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Has COVID-19 shifted the US Phillips curve? An ARDL estimation approach

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Abstract

The Phillips Curve has been one of the main frameworks used in the literature to analyze the trade-off between inflation and unemployment in the USA since the 1960s. However, there is limited literature on the post-pandemic period. This study estimates the Phillips Curve on a monthly basis from 1982 to December 2024, using the ARDL approach. The primary focus of this work is to examine the behavior of the curve during the pandemic period. The main finding is that the slope of the Phillips curve significantly increased in the USA between 2021 and 2024.

Dear John, In addition to the documents, I am sending the Evews file used in the article, which allows you to estimate and replicate the results from Table 1.

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I. Introduction

The Phillips Curve is a theoretical framework used in macroeconomics since the 1960s to explain the variation in price levels. Over the past few decades, there has been considerable debate in the literature about the possibility of this curve becoming flatter in the United States (HOOPER et al (2020)). In other words, the trade-off characteristic of the Phillips Curve might have diminished. However, with the pandemic and the resurgence of high inflation, the question arises whether the Phillips Curve has undergone any changes during this period.

At the end of 2021 and the beginning of 2022, US faced a sharp rise in prices, with an acceleration not seen since the 1980s. The models used by Federal Reserve which had focused on anchoring inflation expectations for monetary policy calibration since the early 1990s, were unable to predict the inflation caused by the pandemic (BENIGNO and EGGERTSSON, 2023). According to authors the resurgence of inflation occurred unexpectedly, with the mistaken diagnosis that it would be transient. The price level reached its peak in the U.S. in June 2022 (9.1%).

This unexpected inflation was the highest in at least 40 years. On the supply side, studies focus on the disruption and reconfiguration of global value chains as the main driver of inflation. One of the most illustrative examples related to global value chains is the semiconductor crisis. In 2021, the Russian invasion of Ukraine disrupted the export of several commodities produced by Ukraine. Between February 2022, when the conflict began, and August 2022, when energy prices peaked, the Global Price Energy Index—a global index tracking energy prices—rose by 44%.

On the demand side, studies such as those by Benigno and Eggertsson (2023) attribute the rise in price levels to an overheated labor market. This overheating, in turn, was the result of highly expansionary monetary and fiscal policies, as observed by Gagliardone and Gertler (2023), which led developed countries to experience very low unemployment rates.

Benigno and Eggertsson (2023) argue that the unexpected inflation following the pandemic in the U.S. was largely caused by an overheated labor market. They base their argument on the "search and matching" literature and use the ratio of job vacancies to unemployed individuals as a measure of labor market tightness. If this ratio exceeds 1, it indicates a strong labor market squeeze. Using quarterly data from 1960 to 2022, the authors show that between 2008 and 2022, there is a positive relationship between labor market tightness and inflation. For the period between 2008 and 2022, the authors found the main variable impacting inflation was the labor market, representing a demand shock.

According to Blanchard and Bernanke (2023), the overheated labor market in the U.S. could have been, a source of persistent inflation. However, the authors argue that by focusing solely on the labor market, economic agents overlooked the potential spillover effects in the product market (supply shocks and changes in consumption patterns) stemming from the pandemic.

Their main conclusions are: the labor market had only a modest impact on inflation, as predicted by the flat Phillips Curve; the primary driver of inflation was in the goods market, driven by energy price increases and sector-specific price hikes resulting from supply disruptions.

Furlanetto and Lepetit (2025) review evidence on the Phillips curve prior to COVID-19. The authors conclude that the median estimate suggests the slope of the

Phillips curve declined significantly after 1990, although they also highlight a high degree of uncertainty surrounding these estimates.

Since the pandemic is relatively recent, few studies have estimated the Phillips curve for this period. In fact, no studies were found specifically focusing on the New Keynesian Phillips Curve that compare the pre- and post-pandemic periods as a way to analyze changes in the slope of the curve. Therefore, this article aims to contribute to the literature by estimating the Phillips Curve for the period from 1982 to 2024, with particular emphasis on the years 2021 to 2024, since no such estimations were found in the reviewed literature. The main purpose of this paper is to compare a sample including post-pandemic data. After this introduction, the paper is structured as follows: a brief literature review, a discussion of data and methodology, results, and finally, the conclusion.

2. Methodology and Data

I estimate a specification of the Linear New Keynesian Phillips Curve for US (equation 1) based on Blanchard et al. (2015) and Hooper et al. (2020). According to the a Hooper et al. (2020), this framework has been regarded as consensual and has been presented by several officials from the Federal Reserve Board.

$$\pi_t = \delta\pi_t^e + \beta u\_gap_t + \lambda X_{t-1} \quad (1)$$

In this curve, π_t is the annual inflation (in this case, I use the Consumer Price Index (CPI). π_t^e is the measure of the ten-year inflation expectation calculated by the Federal Reserve Bank of Cleveland. u_gap_t unemployment gap, which is the difference between the actual unemployment rate and verage unemployment rate, used as a proxy for the natural rate of unemployment (BLANCHARD et al. 2015). X_t is the measure of supply shock, in which I use the Producer Price Index of All Commodities year-over-year change of the monthly data. From now on, I will refer to it as commodity prices.

The monthly sample starts in January 1982 and ends in December 2024, comprising 516 observations, which I divide into 3 periods of 172 observations each. One of the periods includes the pandemic.

In my empirical strategy, I define 2020 as the year of the pandemic. I then estimate the Phillips curve for the period between January 2021 and December 2024, comprising a total of 48 observations, as a means of estimating the Phillips Curve in the post-COVID period. Additionally, I estimate the same model with a sample of the same size for the period prior to the pandemic, from August 2015 to February 2020. It is important to emphasize that I use the average unemployment rate, treating it as the monthly natural unemplyment rate, as suggested by Blanchard, Cerutti, and Summers (2015).

According to Odhiambo (2009), cointegration techniques based on Engle and Granger (1987) and Johansen (1988) are not suitable for small sample sizes. These methods typically require large datasets to produce reliable and consistent estimates, particularly in the case of Johansen's system-based approach.

In contrast, Adebayo et al. (2021) argue that the Autoregressive Distributed Lag (ARDL) approach, as developed by Pesaran et al. (2001), is well-suited for small samples. In this study, a dataset consisting of 48 observations is employed. Given the sample size and the potential mixed integration order of the variables, the ARDL bounds testing approach is adopted to examine the existence of cointegration relationships, as specified in Equation (1).

A key advantage of the ARDL model is that it does not require all variables to be integrated of the same order; it can be applied when variables are a mix of I(0) and I(1), as long as none are I(2). This flexibility distinguishes it from cointegration methods based on Vector Autoregressive (VAR) models, such as Johansen's procedure, which require all variables to be I(1).

While the Generalized Method of Moments (GMM) is one of the most widely used estimation techniques for the Phillips Curve—particularly in dynamic panel data contexts—it often faces challenges related to weak instruments. As noted by Maka and Holanda Barbosa (2022), the presence of weak instruments can compromise the validity of GMM estimations, leading to biased coefficients and unreliable inference.

The ARDL model is part of an equation in the form of an error correction model given by:

$$\pi_t = \sum_{i=1}^{p} \beta_i \pi_{t-i} + \sum_{i=0}^{q} \gamma_i Z_{t-i} + e_t \quad (2)$$

Z_t is the vector of explanatory variables contained in equation 2. After confirmation of cointegration, the next step is to find the best model using selection criteria, such as the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). After choosing the best model, I calculate the long-term coefficients using the ARDL. When determining the maximum lag length, I selected 12 months based on the well-documented lagged effects of macroeconomic variables on inflation within the monetary economics literature. Subsequently, the optimal lag structure was identified through the simulation process.

In time series analysis, there is always the possibility of endogeneity problems, such as simultaneity bias and omitted variable bias. According to Narayan (2004), the ARDL framework allows for the estimation of both short- and long-run relationships, and by including appropriate lags of the variables, it helps to mitigate potential endogeneity arising from dynamic feedback and lagged simultaneity. However, it does not completely eliminate endogeneity problems related to omitted variables or contemporaneous simultaneity.

3. Results

As stated in the previous sections, the ARDL model has econometric characteristics that allow for the estimation of the New Keynesian Phillips Curve for the U.S. between 1982 and 2024, including the post-pandemic period. All variables have integration order smaller than 2.

As shown in Table 1, column (1) displays the cointegration for the entire period, and the coefficients are significant and consistent with expectations from the literature, with the effect of expectations being larger than the effect of changes in commodity prices. The trade-off between unemployment and inflation—that is, the slope of the Phillips curve—was 0.15, indicating that a 1% increase in the unemployment gap reduces CPI prices by 0.15%.

Table 1. ARDL Phillips Curve Estimation (Full).

	(1982-2024)	(1982-1996)	(1996-2010)	(2010-2024)	(2015-2019)	(2021-2024)
$E(\pi_t)$	0,72***	-	0,67***	0,82***	0,26***	-0,42
u_t_gap	-0,15**	-	-0,15***	-0,20*	-0,72***	-1,91**
com	0,35***	-	0,21***	0,41***	0,09***	0,32***
$lags$	(0,0,11)	-	(3,1,12)	(0,11,7)	(0,0,1)	(0,0,1)
$Bound\ Value$	13.42***	2.35	9.37***	7.34***	8.16***	6.88***

Source: Table constructed from the data of the study.***, **, *, Significant at the 1%, 5%, and 10% levels, respectively.

Columns (2), (3), and (4) of Table 1 show the results for the sample divided into periods. In column (2), the sample spans from 1982 to 1996. Since there was no cointegration in this period, the long-term coefficients were not reported.

In column (3), which covers the period from 1996 to 2010, and in column (4), which spans from 2010 to 2024, cointegration is observed. The coefficients have signs consistent with the literature.

In the most recent period (column (4)), the trade-off of the Phillips curve was steeper, signaling an increase in the slope of the curve during this period. Additionally, the commodity price shock had twice the impact on inflation compared to the previous period.

Columns (5) and (6) present an exercise to compare the estimates of the Phillips Curve for the period before the pandemic, from 2015 to 2019 (column (5)), and for the period after the pandemic began, from 2021 to 2024 (column (6)). This comparison helps support the literature regarding the causes of inflation, which had not reached double digits in the U.S. since the 1980s.

While the results are limited by the sample size, it can be inferred that the slope of the Phillips curve increased significantly during the pandemic. According to the results, before the pandemic, a 1% decrease in unemployment led to a 0.71% increase in inflation, while after the pandemic, this impact rose to nearly 2%. Additionally, the effect of commodity prices in the post-pandemic period was greater than in the period immediately preceding the pandemic.

A summary of the results provides evidence that the Phillips curve, which became flatter between 1996 and 2010 like reported for Kley (2015) began to steepen from 2010 onward, with an even sharper slope during the pandemic. This steepening reflects the increased trade-off that occurred, contributing to the unexpected rise in inflation in the U.S. during the two-year period of 2021 and 2022. Moreover, the supply shock caused by the pandemic, along with the war in Russia and Ukraine, appears to have been responsible for a portion of the price increases during this period.

In the appendix, alternative model specifications were tested. We estimated the model without inflation expectations (Table A2) and also estimated the model replacing the supply shock variable with the Bloomberg Commodity Index (Table A3). However, this index only begins in 1991, so we were unable to compare all the samples. Comparing the results for the pre-crisis and post-crisis subperiods, Tables A2 and A3 tell the same story as Table 1. The Phillips curve became steeper during the 2021–2024 period.

4. Conclusion

According to Blanchard and Bernanke (2023): "Pandemic-era inflation has been a complicated phenomenon involving multiple sources and complex interactions." My estimates suggest that the demand shock had a greater impact than the supply shock, resulting in a steeper Phillips curve in line with the findings of Benigno and Eggertsson (2023). A potential direction for further research, based on the findings of this paper, is to explore whether the source of the demand shock was more significant on the fiscal or monetary side.

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Appendix

Table A1: Description of data used for estimation

Variable	Name	Description	Source
π_t	Consumer Price Index (CPI)	The Consumer Price Index for All Urban Consumers: All Items (CPIAUCSL) is a price index of a basket of goods and services paid by urban consumers. Percent changes in the price index measure the inflation rate between any two time periods.	Federal Reserve of St.Louis (FRED Data)
$E(\pi_t)$	10-year Expected Inflation (EXPINF10YR)	The 10-year expected inflation estimate that I report is the rate that inflation is expected to average over the next 10 years.	Federal Reserve of Cleveland
u_{t}_gap	Deviation of the unemployment rate in relation to the average unemployment rate.	The unemployment rate represents the number of unemployed as a percentage of the labor force. Labor force data are restricted to people	U.S. Bureau of Labor Statistics

		16 years of age and older, who currently reside in 1 of the 50 states or the District of Columbia, who do not reside in institutions.	
com	Producer Price Index (PPI)	Producer Price Index by Commodity: All Commodities	Federal Reserve of St.Louis (FRED Data)
$bcom$	Bloomberg Commodity Index (BCOM)	Bloomberg Commodity Index is calculated on an ER basis and reflects commodity price movements.	Bloomberg

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Table A2. ARDL Phillips Curve Estimation (Without expectation).

	(1982-2024)	(1982-1996)	(1996-2010)	(2010-2024)	(2015-2019)	(2021-2024)
u_t_gap	-0.19	-	-0.98***	-0.46	-1.02***	-1.53***
com	0.91***	-	0.41***	0.92***	0.06***	0.31***
$lags$	(12,3)	-	(1,2)	(0,1)	(0,1)	(0,1)
$Bound\ Value$	10.24***	2.28	4.8**	10.58***	8.92***	9.19***

Source: Table constructed from the data of the study.***, **, *, Significant at the 1%, 5%, and 10% levels, respectively.

Table A3. ARDL Phillips Curve Estimation (Blommberg Commodity).

	(1982-2024)	(1982-1996)	(1996-2010)	(2010-2024)	(2015-2019)	(2021-2024)
$E(\pi_t)$			-	1.45***	0,54***	0.59
u_t_gap			-	-0.08	-0,58***	-1.24***
$bcom$			-	0.12***	0,04***	0.13***
$lags$			-	(1,1,8)	(1,0,3)	(0,0,1)
$Bound\ Value$			(0,1,9)	3.55*	3.80**	11.67***

Source: Table constructed from the data of the study.***, **, *, Significant at the 1%, 5%, and 10% levels, respectively.