Argonne NATIONAL LABORATORY

County Economic Impact Index

Measuring the Ongoing Economic Effects of COVID-19

Decision and Infrastructure Sciences Division

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Measuring the Ongoing Economic Effects of COVID-19

prepared by

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Executive Summary

What is the County Economic Impact Index (CEII)?

Disruptive events, including the COVID-19 pandemic, often result in significant changes in employment, personal income, industry output, and other measures of economic well-being and activity. Depending on the nature of the disruption, economic consequences can be relatively short-lived or they can linger for months or years. Argonne National Laboratory (Argonne) developed the CEII to track near real-time impacts to local economies across the United States. The CEII also provides insight into economic recovery over time. A CEII value of 1 indicates that a county's economy is in the same position as it was in January 2020, while scores below 1 indicate that it is worse off and scores greater than 1 indicate that it has since grown. It does not account for economic growth that would have happened under normal circumstances that did not occur.

What Does the CEII Measure?

The CEII estimates the change in overall county-level economic activity during the COVID-19 pandemic relative to January 2020. It shows which counties may be more susceptible to large reductions in economic activity compared to normal conditions by looking at which industries make up each county's economy and then tracking monthly changes in industry employment at the national level. Economic activity in the CEII is measured by the total value added of all industries within the county, also referred to as the county's Gross Domestic Product (GDP)[1]. Accordingly, the CEII data also includes annualized monthly estimates of county-level value added for more than 100 industries. Counties with economic activities dominated by industries experiencing rising unemployment can expect larger direct impacts to their local economies, particularly if the industries account for a large portion of the economic output of that county. Results are updated monthly and available for all U.S. counties, as well as the District of Columbia, Puerto Rico municipios, and the U.S. Virgin Islands.

Why Is the CEII Important?

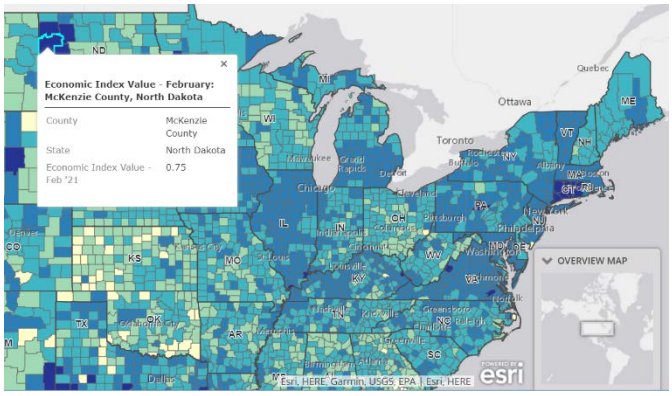
The CEII provides the ability to monitor trends over time of the economic health of counties in the United States. One way to measure overall economic activity in a region is through its gross domestic product (GDP), or the monetary value of all final goods and services produced in an economy in a given year. GDP can also be thought of as the total sum of the value added by each industry in an economy. Higher GDP values are associated with more economic activity in a region, while lower values are associated with less economic activity. For this reason, GDP is often used as an assessment of an economy's overall size and health. While not a perfect indicator of overall economic wellbeing, increasing GDP over time generally implies an economy is experiencing more economic activity (i.e. more production of final goods and services, higher levels of personal expenditure and investment, higher wages and profits, government purchases, etc.). Decreases in GDP may imply that an economy is experiencing higher levels of unemployment, lower wages, lower profits, and overall less production and spending in the economy. As

[1] Strictly speaking, Gross Domestic Product (GDP) refers to the entire domestic economic output of a nation. In the context of this document, GDP refers to the gross regional output of a county, or the county's contribution to GDP.

such, CEII values lower than 1 imply that more people are unemployed (due to fewer jobs) and businesses are producing and earning less than they were prior to COVID-19.

How Can I Use the CEII?

You can use the CEII story map to check on the current or trending economic situation in your local area. From the "Economic Index" tab at the top, clicking on your county will give you a pop-up box that provides the Economic Index calculation (EconomicIndex[month]) by month. Darker blue shades indicate less stable economies, while lighter green or yellow shades indicate more stability.



Users can also download the data here to see monthly results since January 2020, as well as to see county impacts by industry.

Introduction

Disruptive events, which include natural and human-caused disasters, international conflict, trade disputes, social unrest, climate change, and pandemics, have economic consequences. In addition to disruptions to physical infrastructure and systems that may interrupt access to critical services and supply chains, disruptive events often result in significant changes in employment, personal income, industry output, and other measures of economic well-being and activity. Depending on the nature of the disruption, economic consequences can be relatively short-lived, recovering within a few days of an event, or they can linger for months or years. While economists have developed a variety of methods (such as computable general equilibrium and input-output models) for estimating cascading impacts from economic disruptions, there is a need for near-real-time indicators of local economic conditions by decision makers responsible for managing impacts and consequences during long-term events.

This whitepaper introduces Argonne's County Economic Impact Index (CEII). The goal of the CEII is to identify regions whose local economies may be more adversely affected during medium- to long-term disruptions with near real-time (and readily available) data and track their recovery over time relative to a pre-event baseline. The index shows which counties are potentially more susceptible to large reductions in economic activity compared to normal conditions by accounting for the industrial make-up of each county's economy and tracking monthly changes in national employment by industry. Counties with economic activities dominated by industries experiencing relatively large increases in unemployment can expect larger direct impacts to their local economies, particularly if the industries are high-value.

One way to measure overall economic activity in a region is through gross domestic product (GDP), or the monetary value of all final goods and services produced in an economy in a given year. Higher GDP values are associated with more economic activity in a region, while lower values are associated with less economic activity. For this reason, GDP is often used as an assessment of an economy's overall size and health. While not a perfect indicator of overall economic wellbeing, increasing GDP over time generally implies an economy is experiencing more economic activity (i.e. more production of final goods and services, higher levels of personal expenditure and investment, government purchases, etc.), while decreases in GDP imply that an economy is shrinking.[2] Decreases in GDP may imply that an economy is experiencing higher levels of unemployment, lower incomes, and overall less production and spending in the economy. Traditionally, economists have officially recognized an economic downturn as a recession after two consecutive quarters of negative growth in real GDP.

There are a few different approaches to measuring GDP that evaluate the total contributions of separate components. These include the expenditure, income, and output approaches.[3] The expenditure approach measures total consumer expenditures, government purchases, capital and real estate investments, and imports and exports. The income approach measures the income from all factors of production in an economy, such as employee compensation and business gross operating surplus. The output, or value-added, approach measures the total value of all final goods and services and services produced in

[2] Increases in GDP may not necessarily be associated with other positive changes in economic wellbeing like reduced unemployment. For example, if increased GDP is achieved by investments in automation and other efficiency-improving capital rather than increases in output, employment losses could be an important consideration of economic wellbeing inaddition to any productivity gains implied by GDP growth.

[3] While the three approaches should all yield an equal result in theory, in practice they vary somewhat due to imperfect measurements of their various components.

an economy; in other words, it is the sum total of the value added by each industry. The CEII is based on this approach.

Value-added is the total output of an industry minus its inputs. For example, if a factory purchases steel for $2,000 that it turns into a vehicle worth $10,000, its total output is $10,000 while its value-added is $8,000. As such, an industry's value-added is a representation of its value to an economy. Decreases in a specific industry's value-added mean that it is adding less value to an economy, either because it is selling and producing fewer goods and services (which may be an indicator of reduced consumer income and demand), or because the inputs (such as labor, capital, energy, materials, etc.) it relies on have become more costly relative to its sales. While other measures of economic wellbeing are certainly important, decreases in a region's total value-added imply less overall economic activity, an indicator of potentially challenging economic conditions for the people who live and work there.

Method

The CEII represents the current (or near-current) level of economic activity in a county relative to a pre-event baseline. As such, the first step in calculating the CEII is calculating the baseline economic activity by industry (represented here as value-added) at the county level since data is not readily available at this level. Value-added for each county c and industry i is calculated for the baseline period as the value-added for the country as a whole multiplied by the share of national employment in industry i in county c in the base period (note, the sum over all industries is the county's total value-added, or GDP):[4]

$$VA_{c,i,base} = VA_{US,i,base}\frac{Emp_{c,i,base}}{Emp_{US,i,base}}$$

The second step is calculating the change in employment in each industry on a rolling basis, as this data is updated more frequently at the national level. This is calculated as the percentage change in employment nationally in industry i and month m from the pre-event base period (note, the pre-event base period may differ from the base period used to calculate value-added, and is thus designated with a hat[5]):

$$\%\Delta Emp_{US,i,m} = \frac{Emp_{US,i,m} - Emp_{US,i,\widehat{base}}}{Emp_{US,i,\widehat{base}}}$$

By multiplying the above equation by the baseline employment for each industry i in county c, summing over all industries in the county, and then dividing by total baseline county employment, this can be used to calculatethe total *estimated* percentage change in county employment in month m:

[4] This equation implies that all employees within an industry represent an equal amount of economic output and is thus more accurate for labor-intensive industries than for capital-intensive ones.

[5] Detailed value added by industry tables are updated annually by the Bureau of Economic Analysis, with the previous year's data becoming available late in the current year. It is assumed that (proportionally) value added by industry does not vary significantly from year to year. Because the CEII is ultimately represented as a proportion, a slight difference in reference period from the employment data does not pose an issue.

$$\%\Delta EmpEst_{c,m} = \frac{\sum_i \left(Emp_{c,i,base} \cdot \%\Delta Emp_{US,i,m}\right)}{\sum_i Emp_{c,i,base}}$$

This gives the change in employment in county c weighted by changes in national employment by industry. However, applying this calculation may not accurately capture the actual change in county employment in month m since it is based on national employment data. The actual percentage change in employment in county c in month m is:

$$\%\Delta Emp_{c,m} = \frac{Emp_{c,m} - Emp_{c,\widehat{base}}}{Emp_{c,\widehat{base}}}$$

The adjusted percentage change in employment in county c for industry i is then calculated as the national percentage change in employment in the industry adjusted by the difference between the actual and estimated change in county employment:

$$\%\Delta EmpAdj_{c,i,m} = \%\Delta Emp_{US,i,m} + (\%\Delta Emp_{c,m} - \%\Delta EmpEst_{c,m})$$

The difference between the actual and estimated change in county employment, or error, is a county-specific constant applied evenly across all industry-specific changes. The adjusted percentage change in county employment by industry represents the prospective change in value-added in industry i in county c. The new potential value-added (based on changes in employment) is then calculated as:

$$VA_{c,i,m} = VA_{c,i,base}\left(1 + \%\Delta EmpAdj_{c,i,m}\right)$$

The monthly CEII is represented by the ratio of the new total value-added for county c to its total baseline value-added:

$$CEII_{c,m} = \frac{\sum_i VA_{c,i,m}}{\sum_i VA_{c,i,base}}$$

Larger values of the CEII imply greater overall economic stability or even growth. Values equal to 1 imply that a county's economic activity is identical to its pre-event baseline, values below 1 indicate that the economy is experiencing less economic activity relative to the baseline, and values over 1 indicate that the economy has greater activity relative to the baseline.

As with any economic indicator, the CEII is not perfect. The sections below detail additional assumptions, notes, and limitations of the approach as well as current data sources and key results.

Data Sources

Table 1: Data sources used to calculate the County Economic Impact Index

Index Data	Data Source	Reference Period
Employment by Industry, US Total	Bureau of Labor Statistics (BLS), Quarterly Census of Employment and Wages (QCEW)	Annual, 2019
Employment by Industry by County	BLS, QCEW	Annual, 2019
Current Employment by Industry (excl. Agriculture), US Total	BLS, Current Employment Statistics (CES): Employment and Earnings, Table B-1a: Employees on nonfarm payrolls by industry sector and selected industry detail, seasonally adjusted	Monthly, Jan '20 - Feb '21
Current Employment (Agriculture), US Total	BLS, Labor Force Statistics from the Current Population Survey (CPS), Table A-7: Employed persons by class of worker and part-time status, seasonally adjusted	Monthly, Jan '20 - Feb '21
Current Employment by County, Total	BLS, Local Area Unemployment Statistics (LAUS): Labor force data by county, not seasonally adjusted, Jan 2020 – Feb 2021(p)	Monthly, Jan '20 - Feb '21
Detailed Value Added by Industry, US Total (nominal dollars)	Bureau of Economic Analysis, Industry Data: Underlying Detail of Industry Economic Accounts Data: GDP by Industry; U.Value Added by Industry	Annual, 2019
Seasonality Factor by Month and County	BLS, LAUS: Labor force data by county, not seasonally adjusted, January 2010 – December 2019	Monthly, Jan '10 – Dec '19

Additional Notes and Limitations

- The changes in employment are calculated using employment levels rather than the unemployment or employment rate, which account for changes in the labor force. Due to the increased potential for decreases in the labor force participation rate during prolonged economic disruptions (such as the COVID-19 pandemic), the unemployment rate may not reflect the true magnitude of employment losses. A more ideal measure is the employment per working-age population, however, such data is not readily available at the county level. Not accounting for population may not control for large swings in employment in small population areas and may overstate changes in employment relative to the employment rate (similarly, the unemployment rate may understate actual decreases in employment).
- The index represents changes in county employment based on national trends. While these changes are scaled to changes in individual county employment, they still may not be representative of actual changes in industry composition at the local level.
- The calculation of county value added assumes that all employees within an industry represent an equal share of that industry's output, which is a better assumption for labor-intensive industries than for capital-intensive industries.
- The BLS employment statistics do not account for self-employed (or "non-employed") individuals.
- The index accounts for nondisclosed and suppressed employment in industry/county

combinations in the BLS/QCEW dataset that have been withheld for purposes of confidentiality. In regions with suppressed data, the index assumes industry employment per establishment within a state is homogenous. See Nondisclosed Data section below for more details.

- These estimates do not directly account for provisions granted by the Coronavirus Aid, Relief, and Economic Security (CARES) Act or the Paycheck Protection Program (PPP); however, these provisions are observed indirectly through the use of the aggregate data.
- The index assumes that "economic impact" is best measured by changes in a county's value-added (or, gross county product) and that this is an indicator of overall economic well-being in the county.
- The most current index estimates rely on employment projections from the BLS/LAUS dataset, which may be modified as projections are adjusted in later months. This implies that the May index values availablein July may differ from the May index values in the August update after the projected estimates from the LAUS have been adjusted.
- While the index estimates monthly value-added by county, it is not intended to represent an estimate of current value-added ahead of those produced by the Bureau of Economic Analysis. It relies on their most recent detailed value-added by industry release (in this case 2019).
- The index does not explicitly account for mobility of individuals between their place of work and their place of residence if they are not in the same county. The BLS/QCEW is a census of establishments that counts where people work, while the BLS/LAUS is based off of the Current Population Survey and estimates local employment based on where people live. This difference is captured, in part, by the adjustment factor between estimated and actual changes in local employment. For certain regions where significant commuting exists, the adjustment factor will be larger because the estimated change will be less accurate.

Industry Mapping and Aggregation

The index currently accounts for monthly employment changes in 111 separate industries comprised of industry codes as defined by the North American Industry Classification System (NAICS) codes. The list is comprised of 72 three-digit codes, 27 four-digit codes, 5 two-digit codes, and 7 industry aggregates defined for the purposes of this study, which include separately federal, state, and local government. The government codes, named G1,G2, and G3, respectively, account for employment in all sectors associated with government owned establishments; the remaining 108 industries account for private employment only. The primary objective of the selected industry aggregation scheme was to achieve correspondence between the BEA's detailed value added estimates and the BLS' CEW estimates.

Agricultural and Farm Employment

The index uses a separate source for employment in the agricultural industry, as farm employment is not included in the BLS/CES data. Seasonally adjusted employment for agriculture and related industries is accounted for by data from the Labor Force Statistics from the Current Population Survey and is used to represent the entirety of NAICS 11 in the index, which includes employment in the entire agricultural

sector, such as crop farming, logging, and fisheries. A monthly data source that separates current employment in these sectors is not readily available.

Nondisclosed Data in the QCEW

Due to confidentiality concerns, the BLS withholds employment data for disaggregated industries in counties where specific employers and establishments could potentially be identified in its QCEW dataset. The BLS does, however, report the number of establishments for these industry levels for each county. Nondisclosed data poses a challenge for estimating the economic impact index, since approximately 41 percent of the records matching the industry aggregation are suppressed. To avoid significantly undercounting employment by industry for certain counties and systematically miscalculating the estimated monthly change in county employment ($\%\Delta EmpEst_{c,m}$), these values were filled by calculating the average employees per establishmentat the state level for each industry and multiplying by the number of establishments in a county (the national average was used in cases where the state-level data is nondisclosed).

While there is a slightly more accurate method for replacement of nondisclosure values, it has not been implemented in the interest of simplicity and inconsistencies in the QCEW data. This method involves subtracting out the reported county employment by industry from the state totals before calculating the state average employment per establishment. Using this method would only be accounting for employment by establishment for county/industry combinations with unreported employment, not inclusive of reported employment.

Seasonal Adjustment

The index relies on monthly county employment data from the BLS Local Area Unemployment Statistics (LAUS) to adjust estimates of national changes in employment by industry to actual changes in county employment. Because the LAUS relies on data from the Current Population Survey (CPS), a monthly survey of 60,000 households nationwide, the BLS does not provide seasonally adjusted estimates at the county level due to a lack of statistical significance. The estimates themselves are model-based.[6] However, due to significant seasonal variation in these estimates and in order for changes in a given period to be compared against a baseline period, the seasonality in these estimates needs to be accounted for. Note that the BLS' QCEW also producesseasonally adjusted county employment estimates by month, however, they are not released monthly.

To adjust the LAUS county data for seasonality, the employment for each month and county between 2010 and 2019 was divided by the annual average employment in the county to obtain a factor representing the ratio of that month's employment to the annual average. The average monthly seasonality factor was then calculated by taking the average of these factors for each month between 2010 and 2019. For example, in a given county, January employment may on average only be 80% of the annual average, while in July it may be 15% above. The seasonality factors would then be 0.8 and 1.15, respectively (the average factor is 1). The reported employment estimates were then divided by the seasonality factor for each month to arrive at the seasonally adjusted employment estimate. This process smooths the

[6] Bureau of Labor Statistics, https://www.bls.gov/lau/laufaq.htm#Q16

employment data, particularly in regions with significant seasonal variation in employment, in order to better isolate changes in the employment level due to the economic disruption.

The Year over Year Index

In addition to evaluating changes in economic activity versus a predefined baseline period, the CEII can be calculated relative to the previous year's data (that is, the "baseline" for each month is the economic activity for that month in the previous year, rather than a pre-event baseline). Calculating the index in this manner may provide additional insight into potential seasonal differences across specific industries and counties. While the equations for the year-over-year index are identical to the CEII, the year-over-year index uses seasonally unadjusted versions of the data for the monthly industry employment variables in Table 1. It also does not implement the seasonal adjustment procedure detailed in the above section on the LAUS data. The data for theyear-over-year index are shown in Table 2.

Table 2: Data sources used to calculate the year-over-year County Economic Impact Index

Index Data	Data Source	Reference Period
Current Employment by Industry (excl. Agriculture), US Total	BLS, Current Employment Statistics (CES): Employment and Earnings, Table B-1b: Employees on nonfarm payrolls by industry sector and selected industry detail, not seasonally adjusted	Monthly, Jan '20 – Feb '21
Current Employment (Agriculture), US Total	BLS, Labor Force Statistics from the Current Population Survey (CPS), Table A-22: Employed persons in agriculture and nonagricultural industries by age, sex, and class of worker, not seasonally adjusted	Monthly, Jan '20 – Feb '21

Special Considerations for Territories

The CEII dataset includes estimates for Puerto Rico and U.S. Virgin Islands (USVI). For Puerto Rico, estimates are provided for all 78 municipalities (municipios); for USVI, estimates are provided for St. Croix as well as an aggregated region that includes the islands of St. Thomas, St. John, and Water Island. Some months are missing for some municipios within Puerto Rico as data from the LAUS were not available in the early days of the pandemic. The estimates for Puerto Rico rely on the exact same data sources as the other counties within the CEII; those for the USVI rely on the same date sources as well, however, the LAUS estimates are not provided by the BLS and instead must be downloaded separately from USVI's Department of Labor website.

Importantly, U.S. GDP estimates do not include economic output from the U.S. territories or freely associated states. Because the CEII calculates local value added by industry as the share of the national value added in that industry made up by local industry employment, the value added by industry for Puerto Rico and USVI regions do not actually represent a portion of the U.S. GDP (i.e. if one were to sum up the total value added from all counties, not including Puerto Rico or USVI, it would equal the total U.S. value added). Rather the CEII assumes that the average output per worker for an industry is the same in Puerto Rico and the USVI as it is for the states.

For the Pacific Island territories (PITs), which include Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands, a separate economic impact index has been developed because the data sources and assumptions contain some significant departures from those in the CEII. Namely,

employment data for the PITs are not included in the BLS' QCEW statistics or LAUS estimates. A detailed discussion of the methodology and data used for estimating impacts to PITs is under development in a forthcoming whitepaper.

Key Results

Table 3: Top 20 most affected counties from COVID-19 according to the County Economic Impact Index for February 2021

Rank	State	County	Est. Value-Added (Jan '20) ($M)	Est. Value-Added (Feb '21) ($M)	Economic Impact Index
1	Texas	Loving County	$81	$35	0.431
2	Texas	Reeves County	$1,839	$1,164	0.628
3	Texas	Ward County	$1,423	$1,012	0.710
4	Texas	McMullen County	$533	$394	0.735
5	North Dakota	McKenzie County	$2,928	$2,244	0.751
6	Alaska	Kusilvak Census Area	$261	$251	0.776
7	Texas	La Salle County	$583	$461	0.788
8	Alaska	Dillingham Census Area	$346	$361	0.810
9	Texas	Zapata County	$675	$547	0.812
10	Texas	San Augustine County	$340	$277	0.815
11	Texas	Dimmit County	$1,356	$1,107	0.817
12	Illinois	Gallatin County	$201	$165	0.817
13	North Dakota	Williams County	$6,085	$5,013	0.821
14	Texas	Martin County	$536	$443	0.823
15	New Mexico	Lea County	$6,174	$5,062	0.824
16	Texas	Yoakum County	$785	$650	0.825
17	Texas	San Saba County	$349	$291	0.826
18	Iowa	Mitchell County	$783	$648	0.827
19	Texas	Live Oak County	$1,213	$1,035	0.827
20	Texas	Ector County	$12,720	$10,673	0.829

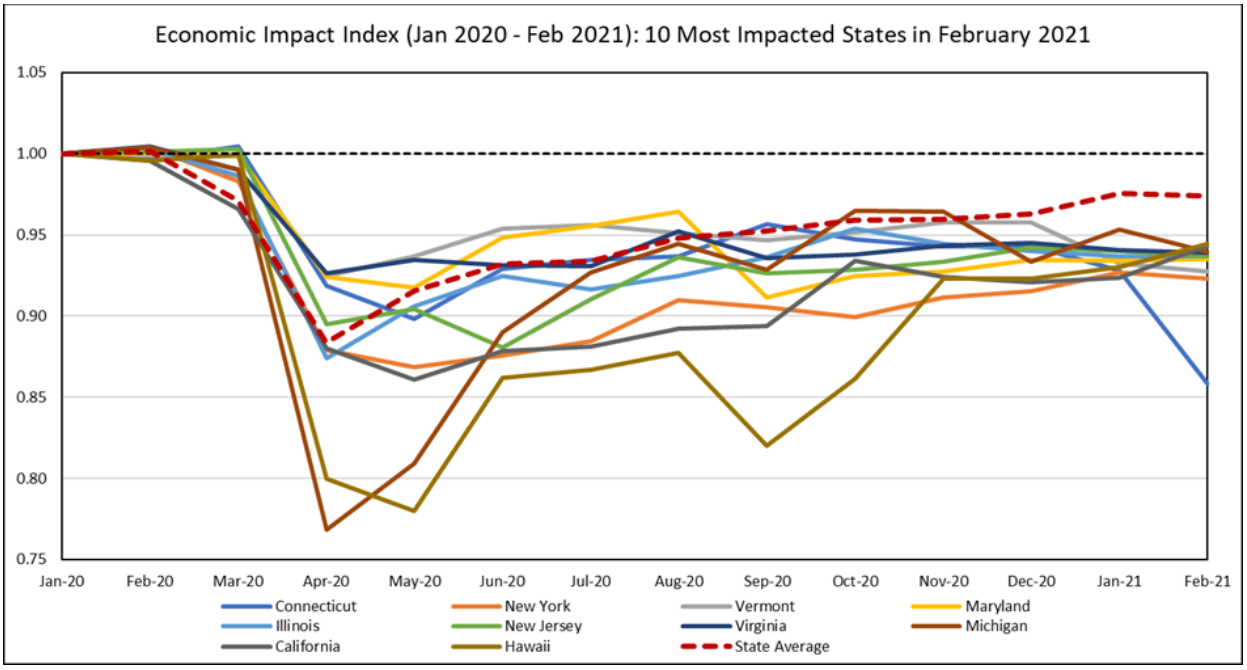


Figure 1:The Economic Impact Index for the 10 most impacted states in February 2021, January 2020-February 2021

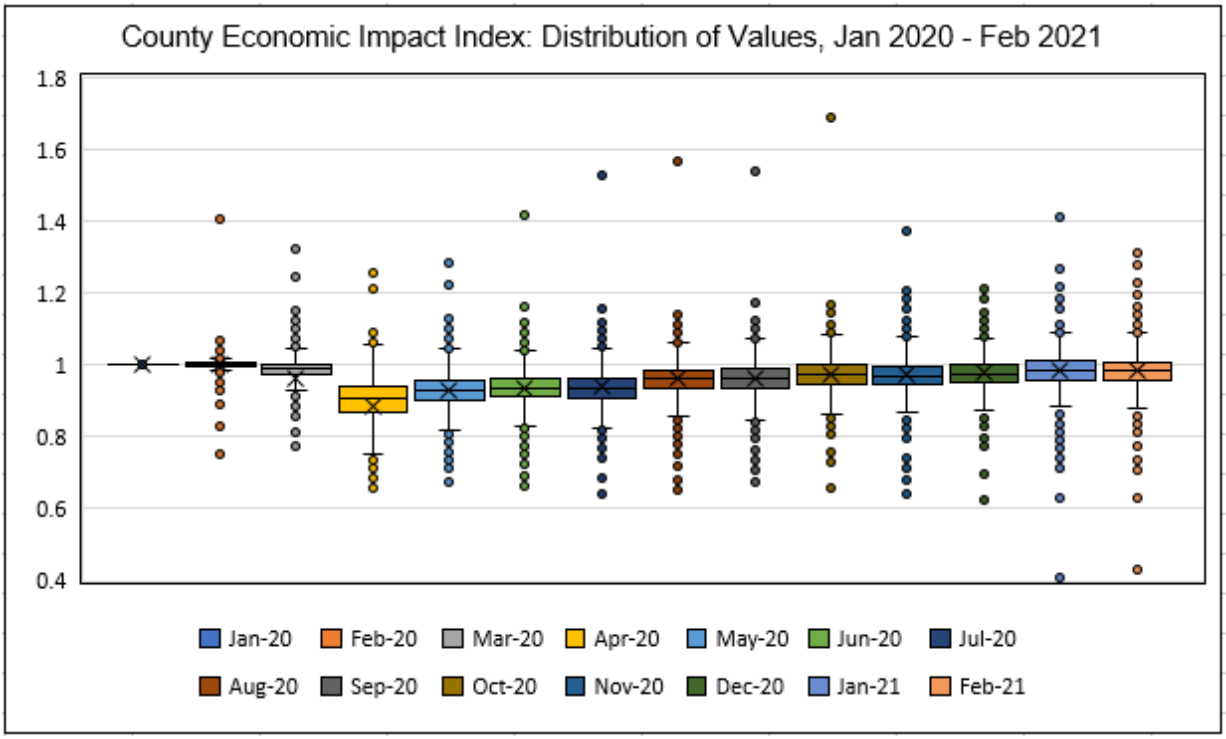


Figure 2: Distribution of values for the County Economic Impact Index, January 2020-February 2021

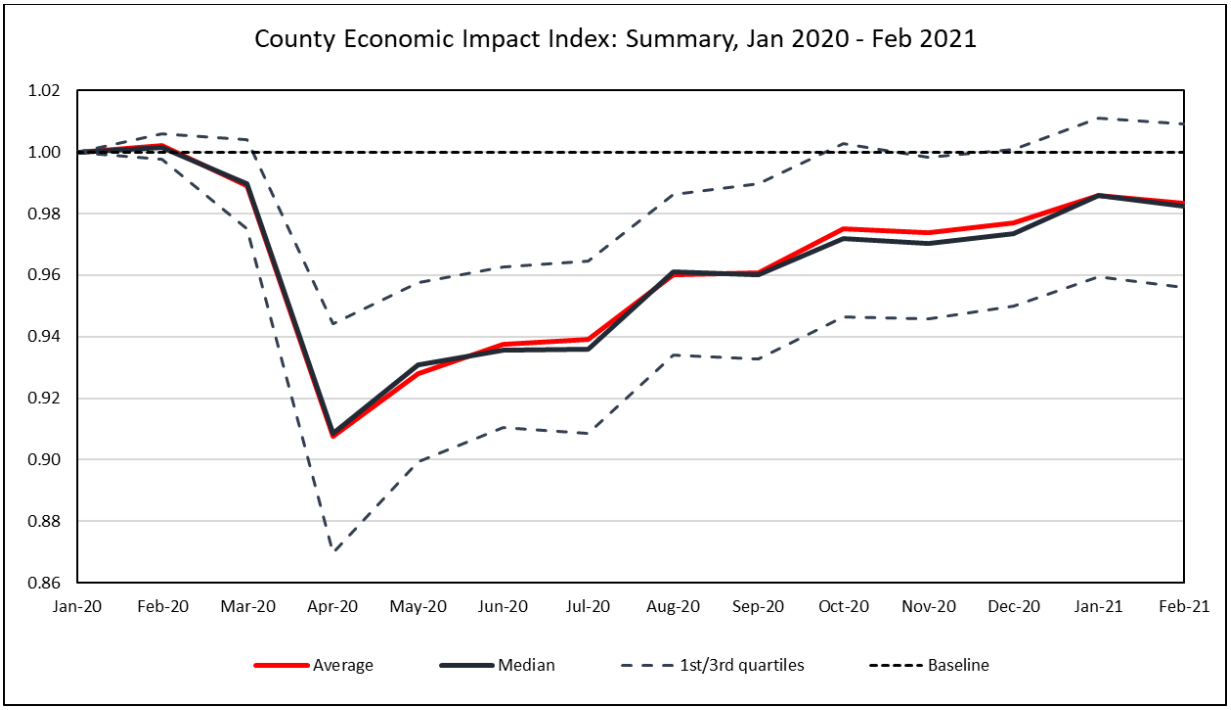


Figure 3: Summary statistics over time, January 2020 – February 2021

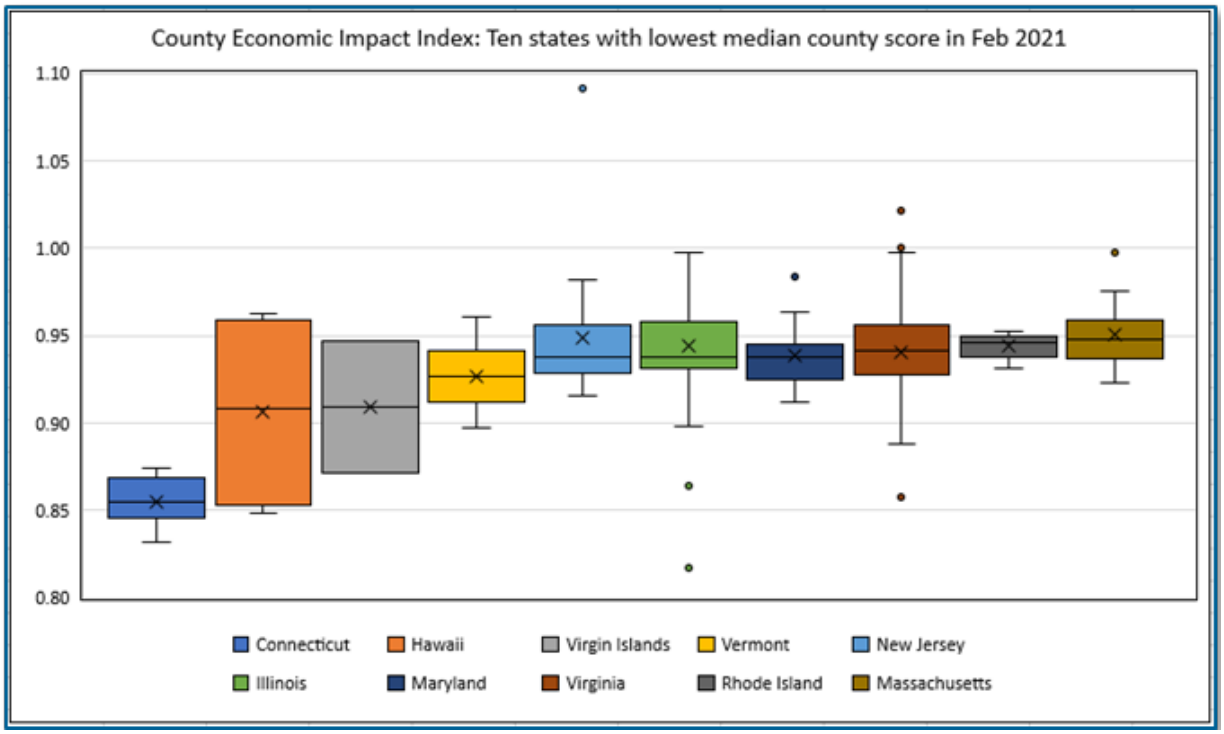


Figure 4: Ten states with lowest median CEII scores, February 2021

Appendix A: Data Dictionary

The following table describes the data columns provided in the index data file.

Table 4: Data Definitions

Sheet	Column Name	Units	Description
Both sheets	area_fips	-	Unique FIPS code representing each county
	state	-	State name
	county	-	County name
econ index	va_base	Billions USD	Total estimated value-added (sum of all industries) by county for base month (January 2020)
	va_[month]	Billions USD	Total estimated value-added (sum of all industries) by county for [month]
	pcEmpAct_[month]	Proportion	Percentage change in county employment in [month] from the base month (January 2020); calculated from the BLS/LAUS county-level data
	index_[month]	Proportion	Economic impact index by county for [month]
county by industry	naics	-	Unique industry code corresponding to the North American Industry Classification System (NAICS)
	naics_label	-	Industry name corresponding to the NAICS code
	va_base	Billions USD	Estimated value-added by industry by county for base month (January)
	va_[month]	Billions USD	Estimated value-added by industry by county for [month]
	pcEmpUS_[month]	Proportion	National percentage change in employment by industry in [month] from the base month (January 2020); calculated from the BLS/CES data
	pcEmpAdj_[month]	Proportion	Adjusted percentage change in employment by industry by county for [month] from the base month (January 2020); calculated as documented above

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