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Evaluation of US and China's post-pandemic recovery

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Abstract: We focus on the relationship between inflation and unemployment in the United States and China, the two biggest economic systems in the world before and after the COVID-19 pandemic. We used a comprehensive monthly dataset of two countries' Consumer Price Index (CPI), unemployment rate, and interest rate from 2019 to 2022 and performed time series regressions to analyze the relations among these variables. We found strikingly different paths for the two countries, with the US path closely matching conventional economic theory, while China's deviated significantly.

Keywords: Economic impact, Unemployment Rate, Inflation Rate, COVID-19.

1. Introduction

We investigate the economies of the United States and China before and after the 2020 CoVID-19 pandemic, focusing on how the two countries recovered. Comparing changes in the inflation and unemployment rate of the United States and China in the early and recent stages of the pandemic, we gain insight about the impact of the coronavirus on the society of the two countries.

The pandemic had a huge negative impact on countries' economies, and on most global economies. Global trade slowed, workers lost their jobs, and economies went into recession. Unemployment in the United States increased to double digits [3]. (Hoover, 2022) Now, with reduced cases, many countries' economies are recovering. For instance, China has a gradual growth rate in the second half of 2020.

The inflation rate is a key indicator of price level while the unemployment rate is an indicator of output level. A. W. H. Phillips, a New Zealand economist, investigated the relationship between unemployment and inflation. He plotted a graph of the inflation and unemployment rate and found the relationship between them by drawing curves. This is known as the Phillips curve. In Keynesian's view, due to downward inflexible nominal wages, there is a tradeoff between inflation and unemployment. Furthermore, in the Neoclassical view, although there is a tradeoff between inflation and unemployment in the short run, the long-run Phillips curve is vertical at the natural rate of unemployment since the economy can self-adjust itself in the long run. Therefore, recovery will lead to a shifting of the Phillips curve to the left, which represents a decrease in both inflation and

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unemployment. Although there are two different views about the Phillips curve, it is a theory that analyzes the two important indicators of macroeconomics.

2. Literature search

A 2021 paper, using the UK and India as examples, examines the impact of the epidemic on inflation and unemployment rates. According to Victor, both the UK and Indian economies have been negatively impacted by the epidemic and will need to be stimulated to return to pre-epidemic economic conditions in the long term [8]. (Victor et al. 73) The paper uses wavelets transform of time series analysis, a useful method for studying the relationship between variables change over time in economics, as the methodology to process the data. Another studied the inflation rate during the pandemic in Indonesia. The authors used data panel regression, a method that combines cross-section data and time series, to analyze and forecast inflation [9]. (Yuniarti, Rosadi and Abdurakhman 012039)

Gunay, Samet, Gökberk Can, and Murat Ocak predicted the recovery of the Chinese economy after the epidemic [4]. (Gunay, Can, and Ocak 3-17) Using the MIDAS methodology to analyze the data, the authors conclude that although the Chinese economy was hit harder by the epidemic than the 2008 global financial crisis, they expected China's economy to recover in the following years.

Faria-e-Castro and Miguel did research that focuses on the impact of fiscal policy, in part on the impact of the recovery from the pandemic [3]. (Faria-e-Castro 104088) The paper models the impact of fiscal policy during the epidemic and concludes that fiscal policy, such as tax cuts, is useful but does not play a particularly significant role in stimulating the economy during the recovery after the pandemic.

In another paper written by Petrova, L. A., T. E. Kuznetsova, and V. M. Volodin, the authors examine the economic situation in developed countries, mainly Russia, and through analysis and modeling predict economic recovery after the epidemic, conclude that monetary policy is necessary for economic recovery, and point out the importance of innovation and education for global economic recovery [6].

After reading those papers, we learned various views from others about the impact of the pandemic on the global economy and the recovery of the economy after the pandemic, including the impact of various policies on the economy. Also, we learned a lot of methods to analyze the data from the pieces of literature. Finally, decided to use also time series regression as our methodology to analyze the data.

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3. DATA

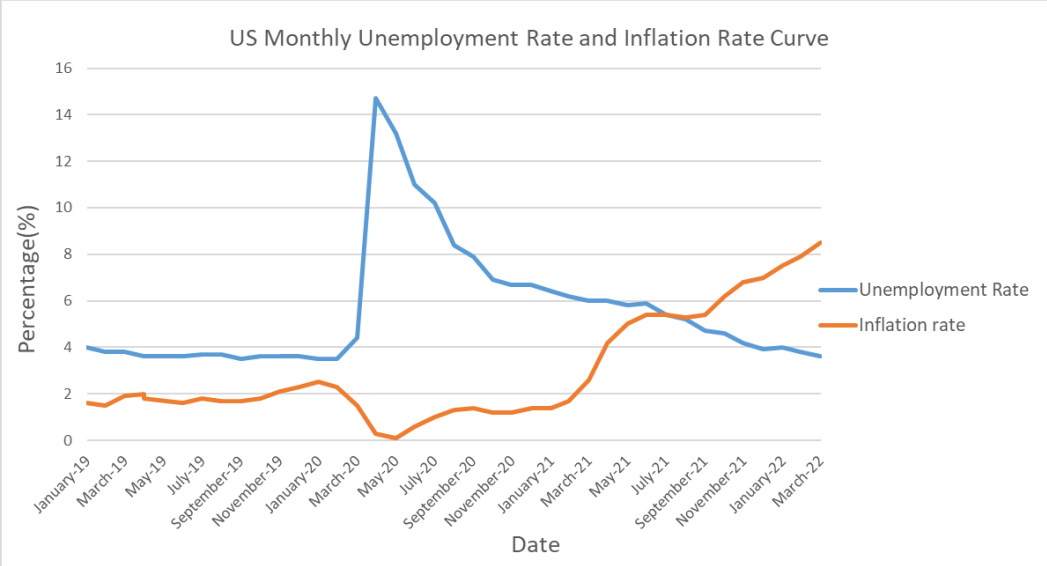

Figure 1: US Monthly Unemployment Rate and Inflation Rate Curve.

The spread of Coronavirus has impacted human society worldwide. According to the graph, the unemployment and inflation rate started to have a big shift, compared with the previous data before the first confirmation of the COVID-19 case in the United States on January 20th, 2022. Before the spreading of the pandemic in the US, which refers to the time before March 2020, the unemployment of the United States was stable and only fluctuated in a small range (between 3.6% to 4%). However, along with more and more cases and lack of control, the coronavirus causes an extreme increase in the unemployment rate in the United States; Unemployment reached its peak (14.7%) in May of the same year and then started to gradually recover. Until recently (March 2022), the unemployment rate has returned to the same level as the pre-pandemic period. However, the graph of the inflation rate in the United States shows a different but reasonable trend. During the pre-pandemic period (before November 2021), along with the stable unemployment rate, the inflation rate is approximate in linear regression. Then, because of the sharp increase in the unemployment rate, the inflation rate decreased. Until recently, since more and more workers find their new job, which reduces the unemployment rate, the inflation rate starts to recover. The relationship between unemployment and the inflation rate in the United States could be explained by the Phillips curve.

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Figure 2: China Monthly Unemployment Rate and Inflation Rate Curve.

The first case of COVID-19 was identified in Wuhan, China, in December 2019. And then Covid-19 spread out at the beginning of 2020 (January in China). Therefore, the unemployment rate reached a peak (6.2%) from the end of February 2020 to the end of August 2020(5.7%) which is understandable since the stores had to be closed due to the characteristic of COVID-19 (spread quickly and widely) and so that lots of people lost their jobs. Compared to the stable period of unemployment rate from January 2019 to the end of January 2020 (5%~5.3%). Then the government took some immediate measures to impede the spread of the pandemic, and the unemployment rate declined to a stable level from the end of September 2020 to the end of February 2022 (4.9%~5.5%). However, since March 2022, another variant of COVID was explored again in China, and the unemployment rate increased consistently (5.8%). Some cities' system lockout, for example, Shanghai went to a closure because of it. It makes sense why the unemployment rate increased. Other than that, the inflation rate of China was greatly affected by the pandemic too. From the end of January 2019 to the end of September 2019, the inflation rate in China was at a stable state (1.5%~3%). But between the end of October 2019 to the end of April 2020, the inflation rate was high (3.3%~5.4%). The peak point of China's inflation rate was at the end of January 2020 when the COVID-19 "formally" explored, this data makes sense. But the inflation was declining between the end of January 2020 to the end of May 2020 (5.4%-3.3%) which is unintelligible. Researchers surmise that there might be some government intervention in it. Between the end of May 2020 to the end of August 2020, the inflation rate was stable (2.4%~2.7%). Then there was another decline between the end of September 2020 to the end of September 2021(1.7%~0.7%), the range was between -0.5%~1.7%. There was a short period of inflation rate float between the end of October 2021 to the end of March 2022. There wasn't a consistent increase in the inflation rate compared to the increase in the unemployment rate in March 2022 due to the new explosion of the COVID-19 variant. Researchers considered that the regions that were greatly affected by COVID-19 variant weren't the whole China. But for some cities with large population mobility, for example, Shanghai, the closure of cities like Shanghai would cause an increase in the unemployment rate of the whole country since lots of people work there. However, the regional inflation rate would increase but will not make a big impact on the national inflation rate. That might be the alternative explanation of why there wasn't an increase in inflation at the end of March 2022 compared with the increase of unemployment rate at the same time. Overall, the graph

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of data reflects the fact that the inflation rate and unemployment rate of China were influenced by the pandemic to a great extent but there isn't a correlation between two rates. However, after the intervention of the government during the process, both two rates would change but to different ranges. Some reasons surmised by the researchers about why there is a difference between the slope of two graphs were explicated in this paragraph too.

4. ANALYSIS

4.1. Regression Model Introduction

To investigate the deeper relationship between the unemployment rate and inflation rate, we applied Time series analysis for these two variables. In this regression, it is emphasized that through continuous remote sensing observation for a certain period, the relevant features of images are extracted and the change process and development scale are analyzed. The Basic formula is:

$$Inflationt = a0 + a1 * Inflationt - 1 + a2 * Unemploymentt - 1 + a3 * Inflationt - 2 + a4 * Unemploymentt - 2 + a5 * (Unemploymentt - 1 * Inflationt - 1)$$

$$Unemploymentt = = b0 + b1 * Inflationt - 1 + b2 * Unemploymentt - 1 + b3 * Inflationt - 2 + b4 * Unemploymentt - 2 + b5 * (Unemploymentt - 1 * Inflationt - 1)$$

4.2. Time Series Analysis

In this study, based on the Time series analysis of the unemployment rate and inflation rate, we need to compare the data of current time t and one or two periods before, which are t-1 and t-2, to look for a potential relationship. In the regression model, the y value equals to the inflation rate at time t, x value has five components: unemployment rate at time t-1, inflation rate at time t-1, unemployment rate at time t-2, inflation rate at time t-2, and the intersection term of the unemployment rate and inflation rate at time t-1.

Table 1: Regression Results for Unemployment Rate in the U.S.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	2.278857718	1.027685498	2.217466065	0.034054714	0.182879326	4.37483611
Unemployment Rate (T-2)	0.0250374 9	0.189587039	0.132063302	0.89578767	-0.361627825	0.411702806
Inflation rate (T-2)	1.810150102	0.829434294	2.182391198	0.036780337	0.118507707	3.501792496
Unemployment Rate * Inflation Rate (T-1)	0.132405134	0.11145303	1.187990433	0.243859653	-0.09490482	0.359715087
Inflation (T-1)	-2.408184772	1.059519777	-2.272902142	0.030114838	-4.569089605	-0.247279939
Unemployment (T-1)	0.605074895	0.201132789	3.008335438	0.005178121	0.194861869	1.015287922

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Table 1 is the output after running a regression. We can see that under the "P-value" column, the value of the Unemployment Rate (T-2) is extremely large, which is greater than 0.8. At the same time, the p-value of the intersection term is 0.24, which is also too big. This indicates that the inflation rate at time t is uncorrelated with these two values. In this case, these two values should be abandoned. For the rest P-values, under the significance level of 0.1, they are all statistically significant. Thus, we reduce the number of independent variables and apply linear regression again.

Table 2: Reduced Regression Results for Unemployment Rate in the U.S.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	2.317147447	0.970684202	2.387128011	0.023059378	0.339928431	4.296366464
Inflation rate (T-2)	1.759221841	0.722972449	2.433317954	0.020726654	0.286575153	3.231868529
Unemployment Rate(T-1) * Inflation Rate (T-2)	0.133033009	0.109628727	1.213486761	0.233824988	-0.0902734	0.356339418
Inflation (T-1)	-2.36512641	0.99250849	-2.382978519	0.023280218	-4.386800046	-0.342452775
Unemployment (T-1)	0.624305808	0.136596042	4.570453146	6.89308E-05	0.346068776	0.902542284

This time, most of the P-values are less than 0.1. We can conclude that these variables are statistically significant under the significance level of 0.1. The formula of Unemployment Rate is:

$$Ut == 2.32 + 0.62 * Ut-1 - 2.37 * It-1 + 1.76 * It-2 + 0.13 * (Ut-1 * It-2)$$

We can rewrite this formula as:

$$Ut == 2.32 + 0.62 * Ut-1 - 0.61 * It-1 - 1.76 * (Ut-1 - It-2) + 0.13 * (Ut-1 * It-1)$$

If inflation were zero, unemployment would revert to a mean of 2.32 / (1 - 0.62) = 6.2%. But higher inflation in the previous month reduces unemployment, as does a higher increase in inflation from two months ago to one month ago. However, inflation and unemployment are both high, which increases unemployment. This is consistent with the Phillips curve.

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Table 3: Reduced Regression Results for Inflation Rate in the U.S.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.338117848	0.212461212	-1.591433301	0.121343992	-0.770887175	0.094651479
Inflation rate (T-2)	-0.722150931	0.158242611	-4.563568086	7.03117E-05	-1.044480582	-0.399821279
Unemployment Rate * Inflation Rate (T-1)	-0.029246658	0.023995293	-1.218840978	0.231810466	-0.078123471	0.019630155
Inflation (T-1)	1.870721105	0.217238064	8.611387305	7.6878E-10	1.42822165	2.313220561
Unemployment (T-1)	0.067611833	0.02989784	2.261428732	0.030663703	0.006711927	0.128511174

Similarly, we can also perform a reduced regression model on the inflation rate in China. From this figure, unlike the data of the U.S., most of the p-values are greater than 0.1, which means they are statistically insignificant under the level of 0.1. In this case, time series analysis can't lead to a positive conclusion.

$$It == -0.34 + 0.07 * Ut-1 + 1.87 * It-1 - 0.72 * It-2 - 0.03 * (Ut-1 * It-1)$$

We can rewrite this formula as:

$$It == -0.34 + 1.15 * It-1 + 0.72 * (It-1 - It-2) + 0.07 * Ut-1 - 0.03 * (Ut-1 * It-1)$$

If the unemployment rate is zero, the inflation would revert to a mean of -0.34 / (1-1.15) = 2.3%. Higher unemployment increases inflation, but only slightly, contrary to the Philips curve, but if inflation and unemployment get high enough, it reduces inflation.

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Table 4: Reduced Regression Results for Unemployment Rate in China.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.239454805	0.555576035	2.230936413	0.032388239	0.11038846	2.368521151
Inflation (T-1)	0.045335334	0.022334709	2.029815318	0.050259359	-5.42553E-05	0.090724923
Unemployment (T-1)	0.751373885	0.106983365	7.023277431	4.17564E-08	0.533957495	0.968790206

Table 5: Regression Statistics of the unemployment rate in China.

Regression Statistics	
Multiple R	0.819685497
R Square	0.671884314
Adjusted R Square	0.652583391
Standard Error	0.193423089
Observations	37

In table 4, we applied the same regression model to estimate the unemployment rate at time T in China. All P-values are below 0.10, which is statistically significant. The formula at Time T should be:

$$Unemploymentt = 1.24 + 0.05 * Inflationt - 1 + 0.75 * Unemploymentt - 1$$

If inflation were zero, the first regression suggests unemployment would revert to a mean of 1.24 / (1 - 0.75) = 5.0%. This refers to the natural rate of unemployment. However, the coefficient of inflation rate at t-1 is positive, which means a 1% increase of the inflation rate will cause a 0.05% increase of unemployment. This disobeys the standard economic theory since these two variables should change in the opposite direction.

Table 6: Reduced Regression Results for Inflation Rate in China.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.149281985	0.16025783	0.931511	0.358354	-0.17677	0.475329
Inflation rate (T-2)	-0.26892134	0.18269834	-1.47194	0.15051	-0.64062	0.102781
Unemployment Rate * Inflation Rate (T-1)	-0.166546517	0.10274865	-1.62091	0.114554	-0.37559	0.042497
Inflation (T-1)	2.094854541	0.504608692	4.151444	0.000218	1.06822	3.121489

Last, we use the regression to estimate the inflation rate at time T in China. By Figure 3.6, the formula of inflation rate in China at time t should be:

$$It == 0.15 + 2.09 * It - 1 - 0.27 * It - 2 - 0.17 * (Ut - 1 * It - 1)$$

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This equation can be written as:

$$It == 0.15 + 1.82 * It-1 + 0.27 * (It-1 - It-2) - 0.17 * (Ut-1 * It-1)$$

However, there is a surprising fact that under this model, the inflation rate will grow rapidly unless the unemployment rate is greater than 100%. This phenomenon does not correspond to reality, which also indicates that China's economic recovery is different from the U.S. economy's.

5. Conclusion

The U.S. and China are recovering differently. The recovery of the U.S. economy fits the characteristics of the Phillips curve. That means unemployment and inflation move in opposite directions. However, for China, the unemployment rate and inflation rate change in the same direction.

One possible explanation is COVID-19 reduced economic growth, but also hurts labor market demand and exacerbated the rise of unemployment. At the same time, China has implemented a strict home-quarantine regime during the pandemic. Many workers were unable to go out, which made labor-intensive enterprises find it difficult to recruit workers. Due to this restriction, small enterprises were more affected by the epidemic than big ones. In China, many labor-intensive industries, such as weaving, are represented by small and micro-enterprises.

To sum up, during the prevention and control of COVID-19, both the supply and demand of the labor force in China shrank at the same time, and when the supply shrinks more than the demand, the labor cost rises, which leads to the rise of production costs, the rise of prices, and ultimately leads to the rise of the inflation rate.

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