The Link Between Economic Slack and Inflation: An International Perspective

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Motivation and Outline of the Paper

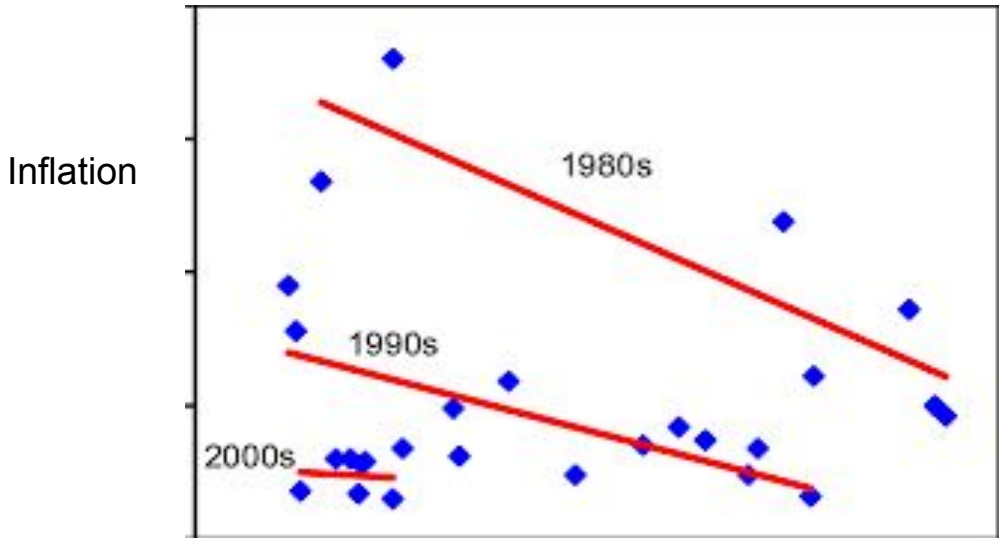
- Inflation has been rising around the world (to 40 year highs), and Central Banks have been raising interest rates to bring inflation down
- CENTRAL QUESTION: How aggressive do Central Banks need to be? The answer depends on how sensitive inflation is to economic activity, what economists call the slope of the **Phillips Curve** → the **sensitivity** parameter
- BUT: There is debate among economists on how flat is the Phillips Curve, with earlier studies emphasizing a decline over time

Motivation and Outline of the Paper

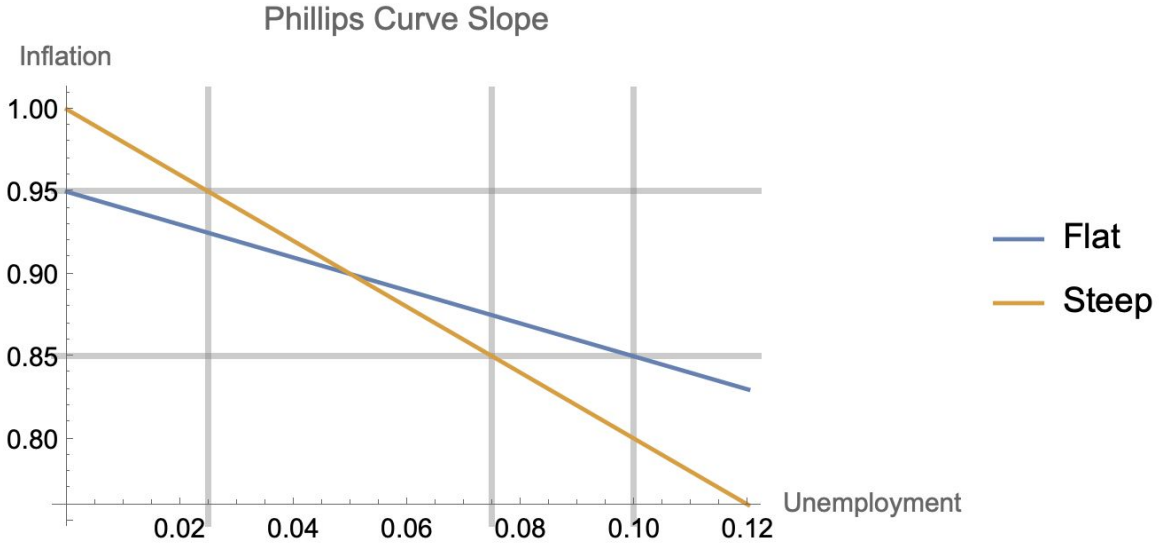
- My paper uses **data and econometric methods** to update estimates of the sensitivity of inflation to economic activity
- The HYPOTHESIS is that the Phillips Curve flattened less than previously thought
- I extend recent work using data from 39 countries (other studies focus on single countries like the U.S. or a small number of countries)
- **I find that the sensitivity has indeed declined by less than previous studies, and it is similar to more recent studies challenging the status quo**

Traditional view of the Phillips Curve

- Economists (Mishkin 2007) believe the Phillips Curve evolved like this:



The Problem if the Phillips Curve is Flat



HOW SLOPE AFFECTS UNEMPLOYMENT (illustrative example)

- To reduce inflation from 0.95 to 0.85:
  - The steep curve → increased unemployment from 0.025 to 0.075
  - But the flat curve → increased unemployment from 0 to 0.10
  - So the flat curve implies TWICE the rise in unemployment

Literature Review and history

- Phillips (1957) discovered the Phillips Curve, and Bernanke (2007) explained that it is still one of the best methods for analyzing and forecasting inflation
- Mavroeidis et. al. (2014) and Nakamura et. al. (2022) present econometric estimates of the sensitivity parameter. Key issue:
  - If inflation is NOT very sensitive to economic activity (the Phillips Curve is “flat”), the Fed and other CB’s have to be very tough → economic pain (as Mishkin 2007 explained).
- Traditional estimates (Mishkin 2007) showed a flattening Phillips Curve
- Nakamura et. al. (2022) using data from U.S. states challenged this, showing reductions in expected inflation account for most of the observed flattening
- I expand Nakamura et. al. (2022) using panel data for 39 advanced countries over the period 1980-2019.
- My findings agree, finding that the Phillips Curve did not flatten as much over time as earlier research believed.
- In addition, my estimated sensitivity parameter is fairly close or even larger to that estimated by Nakamura et. al. (2022). This implies that:
  - The Fed might not have to be as aggressive as many believe to fight inflation, causing less economic pain.

The Phillips Curve equation

- The “Phillips Curve” represents the relationship between inflation and the economy. From Nakamura et. al. (2022), presented as an equation:

- Inflation = Constant + Control Variables + Beta x Unemployment Rate + Error

- I estimate this equation, with various econometric refinements (next slide):

Methodology

- To estimate the equation, I use panel econometric methodology (controlling for country fixed effects and time effects--which capture the fall in inflation expectations-- and using HAC covariance estimation to obtain robust results)
- I test various specifications, using unemployment and the output gap (data provided by the IMF World Economic Outlook database) as possible economic activity indicators
- I look at the whole sample 1980-2019 and separately at a more recent sample 1999-2019 and for a subset of countries using the same currency (the Eurozone)
- I test results for robustness by controlling for autoregressive effects and by using instrumental variables
- In the Appendix I include some full regression results

Results Summary

- Baseline results uncorrected for various important effects, with unemployment as a measure of economic activity, indeed show a large flattening of the Phillips Curve
- However, Nakamura et. al. (2022) found that correcting for various issues (autoregressive errors, homogeneity of the sample, including time fixed effects) results in a much smaller flattening for the U.S. than earlier research believed (such as Mishkin 2007).
- For my much larger sample (39 countries), and controlling for autoregressive effects (in some specifications) and using instrumental variables (in other specifications) I agree with Nakamura et. al. (2022).
- Moreover, in the specifications that match more closely (using unemployment as the economic activity variable) the sensitivity parameter is close to or a bit larger than that found by Nakamura et. al. (2022).
- In addition, my results using output gap as the economic activity variable (which is not used by Nakamura et. al. 2022), find even smaller flattening of the Phillips Curve.
- Results are statistically significant (sensitivity parameter different from zero with the expected sign, MINUS for the unemployment rate, and PLUS for the output gap).

SUMMARY TABLE - HAS THE PHILLIPS CURVE BECOME FLATTER?

COMPARING SENSITIVITY PARAMETER ESTIMATES OVER TIME

(WITH FIXED EFFECTS both TIME and CROSS-SECTION, and HAC COVARIANCE)

	Equation hac2te (no lagged dependent variable in regression)		Equ. te (yes lagged dependent variable)	
ECONOMIC ACTIVITY	**UNEMPLOYMENT**	**OUTPUT GAP**	**UNEMPLOYMENT**	**OUTPUT GAP**
ALL COUNTRIES			Long-run estimate	Long-run estimate
FULL TIME SAMPLE	-0.80	0.20	-0.70	0.43
RECENT SAMPLE	-0.14	0.08	-0.23	0.20
Ratio	**5.8**	**2.5**	**3.0**	**2.2**
EUROZONE				
FULL TIME SAMPLE	-0.37	0.27	-0.24	0.38
RECENT SAMPLE	-0.11	0.07	-0.23	0.19
Ratio	**3.4**	**3.9**	**1.1**	**2.0**

CONCLUSION: **PHILLIPS CURVE FLATTENED BUT BY LESS THAN BASELINE CASE**

SUMMARY - HOW DOES MY SENSITIVITY PARAMETER ESTIMATE COMPARE?

UNEMPLOYMENT IS THE ECONOMIC ACTIVITY VARIABLE

(WITH FIXED EFFECTS both TIME and CROSS-SECTION, HAC COVARIANCE, LAGGED CPI, AND INSTRUMENTS)

	INSTRUMENTS	**SENSITIVITY**	
NAKAMURA et. al. (2022)	LAGGED UNEMPLOYMENT, RELATIVE PRICE	-0.11	(FULL SAMPLE)
BABB and DETMEISTER (2017)	NOT USED	-0.12 to -0.24	
ROBERTS (2006)	NOT USED	-0.39	(FULL SAMPLE)
ROBERTS (2006)	NOT USED	-0.20	(RECENT SAMPLE)
		Long-run estimate	
THIS PAPER (2023)	LAGGED UNEMPLOYMENT	-0.90	(FULL SAMPLE)
THIS PAPER (2023)	LAGGED UNEMPLOYMENT	-0.17	(RECENT SAMPLE)
THIS PAPER (2023)	LAGGED FISCAL VARIABLES	-0.51	(FULL SAMPLE)

CONCLUSION: **SENSITIVITY PARAMETER LARGER THAN ESTIMATED BY NAKAMURA et. al. 2023**

The Instruments

- The role of instrumental variables is to address endogeneity (when the error is correlated with the independent regressors, causing biased estimates)
- Using lags for instruments reduces the possibility of endogeneity
- Lagged Unemployment
  - Employed by Nakamura
  - I use two lags, and results are larger than full sample but a bit lower than recent sample without instruments
- Lagged Government Expenditures and Government Debt
  - Cochrane (2023) explains the link between fiscal variables and inflation, government spending/debt adds to domestic demand and crowds out private supply, raising inflation
  - I use these variables as instruments as the Government decides spending in advance (so less chance of correlation with the error term) and debt is mostly pre-determined
- The lagged Unemployment and Fiscal Instruments are STRONG instruments (this can be shown by regressing inflation on the instruments and checking R-square and F-statistic)
  - Unemployment: F-Stat = 113.22 (p-value: 0.0000) and R^2 = 0.87
  - Fiscal: F-Stat = 39.46 (p-value: 0.0000) and R^2 = 0.78

Discussion and Recommendations

- Estimating the Phillips Curve sensitivity parameter is very important for policy makers, especially Central Banks, who are fighting inflation
- But it is not easy, as we have to consider changes in the sensitivity over time, and difficult econometric issues (such as endogeneity and serial correlation in the errors)
- I used expanded data covering 39 countries (most other studies use one or a few countries), and applied Nakamura et. al. (2022) innovations which control for sample homogeneity, changes in inflation expectations, autocorrelation in the errors, and apply instrumental variables
- The bottom line is that the Phillips Curve has not flattened as much as many economists believed
- Hence, the Fed (and other Central Banks) have to raise interest rates by less to control inflation
- This means less economic pain, especially for those economically vulnerable populations.

References/Acknowledgments

- Key references:
  - Babb N.R. and A.K. Detmeister (2017), Bernanke, B. S. (2007), Cochrane J.H. (2023), Gali, J. (2015), Jondeau E. et al (2005), Mavroeidis S. et. al. (2014), Mishkin, F. S. (2007), Nakamura E. et. al. (2022), Phelps, E. S. (1967), Phillips, A. W. (1958), Roberts, J. M. (1995).
- Acknowledgments:
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  - Also, I wish to thank participants in the Economics Honors program who gave helpful comments to earlier drafts of my paper.

Appendix

- Full country sample
- Full regression results for the baseline model (no lagged CPI)
- Full regression results for the expanded model (with lagged CPI)

Full country sample

- Australia, *Austria, *Belgium, Canada, *Cyprus, Czech Republic, Denmark, *Estonia, *Finland, *France, *Germany, *Greece, Hong-Kong (SAR), Iceland, *Ireland, Israel, *Italy, Japan, S. Korea, *Latvia, *Lithuania, *Luxemburg, Macao (SAR), *Malta, *Netherlands, New Zealand, Norway, *Portugal, Puerto Rico, San Marino, Singapore, *Slovak Republic, *Slovenia, *Spain, Sweden, Switzerland, Taiwan (PoC), U.K., U.S.

- The starred countries are the Eurozone members.

Full regression results - baseline model (no lagged CPI)

EQUATION VERSION	EQU-1 hac2te	EQU-2 hac2te	EQU-3 hac2te	EQU-4 hac2te	EQU-5 hac2te	EQU-6 hac2te	EQU-7 hac2te	EQU-8 hac2te
COUNTRY SAMPLE	FULL	FULL	FULL	FULL	EURO	EURO	EURO	EURO
number of countries	39	27	39	27	19	17	19	17
TIME PERIOD	FULL	FULL	RECENT	RECENT	FULL	FULL	RECENT	RECENT
years included	1980 - 2019	1980 - 2019	1999 - 2019	1999 - 2019	1980 - 2019	1980 - 2019	1999 - 2019	1999 - 2019
TOTAL PANEL observations	1413	992	812	566	675	607	399	356
DEPENDENT VARIABLE	CPI	CPI	CPI	CPI	CPI	CPI	CPI	CPI
percent change								
CONSTANT	10.6	3.69	3.04	2.05	7.33	3.95	3.17	2.16
(se)	2.6	0.0211	0.4514	0.0165	1.199	0.022	0.616	0.022
(p - value)	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
LAGGED DEPENDENT VARIABLE	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)
COEFFICIENT								
(se)								
(p - value)								
INDEPENDENT VARIABLE	**UR**	**Output Gap**	**UR**	**Output Gap**	**UR**	**Output Gap**	**UR**	**Output Gap**
sensitivity coefficient	**-0.8**	**0.2**	**-0.1368**	**0.08**	**-0.37**	**0.27**	**-0.11**	**0.07**
(se)	0.3687	0.084	0.063	0.048	0.1383	0.08	0.0687	0.0529
(p - value)	0.0356	0.0236	0.0424	0.1054	0.0150	0.0041	0.1439	0.2052
long-run sensitivity coefficient								
(se, delta method)								
Adjusted R-squared	0.2	0.62	0.44	0.5	0.36	0.61	0.48	0.54
Fixed Effects - cross section	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects - time periods	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariance	hac	hac	hac	hac	hac	hac	hac	hac
Instruments	No	No	No	No	No	No	No	No
NOTE	hac Covariance refers to heteroskedasticity (cross-section cluster) corrected, White method							

Full regression results - baseline model (with lagged CPI)

EQUATION VERSION	EQU-1 te	EQU-2 te	EQU-3 te	EQU-4 te	EQU-5 te	EQU-6 te	EQU-7 te	EQU-8 te
COUNTRY SAMPLE	FULL	FULL	FULL	FULL	EURO	EURO	EURO	EURO
number of countries	39	27	39	27	19	17	19	17
TIME PERIOD	FULL	FULL	RECENT	RECENT	FULL	FULL	RECENT	RECENT
years included	1981- 2019	1981- 2019	1999 - 2019	1999 - 2019	1981- 2019	1981- 2019	1999 - 2019	1999 - 2019
TOTAL PANEL observations	1377	970	810	566	659	594	399	356
DEPENDENT VARIABLE	CPI	CPI	CPI	CPI	CPI	CPI	CPI	CPI
percent change								
CONSTANT	3.31	0.95	1.7	0.9246	2.84	0.9	1.78	0.92
(se)	0.86	0.2	0.3	0.1783	0.074	0.24	0.4	0.2
(p - value)	0.0005	0.0001	0.0000	0.0000	0.0011	0.0021	0.0003	0.0002
LAGGED DEPENDENT VARIABLE	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)	CPI(-1)
coefficient	0.61	0.67	0.54	0.54	0.47	0.70	0.58	0.57
(se)	0.011	0.052	0.059	0.0822	0.099	0.059	0.067	0.084
(p - value)	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
INDEPENDENT VARIABLE	UR	Output Gap	UR	Output Gap	UR	Output Gap	UR	Output Gap
sensitivity coefficient	**-0.28**	**0.14**	**-0.11**	**0.09**	**-0.13**	**0.11**	**-0.10**	**0.08**
(se)	0.125	0.035	0.034	0.029	0.061	0.042	0.037	0.032
(p - value)	0.0335	0.0003	0.0029	0.0048	0.0476	0.0149	0.0165	0.0188
long-run sensitivity coefficient	**-0.70**	**0.43**	**-0.23**	**0.20**	**-0.24**	**0.38**	**-0.23**	**0.19**
(se, delta method)	0.13	0.04	0.04	0.03	0.07	0.04	0.04	0.03
Adjusted R-squared	0.59	0.87	0.64	0.67	0.83	0.89	0.67	0.71
Fixed Effects - cross section	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects - time periods	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariance	hac	hac	hac	hac	hac	hac	hac	hac
Instruments	No	No	No	No	No	No	No	No
NOTE	hac Covariance refers to heteroskedasticity (cross-section cluster) corrected, White method							