Transitioning Economic Statuses of Appalachian Counties during COVID-19

Ruohan Wu

Abstract In the past decade, the Appalachian economy in the United States was scarcely discussed in the literature. No studies were devoted to local economic development after the outbreak of the Coronavirus Disease in 2019. This paper fills the literature gap by empirically examining how the Appalachian economy transitioned under the influence of the pandemic. Using county-level data from the Appalachian Regional Commission between 2019 and 2022, the study investigates how the Appalachian economy regressed during the pandemic. Transitioning economy indices were calculated for 420 local counties by comparing their composite index values before and after the outbreak of the pandemic. Regressions were run to estimate the influences of the unemployment rate, per capita income, and the poverty rate. During the pandemic, the unemployment rate consistently had the largest impact on the Appalachian counties’ composite index value and the least effect on the poverty rate. The results suggest that the most effective strategy is for the government to reduce the local unemployment rate to improve the economic ranking.

Keywords Appalachian counties · Composite Index Value · Unemployment rate · Income level · Poverty rate · COVID-19

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Introduction

To date, an increasing number of studies have discussed the economic damages caused by the ongoing global Coronavirus Disease 2019 pandemic (COVID-19). For example, using global data from 77 countries, Ashraf (2020) found that government actions, such as social distancing orders, public awareness programs, testing, and quarantining policies, had a negative impact on stock market returns but also helped slow the spread of the virus. Gianella et al. (2021) and Ossome (2021) investigated how COVID-19 affected the health system in Peru and Africa. Kesar et al. (2021) and Miyamura (2021) both studied India. The former studied the impact of COVID-19 on employment and food security. The latter focused on how government policies further suppressed the workforce and widened income inequality. Picchioni et al. (2021) concluded that the old Nigerian food system was under a great deal of tension during the pandemic, demanding a social reproduction approach to enhance sustainability. Asante-Poku and van Huellen (2021) evaluated how the Ghanaian supply chain was affected by conducting comparative studies of past commodity prices and economic disturbances. The resilience of the Ghanaian economy was also studied. A long-term negative impact on its finances was expected.

To explore the economic impact of COVID-19, this paper specifically focuses on the Appalachian region of the United States (U.S.). This region is interesting due to its vast area, yet still underdeveloped economy compared to the national average. It covers 420 counties in 13 states, which are located from the south to the northeast of the U.S. The region’s share of the U.S. population shrank from 2002 to 2017. It also featured slower economic growth, a higher unemployment rate, and lower per worker earnings than the national average level (Appalachian Regional Commission, 2019). Therefore, economists need to investigate such a less-developed area in a developed country to determine how to strengthen the weakest link in the economy and further promote aggregate development. Our research question is straightforward: Which factor contributes most directly to transitioning economies in the Appalachian region under the impact of COVID-19?

The answer to this question provides meaningful guidance in economic practices. Understanding the most direct influencer of an economy is important for policymakers to effectively promote growth, especially in the post-pandemic era. With fears of a new recession, times like these call for resilient and strong leadership from the public sectors and cooperation from healthcare, business, and the wider society. Immediate relief measures need to be implemented and adjusted for those that may fall through the cracks. Medium- and long-term planning is needed to rebalance and invigorate the economy following this crisis. A broad socioeconomic development plan that includes specific sector-by-sector plans and aims to create an environment that encourages entrepreneurship is needed so that those with robust and sustainable business models can flourish. It would be prudent for local economists and governments to continuously reassess the state of play and ensure that what has been promised is delivered.
The Appalachian economy has received attention from multiple perspectives in the past. To name a few, Lewis and Billings (1997) studied how the Appalachian culture affected the local economy, and found that concepts such as familism and isolationism cultivated a subculture resistant to economic development. Oberhauser et al. (2001) did a case study on a network of home-based female knitters and examined the impact on household income. Latimer and Oberhauser (2004) looked into the continuing consequences of gender inequality in the Appalachian labor market despite local economic development. Foster (2006) used establishment-level data to study productivity dynamics in the Appalachian region, and confirmed that local development is qualitatively below the U.S. average level, probably due to creative destruction. However, in the last decade, rare attention has been paid to economic development in the Appalachian region, especially during COVID-19.

To fill this important gap in the literature, this study constructed a county-level panel dataset and investigated how the Appalachian counties’ economies were transitioning after the onset of COVID-19. The study acquired composite index values from the Appalachian Regional Commission (2019), calculated how much a county’s economy regressed since the pandemic, and examined effects of determinants such as the local unemployment rate, poverty rate, and per capita income. It was found that a fast-growing unemployment rate contributes the most to the regressing economic status of a county.

This study makes a couple of unique contributions. First, while most of the literature focused on developing countries, the current study discusses a specific area in a developed country that deserves equivalent attention. During the prevailing pandemic, massive uncertainty and risks were borne by the global society. All countries, regardless of their development levels, faced two important questions: how to help the economy recover, and how to mitigate the damage caused by a pandemic that lasted for over 16 months. In this regard, a gap in the extant literature is filled by investigating the economic damages to developed economies.

Second, the unique dataset provides interesting and valuable information. Using the latest data from the U.S., this study is one of the first scholarly works to investigate the pandemic’s concrete effects. It provides data-supported analysis of Appalachia’s transitioning economy before and after the outbreak, describes the fragility of the local economy, updates the common understanding of the economic impacts of COVID-19, and permits the study of how to effectively promote economic development in the future.

Data Description

Currently, information on the Appalachian economy is generally updated to 2019, and reported in Table 1. Column (i) reports the unemployment rate, per capita income, and the poverty rate, as well as the adjusted levels in 2019. The unemployment rate, per capita income, and the poverty rate distributions are all right-skewed

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1 For more details about Appalachian counties, please refer to Online Supplemental Appendix Table 1.
Table 1  Descriptive Statistics of Appalachian Counties’ Economies, 2019 (N = 420)

|                           | Median | Average | Standard error |
|---------------------------|--------|---------|----------------|
| Unemployment rate         | 4.65%  | 4.93%   | 0.07%          |
| Per capita income         | $26,304| $27,399 | $348           |
| Poverty rate              | 16.90% | 17.70%  | 0.27%          |
| Unemployment rate, as percent of the U.S. average | 117.10% | 124.20% | 1.70% |
| Per capita income, as percent of the U.S. average | 56.00% | 58.33% | 0.74% |
| Poverty rate, as percent of the U.S. average | 126.00% | 131.90% | 2.02% |

Data source: Appalachian Regional Commission (2019)
in the Appalachian region. Compared with the national average, the Appalachian region features higher unemployment and poverty rates and a much lower income level. Therefore, this region is less developed than the national average level, requiring further investigations on how to effectively promote the region’s development.

Column (ii) in Table 1 reports the annual percentage growth rate for each variable, in other words, how much in percentage terms the values of these variables changed from 2018 to 2019. On average, Appalachian counties experienced decreasing unemployment and poverty and increasing per capita income. As a percentage of the U.S. average, the Appalachian region’s unemployment rate and per capita income both decreased in 2019, and the poverty rate increased. Compared with the national average, the Appalachian region’s employment improved in 2019; however, its income level and poverty remain problematic.

Information was acquired from the Appalachian Regional Commission (2019), which actively identifies and monitors the economic status of the 420 Appalachian counties. Adopting an index-based classification system, the Appalachian Regional Commission (ARC) evaluates counties’ composite index value (CIV) based on three variables: 1) The three-year average unemployment rate, a commonly accepted measure of long-term structural unemployment; 2) per capita market income calculated as total personal income less transfer payments divided by the total population; 3) five-year poverty rate estimates, calculated by dividing the number of persons living below the poverty threshold by the number of persons for whom poverty status has been determined. Hereafter for simplicity, these variables will be referred to as the unemployment rate, per capita income, and the poverty rate. ARC averages these three variables, which are adjusted as a percentage of the concurrent U.S. average, to estimate CIV for country \( i \) in year \( t \) following Eq. (1):

\[
CIV_{it} = \frac{A_{it} + B_{it} + C_{it}}{3} \times 100
\]

where \( A \) indicates the adjusted unemployment rate, \( B \) indicates the inverse (the reciprocal) of the adjusted per capita income, and \( C \) is the adjusted poverty rate. In this unitless numeric measurement, the ARC weights each variable equally. A bigger CIV value indicates a less developed economy with a higher unemployment rate, lower income level, and higher poverty rate relative to the respective U.S. average level. An increasing CIV indicates a regressing economy.

Every mid-year, ARC updates the CIV in Appalachian counties for the next fiscal year. For example, the CIV for fiscal year 2022 (effective October 1, 2021 to September 30, 2022) was released in June 2021. The annual CIV report is released within local governments to reflect their economic performance. Table 2 reports the CIV statistics from fiscal years 2019 to 2022. Every year, the distribution of the CIV is right-skewed with the majority of CIVs being higher than 100%. Therefore, compared to the U.S. average level, most of the Appalachian counties had higher unemployment, lower income, and a higher poverty rate.

To further investigate Appalachian economic development, Table 3 reports the number of counties whose CIV changed between two subsequent years. Notice that a higher CIV indicates a worsening economy, while a lower CIV indicates an
improving economy. Overall, in these four years, there were more counties that had improving economies (decreasing CIV) than those with worsening economies (increasing CIV). Therefore, the Appalachian region sees slow economic development over time.

**Methods and Results**

This study is interested in which factor contributed the most to the Appalachian counties’ transitioning CIV during the COVID crisis. According to Eq. (1), the levels of the unemployment rate, per capital income, and poverty rates are equally weighted in the estimation of the CIV. Theoretically, the three component factors’ growth rates contribute equivalently to CIV growth. However, empirically the conclusion will be different in the context of COVID-19. Estimated models provide a more practical comparison between these factors in the examined period. Subsequently, the study examines counties’ changing CIV before and after the outbreak of COVID-19. Since the CIV estimates for fiscal years 2021 and 2022 are effective from October 2020 to September 2022, they are considered to be exposed to the pandemic and, therefore, post-COVID. Meanwhile, the CIV for fiscal years 2019 and 2020 were estimated prior to the pandemic and are thus considered to be pre-COVID.

Two models were constructed to examine the determinants of Appalachian counties’ changing economies. In Model 1, each county’s average CIV was computed pre- (in fiscal years 2019 and 2020) and post-COVID (2021 and 2022), respectively, and defined as $d(CIV) = \text{average CIV after COVID} - \text{average CIV before COVID}$. Further, a growth variable is defined as $g(CIV) = d(CIV)/\text{average CIV before COVID}$. In this regard, $d(CIV)$ and $g(CIV)$, respectively, indicate the change and growth of CIV before and after COVID-19.

| Data source: Appalachian Regional Commission (2019) |

### Table 2 Descriptive Statistics of Appalachian Counties’ CIV, 2019–2022 (N = 420)

|         | 2019   | 2020   | 2021   | 2022   |
|---------|--------|--------|--------|--------|
| Minimum | 67.8   | 69.1   | 68.1   | 67.6   |
| Median  | 138.8  | 138.4  | 138.6  | 138.8  |
| Average | 143.8  | 144.7  | 145.5  | 146.3  |
| Maximum | 301.0  | 281.6  | 293.9  | 293.1  |

### Table 3 Numbers (Percentages) of Counties with Changing CIV (N = 420)

|                  | 2019–2020 | 2020–2021 | 2021–2022 |
|------------------|-----------|-----------|-----------|
| Same CIV         | 2 (0.48%) | 7 (1.67%) | 4 (0.95%) |
| Increasing CIV   | 180 (42.86%) | 177 (42.14%) | 167 (39.76%) |
| Decreasing CIV   | 238 (56.67%) | 236 (56.19%) | 249 (59.29%) |

Data source: Appalachian Regional Commission (2019). Percentages of counties are reported in the parentheses.
In Model 2, the data were re-sorted, redefining each county’s \( d(CIV) = CIV_t - CIV_{t-2} \), \( t = \{2021, 2022\} \), comparing a county’s CIV over two years. This alternative method was used to evaluate how much a county’s economy changed before and after the pandemic. A new \( g(CIV) \) was re-estimated accordingly. In both Model 1 and 2, the larger a county’s \( d(CIV) \) is, the more its economy worsened since the occurrence of the pandemic. The larger a county’s \( g(CIV) \) is, the faster its economy worsened.

Ordinary least squares (OLS) regressions were then performed on Eq. (2):

\[
[d(CIV_i), g(CIV_i)] = \beta X_i + \theta_i + \epsilon_i
\]

where \( X_i \) includes the following explanatory variables of county \( i \) observed in 2019, before the pandemic, all as the level or as a percentage of the U.S. average: the growth rate of the three-year average unemployment rate, the growth rate of the inversed per capita personal income, and the growth rate of the five-year estimate of the poverty rate.

In Eq. (2), \( \theta_i \) captures the fixed effects of the states in which the counties are located, and \( \epsilon_i \) is the error term. When estimating Eq. (2), an important endogeneity problem must be addressed because an economically depressed county lacks the opportunity to develop and tends to be trapped in difficulties, being unable to improve its employment or income level. Meanwhile, counties’ employment, income, poverty rate, and CIVs are affected by the same elements of unobserved heterogeneity, such as location, history, or government support.\(^2\)

Notice that in Eq. (2), the explanatory variables captured in \( X_i \) are all time-lagged behind the response variables that evaluate CIV between 2019 and 2022. This method helps to mitigate the endogeneity problem because theoretically, the lagged variables captured in \( X_i \) are not correlated with the concurrent error term \( \epsilon \). It also reveals the longitudinal effects of these explanatory variables because it takes time for counties’ unemployment, income, or poverty issues to have an effect on their development level in the long run.

The results are reported in Table 4. As expected, the growth rates of unemployment, inversed per capita income, and poverty all exert significantly positive influences on the change and growth of the CIV. In Model 1, if the growth of the unemployment rate increases by 1%, \( d(CIV) \) will significantly increase by 0.6 and \( g(CIV) \) by 8.6%. If the growth rate of per capita income decreases by 1%, \( d(CIV) \) and \( g(CIV) \) significantly increase by 0.4 and 4.5%, respectively. A 1% faster growing poverty rate significantly increases \( d(CIV) \) and \( g(CIV) \), respectively, by 0.2 and 3%. Comparatively speaking, given the same percentage change, the growth of the poverty rate exerts the least profound influence on Appalachian counties, while unemployment growth exerts the most.

Meanwhile, if a county’s unemployment rate, adjusted to the percentage of the U.S. average, increases 1% faster, its \( d(CIV) \) will significantly increase by 0.4 and

\(^2\) Some of the explanatory variables are significantly correlated; please refer to the Online Supplemental Appendix Tables 2 and 3. In order to address the multicollinearity issue, tests were conducted on the variance inflation factors (VIF) of the coefficients estimated from the models. The results are in Online Supplemental Appendix Table 4. All the VIFs are well below 5, indicating no severe correlations between the explanatory variables that require special attention.
| Response variables | Model 1 | | | Model 2 | | | |
|-------------------|---------|---|---|---------|---|---|---|
|                   |        | (i) | (ii) | (iii) | (iv) | (v) | (vi) | (vii) | (viii) |
| Unemployment rate growth | 0.628*** - | 8.601*** - | 0.743*** - | 8.728*** - |
| (0.090)  | (1.411) | (0.175) | (0.400) |
| Inversed per capita income growth | 0.430*** - | 4.501*** - | 0.536*** - | 6.254*** - |
| (0.050)  | (0.780) | (0.140) | (0.229) |
| Poverty rate growth | 0.200*** - | 2.960*** - | 0.430*** - | 4.566*** - |
| (0.042)  | (0.669) | (0.100) | (0.319) |
| Unemployment rate growth, as percent of US average | - 0.387*** - | 3.291*** - | - 4.265*** - | 5.994*** |
| (0.058)  | (0.891) | (0.083) | (0.646) |
| Inversed per capita income growth, as percent of US average | - 0.245*** - | 1.993*** - | - 3.316*** - | 4.450*** |
| (0.032)  | (0.493) | (0.067) | (0.369) |
| Poverty rate growth, as percent of US average | - 0.115*** - | 1.534*** - | - 3.071*** - | 1.966*** |
| (0.028)  | (0.422) | (0.048) | (0.516) |
| Adjusted R² | 0.419 | 0.428 | 0.516 | 0.457 | 0.930 | 0.961 | 0.825 | 0.411 |

Data source: Appalachian Regional Commission (2019). Note: Estimations of β are reported in this table. Standard errors are reported in parentheses. *** , ** and * represent significance at 1%, 5% and 10% respectively. In every regression, the fixed effect of states is included as an absolute value or as a percentage of the U.S. average, and exerts the largest influence on both response variables. A 1% faster growing poverty rate, at the same time, exerts the least influence. Therefore, the robustness of the finding is confirmed.
$g(CIV)$ by 3.3%; if a county’s adjusted per capita income, decreases 1% faster, its $d(CIV)$ will significantly increase by 0.2 and $g(CIV)$ by 2%. Additionally, a 1% faster-growing adjusted poverty rate significantly increases a county’s $d(CIV)$ by 0.1 and $g(CIV)$ by 1.5%. The change in unemployment rate again has the biggest influence while the poverty rate has the smallest.

The same findings are also displayed in Model 2, with a set of differently estimated $d(CIV)$ and $g(CIV)$. A 1% faster growing unemployment rate, either in the form of the absolute value or as a percentage of the U.S. average, exerts the largest influence on both response variables. A 1% faster growing poverty rate concurrently exerts the least influence. Therefore, the robustness of the finding is confirmed.

**Discussions and Policy Implications**

Although the CIV is a partial measurement of the overall economy, it is based on the unemployment rate, personal income, and the poverty rate, which all closely relate to the labor market and profoundly affect the economy. Every year, ARC ranks all the Appalachian counties according to their CIVs and releases the results to local governments. If a government intends to enhance its ranking in this area, it must have a better understanding regarding the determinants of the CIV. In this study, the major finding is that, given the same percentage change, the rise in a county’s unemployment rate contributes the most to an expanding CIV or the deterioration of the economy. In other words, an improving employment rate most directly prevents Appalachian counties’ economies from lowering their economic standing, compared to increasing personal income or a decreasing poverty rate. The most effective strategy is for the local government to emphasize reducing the unemployment rate to improve one’s economic ranking.

Here are several useful policy suggestions. First, the government should improve public services provided via the labor market. Lee et al. (2006) investigated U.S. federal employees’ attitudes since the Civil Service Reform Act of 1978, and found that employee perceptions of organizational effectiveness, job satisfaction, and support for organizations were mainly affected by factors such as empowerment, supervisory leadership, teamwork, performance evaluation fairness, and rewards, which are all related to the labor relationship. Therefore, establishing modern business organizations with properly designed employer-employee relationships would be very helpful. Increasing the minimum wage and merit pay can also effectively increase the bargaining power of low- and moderate-wage workers, and create a supportive environment for local entrepreneurs and workers (Coviello et al., 2021).

Another important task is to boost not only the quantity but also the quality of the local workforce. Theoretically, the growth of employment is driven by economic growth facilitated by productivity. Westover et al. (2010) showed that increasing productivity could enhance workers’ job satisfaction and long-term organizational commitment. Prasetyo (2019) proved that entrepreneurial productivity could be the main driving force of employment and economic development. Therefore, improving labor productivity could effectively promote worker motivation and morale, and benefit local employment in the long run. Promoting education and literacy would
be a highly effective policy to bridge the gap between local worker capability and the modern production techniques. More public assistances should be provided to all levels of schools, colleges, universities, and professional institutions which most directly serve all present and future employees and prepare them for different professions. The quality of education is critically important in improving Appalachian employment.

Government-led programs that aim to reform local industrial structure is another way to improve the sustainability and resilience of the local economy. Ham et al. (2011) compared three U.S. federal and state government programs (State Enterprise Community, Federal Empowerment Zones, and State Enterprise Zones) in the 1990s, and found that all of them exerted significantly positive influences on the labor market in terms of the unemployment rate, poverty rate, and income level. A proper leadership role by the government proves to be important. As discussed in Seo (2017), financial supports in the form of direct government loans or government-guaranteed loans provided to small and medium enterprises could strongly improve employment and economic conditions. Policies that ease financial stability, steps to ease pro-cyclicality such as finding new investment opportunities, developing more industries that suit local conditions, and building up the production capacity of the whole society, should all be useful measures to construct a sustainable labor market.

Meanwhile, it is also important for the government to design specific policies based on local economic characteristics. Kaplan et al. (2022) estimated the costs of the pandemic using fatalities and reduced economic activities in the U.S. as well as globally, and explored the causes of different policies. They concluded that the harshness of social-distancing policies was mostly motivated by political instead of public health considerations. Similarly, Boettke and Powell (2021) concluded that the policy responses to COVID-19 around the world were not consistent with recommendations from welfare economics. Governments in the U.S. and around the world made significant errors in responding to COVID-19 because of political rules, institutional arrangements, and the conflict between federalism and demand for control. Therefore, conflicts between economic and political interests must be carefully addressed by all levels of Appalachian governments so that they can safely navigate out of this economic turmoil.

Conclusions

This study empirically looked into the transitioning economies of Appalachian counties before and after the outbreak of COVID-19. Acquiring data from multiple sources, a county-level panel dataset was constructed to investigate the determinants of transitioning the Appalachian economy. The study then evaluated how much a county’s economy was regressing due to the COVID-19 outbreak. Based on two CIV estimators, it was found that the growth in the unemployment rate, per capita income, and the poverty rate all exerted significant effects on the Appalachian counties’ economies during COVID-19. Further, the growth in
unemployment robustly had the biggest impact while the poverty rate the least. Therefore, to mitigate the economic damages caused by COVID-19, the government should endeavor to improve local employment and the labor market.

Of course, this study is subject to limitations with respect to the available years of data. Should more years of information become available, counties’ longitudinal development post-COVID can be studied. One may then be able to answer questions such as how long counties have been affected since the pandemic started, or how fast they can recover after the pandemic ends. However, due to the limited time horizon in the current data, we were only able to investigate Appalachian counties’ economies from 2019 to 2022. In addition, there are very limited data sources on county-level economies in the U.S. This study is from the ARC’s perspective and relied on the CIV, the only official measurement of the Appalachian economy, to evaluate local countries’ economies. Nonetheless, should more variables become available, one can potentially investigate additional interesting facts regarding economic development in Appalachia. Given new county-level data that includes a longer period of observation, the economic impacts of COVID-19 can be studied more comprehensively; for example, how much worker income has been deducted, how the market structure has transformed, and how long it takes for different counties to recover from the crisis.

Meanwhile, there exist meaningful directions to extend this study. For instance, the effects of specific government support (e.g., stimulus packages, wage subsidies, or tax credits) on the Appalachian economy are topics that are worth careful investigation. Provided with detailed information on the relief programs received by local enterprises, interesting findings on their responses to COVID-19 as well as public assistance can consequently be examined.

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