2017. In the corresponding news release, the U.S. Department of Labor announced the following statement:

> "During the week ending March 14, the increase in initial claims are clearly attributable to impacts from the COVID-19 virus. A number of states specifically cited COVID-19 related layoffs, while many states reported increased layoffs in service related industries broadly and in the accommodation and food services industries specifically, as well as in the transportation and warehousing industry, whether COVID-19 was identified directly or not."

where the Coronavirus Disease 2019 (COVID-19) was shown to be responsible. Even after five months, weekly unemployment claims were about 1,106,000 in the week ending August 15th, 2020 when the U.S. Department of Labor further announced the following statement:

> "The COVID-19 virus continues to impact the number of initial claims and insured unemployment."

where the continuous severity of COVID-19 effects on the U.S. unemployment can still be observed.

Recent studies in the literature support the relationship between COVID-19 and unemployment as well. The economic intuition behind this relationship is not only connected to people that are sick due to COVID-19 but also to stay-at-home and mandatory social distancing policies that inevitably disrupt business activity as households and businesses started

spending less, especially on nonessential goods and services (e.g., see Curdia et al. (2020)). Among the corresponding studies in the literature, Bartik, Bertrand, Cullen, Glaeser, Luca, and Stanton (2020) show that businesses have reduced their employee counts by 40% relative to January, Coibion, Gorodnichenko, and Weber (2020) show that the job loss due to COVID-19 has been more than the entire Great Recession period and that participation in the labor force has declined at the same time, Kahn, Lange, and Wiczer (2020) show that the collapse in job vacancies due to COVID-19 has been broad based, hitting all U.S. states, Beland, Brodeur, and Wright (2020) show that unemployment due to COVID-19 has been significantly larger for U.S. states with stay-at-home orders, Shun (2020) show that COVID-19 has reduced labor supply as well as labor demand, Montenovo, Jiang, Rojas, Schmutte, Simon, Weinberg, and Wing (2020), Hensvik, Le Barbanchon, and Rathelot (2020), Fairlie, Couch, and Xu (2020) and Cho and Winters (2020) show how unemployment in different occupations or across demographic groups have been affected by COVID-19, and Kong and Prinz (2020) show that restaurant and bar limitations and non-essential business closures could explain a certain part of unemployment insurance claims. However, none of these studies have investigated the dynamic relationship between COVID-19 and unemployment, where other factors such as inflation, interest rate and thus the monetary policy are controlled for.

Based on this background, this paper investigates the dynamic relationship between COVID-19 and the U.S. unemployment by considering the effects of U.S. monetary policy, both nationally and across U.S. states. Since this investigation requires data on unemployment, interest rates, inflation and COVID-19, which are only available in alternative (e.g., daily, weekly, monthly) frequencies, this paper uses Google search queries capturing the de-

sired variables on a daily basis. The sample covers the daily period between January 1st, 2020 and August 24th, 2020.

Before moving to the formal investigation, it is first shown that daily Google trends can be used as an alternative to conventional U.S. data (with alternative frequencies) on unemployment, interest rates, inflation and developments related to COVID-19. This result is in line with earlier studies such as by Baker and Fradkin (2017) who have used Google trends for the U.S. to investigate the effects of unemployment insurance policy on aggregate job search effort. Similar Google search queries have also been used in earlier studies such as by Dergiades, Milas, and Panagiotidis (2015), Altavilla and Giannone (2017), Castelnuovo and Tran (2017), Wohlfarth (2018), Bicchal and Raja Sethu Durai (2019), Fetzer, Hensel, Hermle, and Roth (2020) or Knipe, Evans, Marchant, Gunnell, and John (2020) for alternative economic questions.

The nationwide formal analysis for the U.S. is achieved by employing a four-variable structural vector autoregression (SVAR) model, where daily data on COVID-19, unemployment, interest rates, and inflation are used. This SVAR model corresponds to having simultaneous equations representing the relationship between the four variables based on their current and lagged values over time. The motivation behind using a SVAR model is that it can predict the effects of interventions, such as changes in monetary policy, on other variables of interest.

The empirical results show that COVID-19 has increased unemployment both in the long-run and the short-run (as in Curdia et al. (2020)), while monetary authorities have reacted to COVID-19 by reducing the interest rate, which has helped reducing the unemployment rate in a minor way. This result is also consistent with studies such as by Bartik, Bertrand, Cullen, Glaeser, Luca, and Stanton (2020), Coibion, Gorodnichenko, and Weber (2020),

Kahn, Lange, and Wiczer (2020) or Kong and Prinz (2020) who provide evidence for the relationship between COVID-19 and unemployment; nevertheless, different from these studies, the results in this paper shed lights on the magnitude of this relationship in a dynamic framework. Historical decomposition analyses further show that the U.S. unemployment is mostly explained by COVID-19, whereas the contribution of monetary policy is almost none, consistent with studies such as by Curdia et al. (2020) who shows that inflationary pressures have fallen with economic downturn during COVID-19.

The implications for the U.S. state-level unemployment are further investigated by including a fifth variable in SVAR model, which is daily unemployment obtained for 50 states and the District of Columbia. The results based on individual state-level analyses suggest evidence for unequal unemployment effects of COVID-19; e.g., COVID-19 has negatively affected unemployment in the state of Washington by about four times of that in New Hampshire. This result is consistent with studies such as by Beland, Brodeur, and Wright (2020), Montenovo, Jiang, Rojas, Schmutte, Simon, Weinberg, and Wing (2020), Hensvik, Le Barbanchon, and Rathelot (2020), Fairlie, Couch, and Xu (2020) and Cho and Winters (2020) who have provided evidence for unequal effects of COVID-19 on unemployment across occupations, demographic groups or U.S. states. Different from these studies, this paper provides evidence using a daily data set that can capture dynamics in a higher frequency.

The results also suggest evidence for unequal unemployment effects of national monetary policy across U.S. states. In particular, accommodative (national) monetary policy has helped reducing unemployment only in certain states, whereas unemployment in certain others have not benefited at all from it. This result is consistent with earlier studies such as by Shi (1999), Algan and Ragot (2010), Ghossoub and Reed (2017), Sterk and Tenreyro (2018) and Auclert

([2019](#)) who also show evidence for distributive effects of monetary policy. Different from these studies, this paper suggests that such distributive effects also exist due to COVID-19.

The rest of the paper is organized as follows. The next section introduces the data set and descriptive statistics. Section 3 introduces the methodology used. Section 4 depicts empirical results, while Section 5 concludes.

2 Data and Descriptive Statistics

The U.S. data on Google trends capturing developments in unemployment, interest rates, inflation and COVID-19 are used for the daily period between January 1st, 2020 and August 24th, 2020. Regarding the nationwide investigation, unemployment is measured by nationwide Google search query of "unemployment," interest rate is measured by nationwide Google search query of "interest rate," inflation is measured by nationwide Google search query of "inflation" and developments related to COVID-19 are measured by nationwide Google search query of "covid." For the state-level investigation, the additional variable of state-level unemployment is measured by the state-level Google search query of "unemployment" for 50 states and the District of Columbia. All data have been obtained from Google Trends, where it does not matter whether small case or capital letters are used for search queries.[1]

The daily series based on Google trends are compared with the corresponding conventional data in alternative frequencies in Figure 1. Conventional data for interest rates (Federal Funds Rate) and COVID-19 cases are already available in daily terms for comparison pur-

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[1]The corresponding web page is https://trends.google.com.

poses.[2] For others, weekly averages of Google trends are taken to have a comparison between unemployment measures, while monthly averages are taken to have a comparison between inflation measures.[3]

As is evident in Figure 1, the spike in U.S. unemployment data starting from mid-March is captured by the nationwide Google search query of "unemployment" with a correlation (over time) of 0.89. Similarly, both reductions in the Federal Funds Rate in March 2020 are highly consistent with the negative value of nationwide Google search query of "interest rate" with a correlation (over time) of 0.64; accordingly, we use the *negative* value of nationwide Google search query of "interest rate" in the formal investigation, below. Monthly U.S. CPI inflation is captured well by the negative value of nationwide Google search query of "inflation" with a correlation (over time) of 0.88; accordingly, we use the *negative* value of nationwide Google search query of "inflation" in the formal investigation, below. Finally, developments related to COVID-19 that are measured by COVID-19 cases in the U.S. are in line with the nationwide Google search query of "covid" with a correlation (over time) of 0.70.

Overall, descriptive statistics suggest that daily Google trends can be used as an alternative to conventional U.S. data (with alternative frequencies) on unemployment, interest rates, inflation and developments related to COVID-19. For the formal empirical investigation, Google trends are converted into weekly changes, both to have stationarity and to control for weekly seasonality by construction.

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[2]Conventional data on Federal Funds Rate have been obtained from Federal Reserve Economic Data, whereas Conventional daily data on COVID-19 cases have been obtained from Centers for Disease Control and Prevention.

[3]Conventional data on weekly unemployment are measured by unemployment insurance weekly claims data of the U.S. Department of Labor, whereas the U.S. CPI inflation data have been obtained from Federal Reserve Economic Data.

3 Estimation Methodology

The formal analyses in this section are achieved by employing SVAR models, where daily data from the U.S. are used. SVAR models correspond to having simultaneous equations representing the relationship between multiple variables based on their current and lagged values over time. The motivation behind using SVAR models is that they can predict the effects of interventions, such as changes in monetary policy, on other variables of interest.

3.1 Nationwide Investigation

The nationwide investigation for the U.S. is achieved by using the SVAR model of $z_t = (c_t, p_t, u_t, i_t)'$, where c_t represents developments related to COVID-19, p_t represents inflation, u_t represents unemployment, and i_t represents interest rates. In formal terms, the nationwide SVAR model for the U.S. is given by:

$$A_o z_t = a + \sum_{k=1}^{12} A_k z_{t-k} + u_t \tag{1}$$

where u_t is the vector of serially and mutually uncorrelated structural innovations.[4] For estimation purposes, the model is expressed in reduced form as follows:

$$z_t = b + \sum_{k=1}^{12} B_k z_{t-k} + e_t \tag{2}$$

where $b = A_o^{-1} a$, $B_k = A_o^{-1} A_k$ for all k. It is postulated that the structural impact multiplier matrix A_o^{-1} has a recursive structure such that the reduced form errors e_t can be decom-

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[4]The number of lags (of 12) has been determined by comparing the Deviance Information Criterion across alternative models. The model variables are confirmed to be stable and no root lies outside the unit circle.

posed according to $e_t = A_o^{-1} u_t$, where the sizes of shocks are standardized to unity (i.e., the identification is by triangular factorization).

The recursive structure imposed on A_o^{-1} requires an ordering of the variables used in the estimation for which we use the one already given by $z_t = (c_t, p_t, u_t, i_t)'$. Within this framework, developments related to COVID-19 c_t affect all economic variables, whereas it is not affected by any of them contemporaneously. Since inflation is mostly steady during the sample period (and prices are sticky in general), p_t is ordered first among economic variables, followed by unemployment u_t that has accelerated starting from March 15th, 2020. Finally, interest rate i_t is assumed to react to all variables, capturing the reaction of the Federal Funds Rate.

3.2 State-Level Investigation

The-state level SVAR model for the U.S. can also be represented by Equations 1 and 2, with the difference of z_t, this time, including the additional variable of the state-level unemployment as $z_t = (c_t, p_t, u_t, i_t, u_t^s)'$, where u_t^s represents unemployment in state s. The purpose of using this particular SVAR model is to obtain the reaction of state-level unemployment to nationwide shocks. State-level SVAR models are estimated individually for 50 states and the District of Columbia, where block exogeneity is used to ensure that all nationwide variables can have an impact on u_t^s, whereas u_t^s cannot have any impact on nationwide variables at any time following a shock.

The estimation is achieved by a Bayesian approach with independent normal-Wishart priors. This corresponds to generating posterior draws for the structural model parameters by transforming each reduced-form posterior draw. In particular, for each draw of the covariance

matrix from its posterior distribution, the corresponding posterior draw for A_o^{-1} is constructed by using by triangular factorization so that the sizes of shocks are standardized to unity. In the Bayesian framework, a total of 2,000 samples are drawn, where a burn-in sample of 1,000 draws is discarded. The remaining 1,000 draws are used to determine the historical decomposition and the structural impulse responses that are necessary for investigating the implications on the U.S. unemployment, both nationally and across U.S. states. While the median of each distribution is considered as the Bayesian estimator, the 16th and 84th quantiles of distributions are used to construct the 68% credible intervals (which is the standard measure considered in the Bayesian literature).

4   Estimation Results

4.1   Results of the Nationwide Investigation

Cumulative impulse responses of nationwide variables to a positive nationwide unit shock of COVID-19 are summarized in Table 1, whereas they are given over time in Figure 2. As is evident, unemployment increases by about 2.4 units after one week and about 7.8 units after two months following a unit shock of COVID-19. This result is consistent with studies such as by Bartik, Bertrand, Cullen, Glaeser, Luca, and Stanton (2020), Coibion, Gorodnichenko, and Weber (2020), Kahn, Lange, and Wiczer (2020) or Kong and Prinz (2020) who provide evidence for the relationship between COVID-19 and unemployment; nevertheless, different from these studies, the results in this paper shed lights on the magnitude of this relationship in a dynamic framework.

The effects of COVID-19 on interest rates are much smaller, about -1.25 units after one week (and insignificant after one month or two months), suggesting that the Federal Reserve System has reacted to COVID-19 shocks by reducing the Federal Funds Rate. The effects of a COVID-19 shock on inflation are significant only in the short-run, similar to studies such as by Curdia et al. (2020) who shows that inflationary pressures have fallen with economic downturn during COVID-19. Therefore, unemployment is the only variable that reacts to COVID-19 in the long run. Historical decomposition estimates for unemployment given in Figure 3 also support this view, where unemployment is significantly explained by COVID-19 during March 2020 and June 2020, whereas contributions of other variables are almost none.

The effects of nationwide variables on the U.S. unemployment are summarized in Table 2, where, following a negative interest rate shock, unemployment decreases by about 0.3 units after one week and 0.54 units after two months, suggesting that the accommodative monetary policy of the Federal Reserve System has helped to reduce unemployment, consistent with studies such as by Curdia et al. (2020).

4.2   Results of the State-Level Investigation

The estimation results of the state-level investigation are summarized in Table 3.[5] Recall that these results provide information on the reaction of state-level unemployment to nationwide shocks. As is evident, one unit of a positive nationwide COVID-19 shock results in about 6.9 units of an increase in unemployment of the median state (Hawaii) after two months, although this reaction ranges between 2.50 (for Washington) and 9.28 (for New Hampshire), providing evidence for unequal unemployment effects of COVID-19 across U.S. states. The latter

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[5]State-specific results can be found in the working paper version of this paper, Yilmazkuday (2020b).

result is consistent with studies such as by Beland, Brodeur, and Wright (2020), Montenovo, Jiang, Rojas, Schmutte, Simon, Weinberg, and Wing (2020), Hensvik, Le Barbanchon, and Rathelot (2020), Fairlie, Couch, and Xu (2020) and Cho and Winters (2020) who have provided evidence for unequal effects of COVID-19 on unemployment across occupations, demographic groups or U.S. states.

Regarding the reaction of the Federal Reserve System to COVID-19, a negative nationwide unit shock on interest rates has resulted in about 0.34 units of a reduction in unemployment of the median state (Alaska). However, this reaction ranges as between about 1.07 units of a reduction in unemployment of the minimum state (Colorado) and about 0.19 units of an insignificant increase in unemployment of the maximum state (Mississippi), suggesting evidence for distributive effects of national monetary policy across U.S. states. This result is consistent with earlier studies such as by Shi (1999), Algan and Ragot (2010), Ghossoub and Reed (2017), Sterk and Tenreyro (2018) and Auclert (2019) who also show evidence for distributive effects of monetary policy. Nevertheless, different from these studies, the results of this paper suggest that such distributive effects also exist due to COVID-19.

5 Conclusion

This paper has investigated the relationship between COVID-19, the corresponding monetary policy, and unemployment using daily data from the United States. The results of a nationwide investigation show that COVID-19 has increased the U.S. unemployment both in the long-run and the short-run, while the Federal Reserve System has reacted to COVID-19 by reducing the interest rate, which has helped reducing the national unemployment rate in

a minor way. Historical decomposition analyses further show that the U.S. unemployment is mostly explained by COVID-19, whereas the contribution of monetary policy is almost none.

The results of a state-level investigation provide evidence for unequal unemployment effects of COVID-19 across U.S. states. The corresponding national monetary policy has been successful in reducing unemployment only in certain states, whereas unemployment in certain others have not benefited at all from it, suggesting evidence for distributive effects of national monetary policy across U.S. states.

Important policy implications follow. First, the econometrically significant effects of COVID-19 on interest rates have lasted only about a week, suggesting that the Federal Reserve System was not able to reduce the federal funds rate any further due to the zero bound, consistent with studies such as by Yilmazkuday (2020a). It is implied that more room for interest-rate reductions is necessary at the time of an economic crisis like the current one. Second, the effects of monetary policy on unemployment are highly heterogeneous across U.S. states, suggesting that monetary policy cannot be effective on its own. It is implied that alternative policies such as fiscal stimulus packages should be considered, especially for the U.S. states that cannot benefit from the nationwide monetary policy.

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Table 1 - Cumulative Nationwide Effects of COVID-19

	After 1 Week	After 1 Month	After 2 Months
Effects on Unemployment	2.407	8.712	8.748
	$[1.937, 2.875]$	$[7.054, 10.525]$	$[6.985, 11.239]$
Effects on Interest rates	-1.251	0.558	0.601
	$[-1.721, -0.825]$	$[-0.227, 1.304]$	$[-0.149, 1.349]$
Effects on Inflation	0.539	-0.374	-0.411
	$[0.904, 0.165]$	$[-1.073, 0.386]$	$[-1.133, 0.333]$
Effects on COVID-19	7.751	12.727	12.289
	$[7.264, 8.292]$	$[10.669, 15.763]$	$[10.139, 15.831]$

Notes: The estimates represent the median across $1,000$ draws. Lower and upper bounds in brackets represent the 68% credible intervals.

Table 2 - Cumulative Effects on U.S. Unemployment

|	After 1 Week	After 1 Month	After 2 Months
Effects of COVID-19	2.407	8.712	8.748
	$[1.937, 2.875]$	$[7.054, 10.525]$	$[6.985, 11.239]$
Effects of Unemployment	3.353	2.913	2.755
	$[3.050, 3.712]$	$[1.941, 3.936]$	$[1.711, 3.780]$
Effects of Inflation	0.051	0.124	0.124
	$[-0.179, 0.274]$	$[-0.287, 0.501]$	$[-0.295, 0.512]$
Effects of Interest Rates	-0.300	-0.545	-0.546
	$[-0.158, -0.441]$	$[-0.856, -0.260]$	$[-0.860, -0.256]$

Notes: The estimates represent the median across $1,000$ draws. Lower and upper bounds in brackets represent the 68% credible intervals.

Table 3 - Cumulative Effects of Nationwide Variables on State-Level Unemployment

|	Median State	Minimum State	Maximum State
Effects of COVID-19	6.906	1.919	8.830
	$[5.181, 9.530]$	$[0.867, 3.143]$	$[7.121, 11.255]$
Effects of Unemployment	1.755	0.437	3.265
	$[1.003, 2.437]$	$[-0.484, 1.304]$	$[2.356, 4.296]$
Effects of Inflation	0.151	-0.264	0.612
	$[-0.116, 0.403]$	$[-0.683, 0.099]$	$[0.297, 0.946]$
Effects of Interest Rates	-0.343	-1.074	0.192
	$[-0.657, -0.029]$	$[-1.421, -0.763]$	$[-0.096, 0.439]$

Notes: The values represent long-run effects measured after two months. The estimates represent the median across $1,000$ draws. Lower and upper bounds in brackets represent the 68% credible intervals.

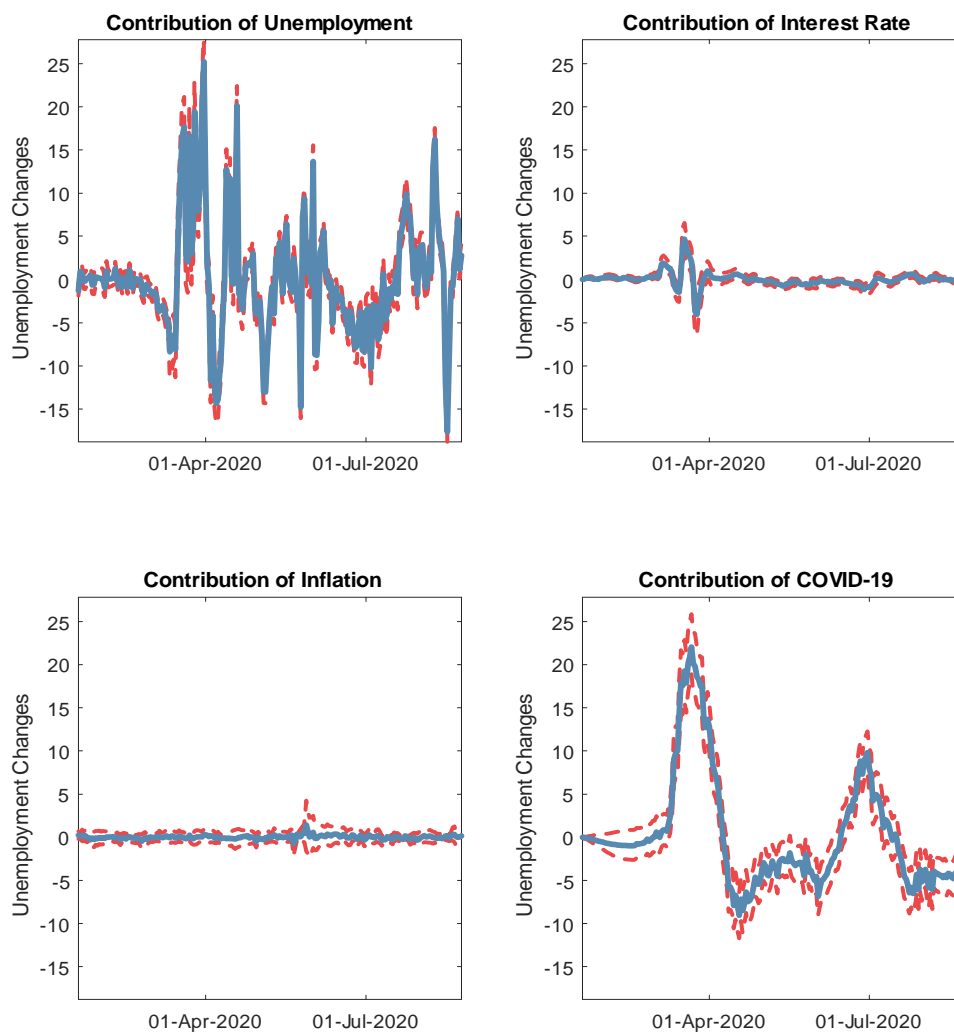Figure 1 - U.S. Data versus Google Trends
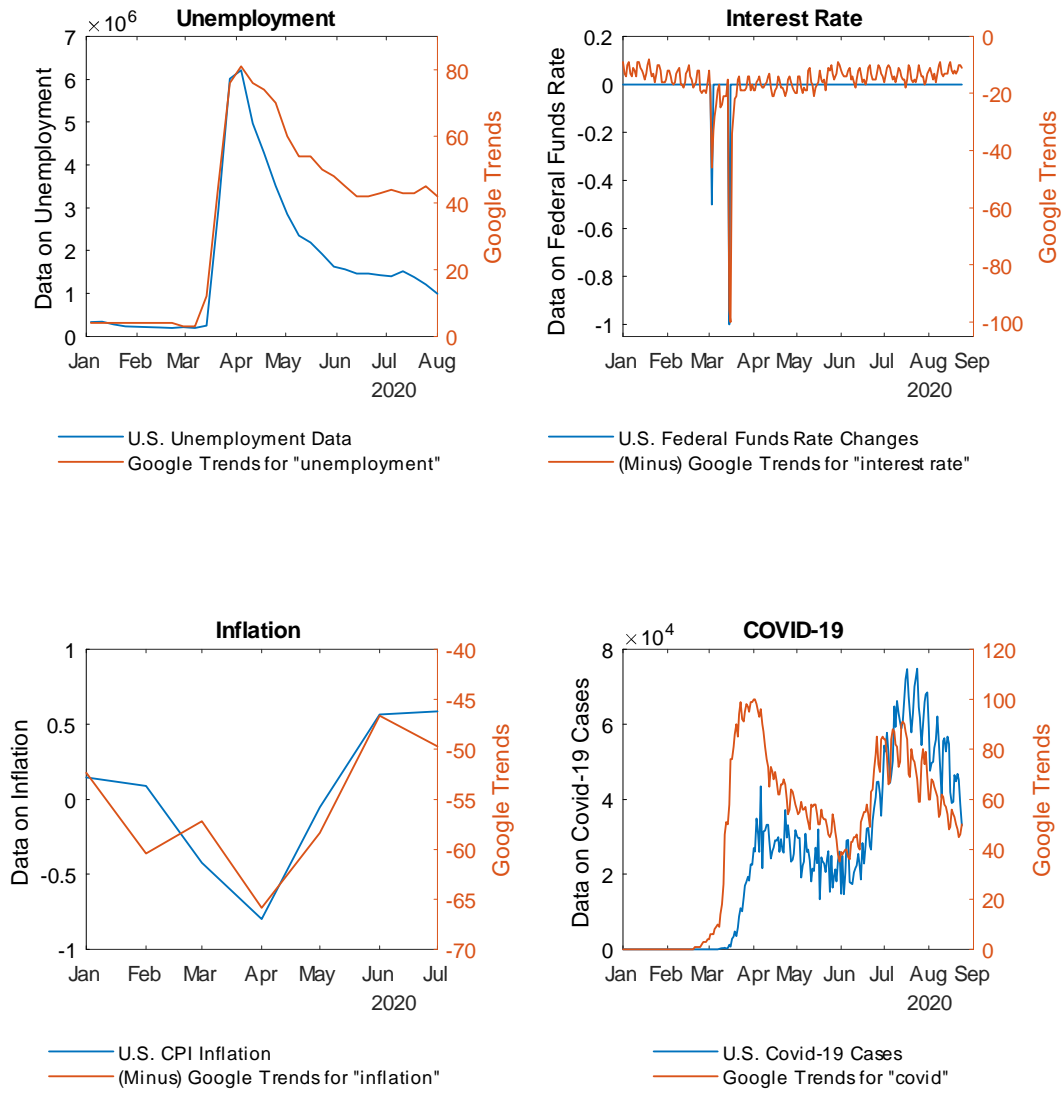
Notes: Google trends represent search interests relative to their peak popularity of 100.

Figure 2 - Cumulative Nationwide Effects of COVID-19
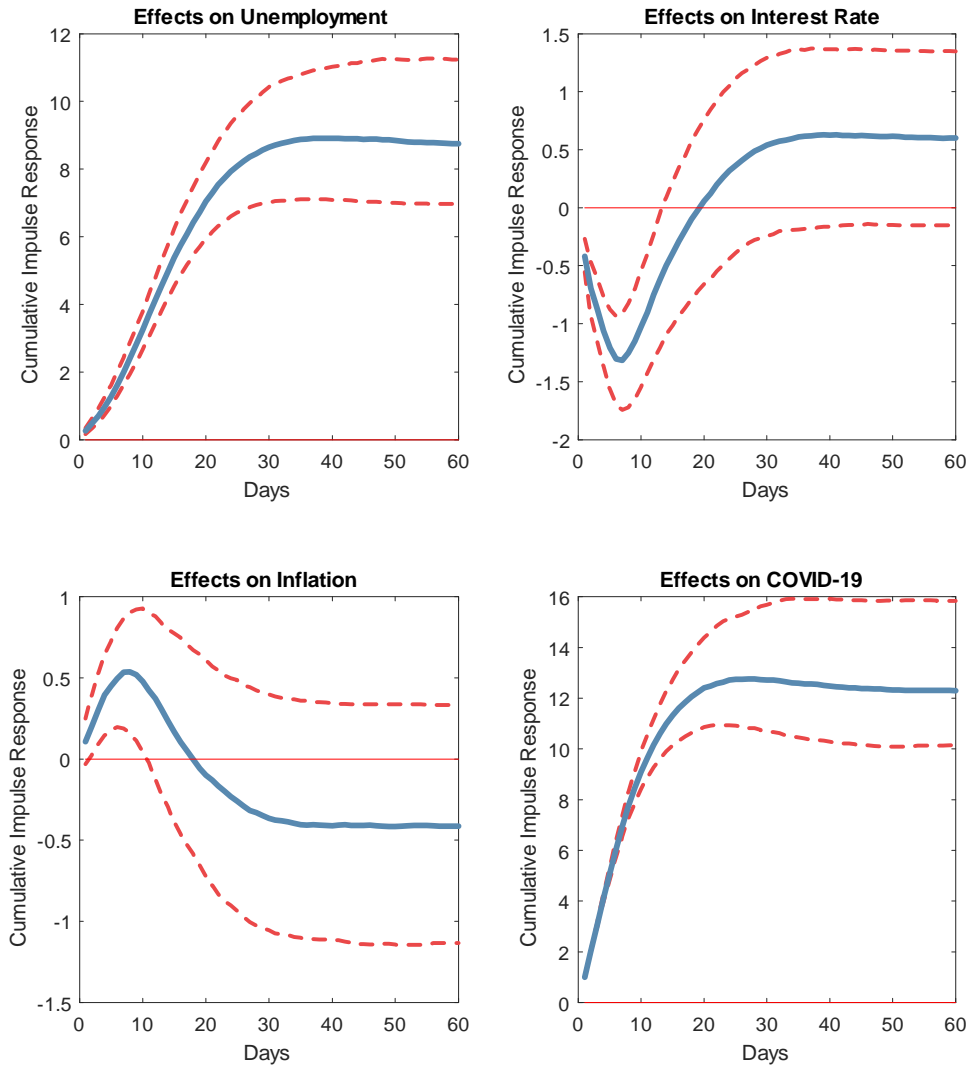
Notes: The solid lines represent the estimates, while dashed lines represent lower and upper bounds that correspond to the 68% credible intervals.

Figure 3 - Historical Decomposition of Nationwide Unemployment

Notes: The solid lines represent the estimates, while dashed lines represent lower and upper bounds that correspond to the 68% credible intervals.