A CROSS-COUNTRY EXAMINATION OF OUTPUT GROWTH AND INFLATION
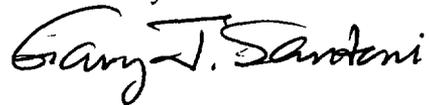
An Honors Thesis (HONRS 499)

by

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ABSTRACT

This paper re-examines the structure of the Phillips Curve, which suggests a negative relationship between inflation and unemployment and a positive relationship between inflation and output growth. For many years, the Phillips curve has been acknowledged as a sound policy and forecasting tool. However, recent experience indicates that output growth, inflation, and unemployment may not be related in the manner initially proposed by Phillips. The purpose of this study is to test the relationship between growth in output and inflation and determine whether the observed relationship is sensitive to the level of development of the country.

ACKNOWLEDGEMENTS

Introduction

The Phillips curve, which suggests an inverse relationship between inflation and unemployment served as a cornerstone of U.S. economic policy for many years. However, recent experience indicates that the opposite relationship may exist. As U.S. unemployment dropped well below five percent over the past few years, inflation also declined. The U.S experience is not exceptional, Deutsche Bank's Mr. Edward Yardeni speculates that the tight labor market is not setting off inflation because we are in a "New Economy" of technology-spurred productivity advances and global competition (Clark, 1999). Mr. Yardeni's comment is motivated by the fact that the Phillips curve has systematically overpredicted inflation in recent decades (Lown, 51). If these errors reflect a permanent change in the structure of the relationship, the Phillips curve can no longer serve as a reliable policy or forecasting tool. Wesbury, writing for the Wall Street Journal, points out the danger, "by mistaking low unemployment for a sign of overheating the Fed runs the risk of creating deflationary forces that could harm the economy."

Purpose

This paper re-examines the structure of the Phillips curve by building on the work of Kormendi and Meguire (1985). Counter to Phillips curve predictions, they observe a negative relationship between inflation and economic growth using cross-section IMF data for 47 countries for the years 1950 to 1977. This study extends their work with IMF data for a cross-section of 50 countries from 1978 to 1990 and evaluates whether their results are sensitive to the time period they examined. In addition, the data are used to

determine whether any observed correlations vary across developed versus less developed countries.

Review of the Literature

Throughout recent economic history, views on the relationship between inflation and measures of economic growth have undergone at least three major transitions. The first was the introduction of the traditional Phillips curve trade-off between inflation and unemployment. Essentially, it was thought that economic policy could produce either a low inflation rate or a low unemployment rate, but not both at the same time. The second transition was the introduction of inflationary expectations. According to this modification, expectations about inflation shift the Phillips curve. Hence, the tradeoff between inflation and unemployment depicted by the Phillips curve does not represent a stable long run relationship. The third outgrowth is marked by the empirically-motivated introduction of a positive relation between inflation and unemployment and is the focus of this paper.

Phillips's initial paper (1958) found a tendency for the rate of inflation to be high when unemployment was low and to be low or negative when unemployment was high. In contrast, several more recent empirical studies have found that prolonged high inflation retards economic growth and raises unemployment. Specifically, persistent inflation reduces the growth rate of real GDP (Motley, 1998). Accordingly, inflation does not foster economic growth or employment in the long run (Humpage, 1996).

The persistent inflation that some contemporary economies confront is largely a post-World War II phenomenon. Before the 1940's, the history of price indices reflected

periods of inflation followed by complementary periods of deflation. In the absence of enduring inflation, early studies of inflation and measures of economic growth necessarily examined the short-run relationship between these variables.[1] Periods of inflation regularly coincided with economic expansions and low unemployment, while periods of deflation tended to concur with economic contractions and high unemployment (Haslag, 1997). Consequently, this data suggests a positive relationship between inflation and growth in output and a negative relationship between inflation and unemployment as suggested by Phillips (1958). However, more recent empirical evidence fails to support this conclusion. Levine and Renalt (1992) question whether a systematic relationship exists between growth, unemployment, and inflation, concluding that the relationship is too fragile to place confidence in. Ericsson, Irons, and Tryon (1993) and Bullard and Keating (1995) find similar results concluding that inflation has no significant long-run effect on output growth and unemployment.

Indeed, some studies have found evidence of a complete reversal of the Phillips relationship. For example, some have maintained that inflation is negatively related to growth in output suggesting that inflation and unemployment are positively related (Kormendi and Meguire (1985), Fischer (1993), Gomme (1993), and DeGregario (1993)). Kormendi and Meguire's cross-country regressions found a negative and significant relationship between inflation and growth, suggesting a positive relationship between inflation and unemployment. Comparing the sample means of 73 countries, Fischer also observed a negative relationship between inflation and economic growth and

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[1] One interesting example to the contrary is Irving Fisher's (1926) statistical examination of inflation, unemployment, and growth. Over the period 1915-1925, Irving Fisher discovered a very high correlation between inflation and unemployment in the United States that is consistent with Phillips conclusions which were to be reached over thirty years after Fisher's investigation.

a positive relationship between inflation and unemployment. DeGregario's test of a

sample of twelve Latin American countries over 35 years verified the relationship found

by Fischer and Kormendi and Meguire for a sample of countries with characteristics

unique to the region. Furthermore, Gomme studied the correlations between inflation,

output growth and unemployment and found concurring results (Haslag, 1997).

Theory

The relationship between inflation and unemployment was discovered by A. W.

Phillips (1958) as he examined the correlation between unemployment and the rate of

change of money wages in the United Kingdom over the period 1861-1957. The

estimated relationship appeared to be inverse like that shown in Figure 1.

Figure 1: The Phillips Curve
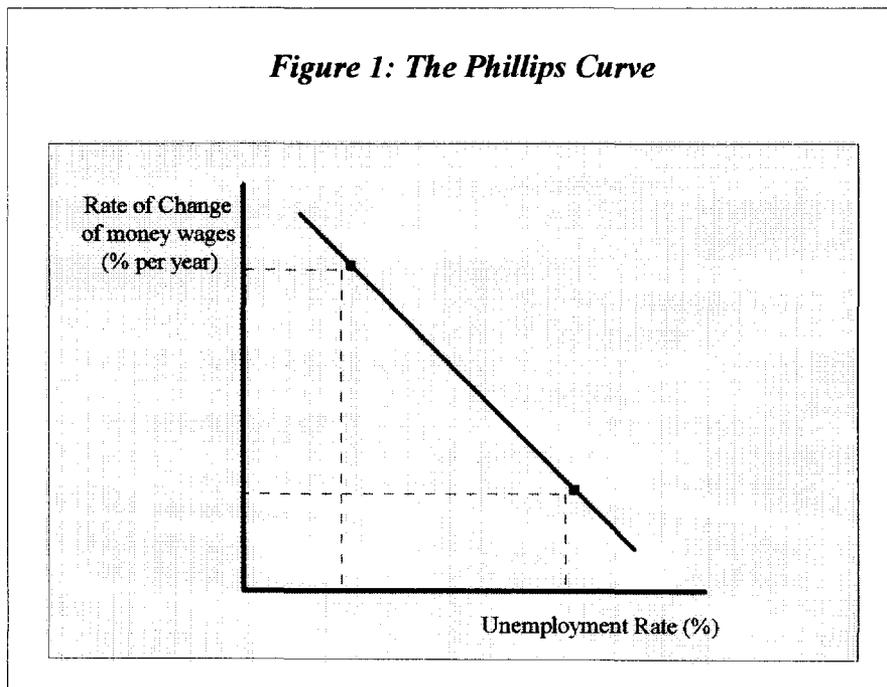
An important distinction to note is that Phillips examined inflation in money wages

rather than inflation in the general level of prices. The presumption is that prices are set

by a mark-up to unit costs of production, the main component of which is wages. It is

important to note that studies subsequent to Phillips' commonly examine data on inflation in the general price level and unemployment. In her article, Clark (1999) points out, "Despite its obvious logic, the Phillips curve has been controversial from the start. Especially contentious: the way later economists stretched it to predict general price inflation, reasoning that since wages make up about two thirds of all business costs, any change in wages must affect general prices as well." As suggested by Clark, the transition from Phillips' original analysis of unemployment and money wage inflation to the more contemporary discussion of unemployment, output growth, and price inflation represents an important modification of the relationship examined by Phillips.

Nonetheless, Samuelson and Solow (1960), in the follow-up study to Phillips', present a price-level modification of the Phillips curve. (See Figure 2) The price level modification is drawn from analysis of U.S. data on unemployment and price inflation. Furthermore, justification for this modification follows from the assumption that the rate of inflation is determined by, among other factors, the rapidity and extent of wage adjustments to the cost of living.

Figure 2: Price-level modification of the Phillips curve

Inflation Rate (% per year)

Unemployment Rate (%)
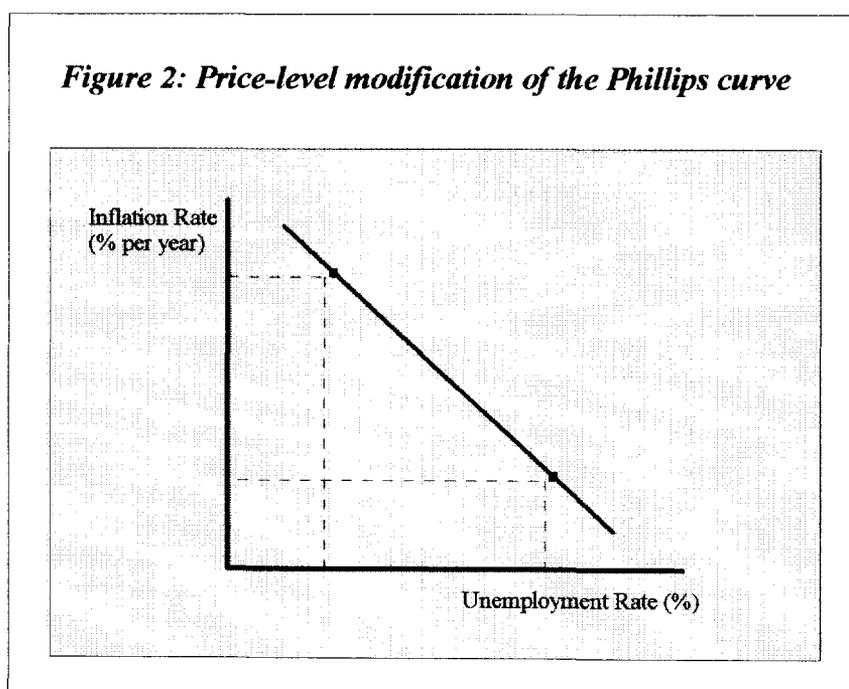
While Phillips's conclusions were based on data for the United Kingdom alone,

researchers soon extended his analysis to other countries, including the United States.

Samuelson and Solow (1960) authored a study using U.S. data which found results

comparable to those of Phillips. For the bulk of their observations, Samuelson and Solow

(1960) found that inflation tended to increase in a tight labor market when unemployment

was low and economic growth was strong. However, the relationship observed in the

U.S. data was not as robust as that for the U.K.

Contemporary Theoretical Refinements

The Phillips curve was adopted by macroeconomists because it provides a

convenient link between the theory of output and employment determination and wage

and price inflation. This theory is summarized in Figure 3. The first graph summarizes

the standard IS-LM model, which is used to predict the level of output and the rate of

interest. The second graph is the modified Phillips curve, which focuses on the

relationship between inflation in the general price level and growth in output.[2] Initially,

the economy is operating at full employment at the intersection of the IS and LM curves.

The level of output is Y_f and the interest rate is r_0. Prices are stable (the rate of inflation

is zero) at this full employment level of output, Y_f (see the lower graph). If this

equilibrium is upset by a cut in taxes or an increase in government spending, for example,

the IS curve shifts rightward to, say, IS` and the demand for output rises above the full

employment level, Y_f. This causes prices to rise. As the price level increases, the real

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[2] These modifications are justified by assuming that the level of output depends inversely upon the level of unemployment and by accepting the hypothesis that prices are set by a mark-up to unit costs of production, the main component of which is wages.

value of the money supply declines, causing the LM curve to shift to the left eventually

returning the economy to full employment output and a stable, but higher, price level. In

the interim, both inflation and output are higher as Phillips suggested.

Figure 3: IS-LM model and the Phillips curve
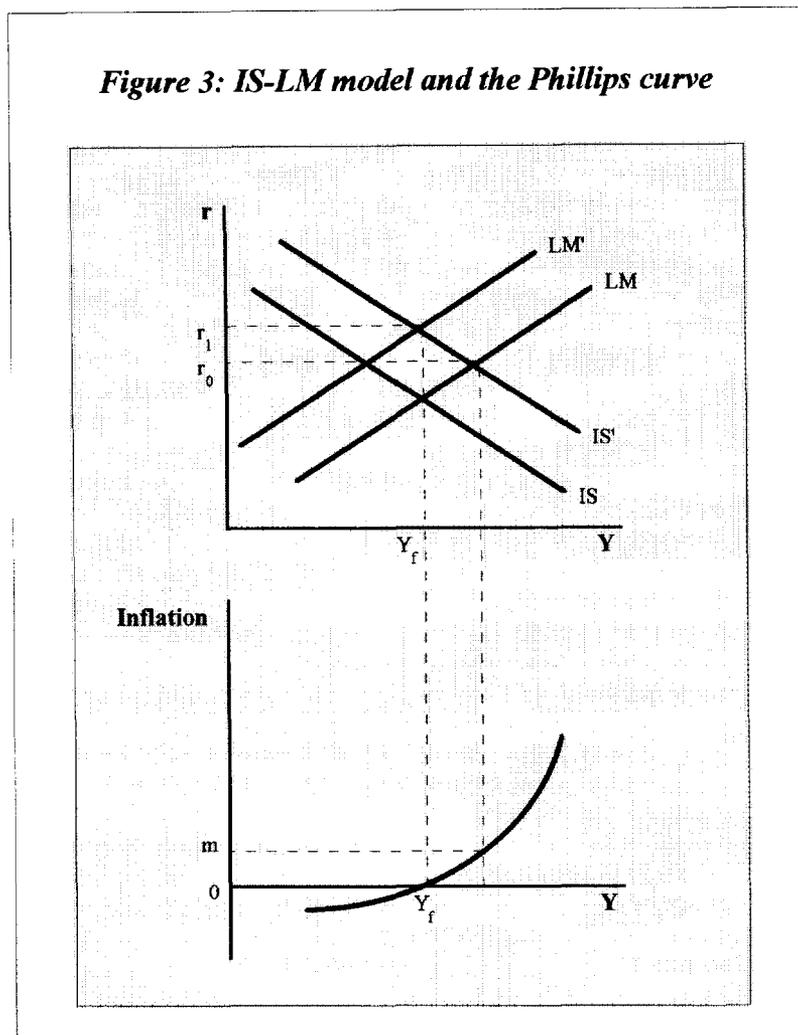
The notion of a positive relationship between inflation and output and a negative

relationship between inflation and unemployment, was challenged separately by

Friedman (1968) and Phelps (1967). They reasoned that the primary determinant of

inflation is monetary growth, which according to theory, including that summarized

above, does not have a long run effect on real output. They proposed that in the long run,

the Phillips curve is vertical at some natural rate of unemployment.[3] Friedman and

Phelps concluded, contrary to Phillips, that there is no expected long-run relationship

between economic growth, inflation, and unemployment.

Recent data appear to reject the Phillips relationship, but they are not completely

consistent with Friedman's argument either. Figure 4 is a scatter diagram of the growth

in U.S. GDP and U.S. inflation. For the sample 1979-1990, there appears to be a

negative relationship between economic growth and inflation, implying a positive

relationship between inflation and unemployment. This is contrary to Phillips' findings.

Figure 4: The Relationship between Inflation and Growth in the United States

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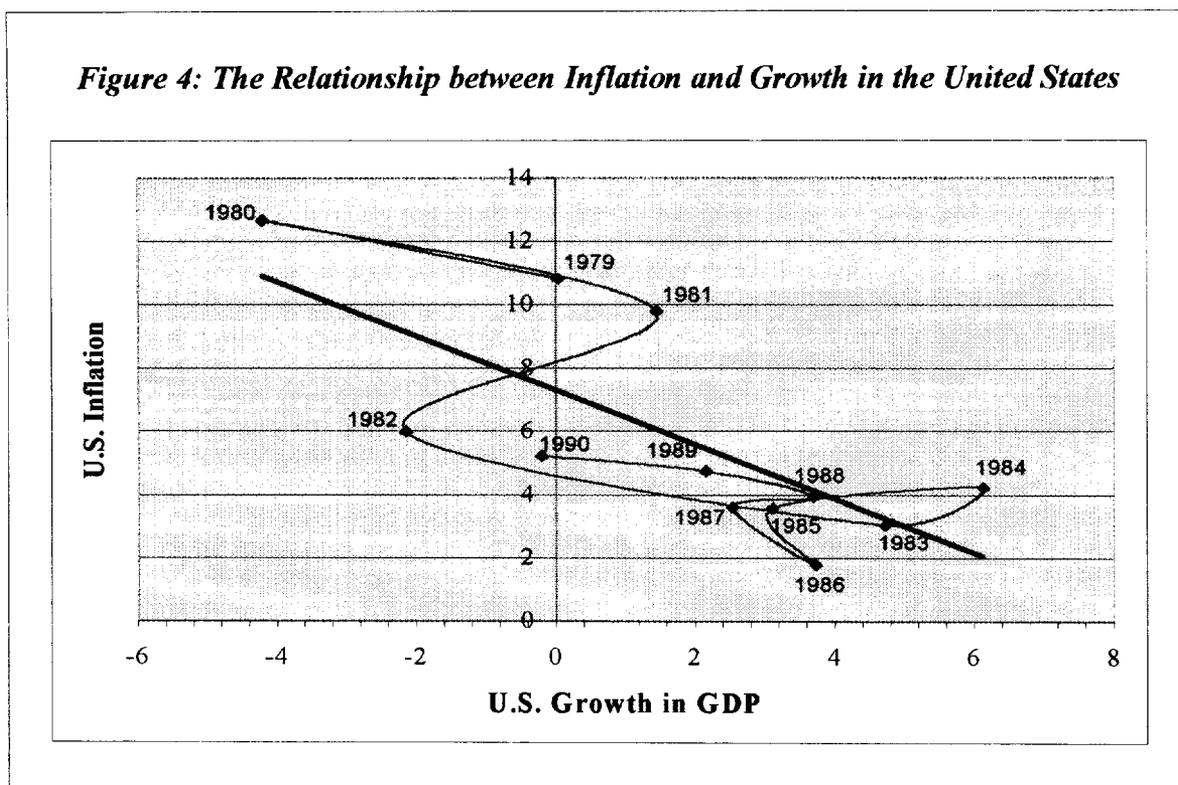
[3] As defined by Friedman, the *natural rate of unemployment* is the level of unemployment where real wage rates tend on average to rise at a "normal" rate. In other terms, it is a rate that can be maintained indefinitely as long as capital formation, technological improvements, etc., remain on their long-run trends. A level of unemployment which is below the natural rate indicates that there is excess demand for labor that will produce upward pressure on real wage prices. Alternatively, a higher level of unemployment is an indication that there is an excess supply of labor which will place downward pressure on real wage rates.

Expectations Augmented Theory

In his Nobel Lecture, Friedman (1977) offered an explanation for the observed positively sloping Phillips curve which remained compatible with his notion of a vertical long-run curve at the natural rate of unemployment. Friedman explained that inflation tends to become increasingly volatile as the rate of inflation rises. Increased volatility leads to greater uncertainty and unemployment may rise and growth may fall as market efficiency is reduced due to the effect uncertainty has on the price coordinating mechanism. Greater volatility may also lead to a decrease in investment which could drive up unemployment rates and suppress output growth. Friedman also argued that as volatility rises, governments tend to impose wage and price controls – which reduce economic efficiency causing an increase in unemployment and a decrease in output (Showdon, 1994).

Hess and Morris of the Kansas City Federal Reserve Bank go a step further than Friedman by suggesting that inflation, itself, is harmful because it creates economic inefficiencies that divert resources away from productive activities. They argue that economic efficiency is essential to attain high levels of economic output, low unemployment, and optimal consumer welfare. The three potential threats to attaining these goals are inflation uncertainty, real growth variability, and relative price volatility.

As inflation rises, empirical tests suggest that inflation uncertainty rises as well. As a result, investors incorporate an inflation risk premium into the interest rate and higher real interest rates result. This effect is costly for at least two reasons: (1) higher real interest rates reduce interest-sensitive spending, such as spending on housing, and (2) higher rates cause businesses to inefficiently substitute labor for capitol, resulting in

output loss. Increased real growth variability, another potential threat, reduces the likelihood that an economy will operate at its full potential. Lastly, relative price volatility due to inflation may lead to non-optimal decision-making by market participants (Hess and Morris, 1996).

Data

Due to data constraints, growth in output, rather than unemployment data, are used to test the Phillips curve relationship. The modification assumes that the level of output depends on the level of employment and that the level of unemployment is inversely related to the level of employment. Furthermore, it is based on the hypothesis that prices are set by a mark-up to unit costs of production, the main component of which is wages. Under this assumption, the Phillips curve theory proposes a positive relationship between inflation and growth in output.

The data for this study are from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). A sample of fifty countries was chosen because each of the countries had continuous annual series for real GDP and the CPI over a common time period. The sample was also determined with regard to the quality of the available data. An appendix containing a listing of the data used is included following the text of this paper. Averaging the rates over a common sample period of thirteen years from 1978 to 1990, a cross section of fifty countries is used as the primary sample to test the relationship between growth in real output and inflation.

The basic empirical framework involves estimating the following equation:

$$GRY_i = \alpha + \beta INF_i + \varepsilon_i \tag{1}$$

where GRY_i is the mean growth of real GDP in country i, INF_i is the mean growth of the CPI in country i, α and β are the parameters to be estimated, and ε_i is an error term.

Finally, the data are used to determine whether any observed correlations vary across developed versus less developed economies. This is accomplished by dividing the sample of countries into two equal-sized pools according to their per capita level of GDP. The purpose is to determine whether the results obtained for the entire sample are sensitive to this reclassification.

Results

Estimation of equation (1) over a cross section of 50 countries from 1978 to 1990 results in a β coefficient of -0.1985 with a standard error of 0.035.[4]

$$GRY_i = 4.7382 - 0.1985 \ INF_i + \varepsilon_i$$
$$(0.528) \quad (0.035)$$
$$[8.976] \quad [-5.658]$$

$$R^2 = 0.400, \quad \text{Adjusted } R^2 = 0.388, \quad N = 50$$

This estimate suggests that about 40% of the variation in measured economic growth is "explained by" variation in the rate of inflation. The F-statistic for the regression, F = 32.0, rejects the null hypothesis of no explanatory power for the regression at better than the 1% level of significance. The estimated coefficient of INF_i is significantly negative and more than five standard errors away from zero. This result is consistent with Fischer's (1993) finding of a negative relationship between growth in output and inflation. The result contradicts Phillips hypothesis which suggests a negative

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[4] In all regressions reported, the standard errors are in parentheses and the t-statistics are in brackets.

relationship between inflation and unemployment and a positive relationship between output growth and inflation.

Results from the Kormendi and Meguire (1985) study testing the macroeconomic determinants of growth using IMF data for 47 countries are drawn from a sample period immediately preceding the sample period used in this paper.[5] They also find a negative coefficient for the inflation variable in their estimates of equations similar to that specified in (1). As a result, this study confirms that Kormendi and Meguire's results are not sensitive to the time period they examined.

Finally, tests are run to determine whether correlations vary across developed versus lesser developed economies. In order to test for this, the sample of fifty countries is divided into two samples- one sample containing more developed countries and a one sample containing lesser developed countries. The countries are divided into two equally sized samples according to their per capita level of GDP.

Countries with per capita GDP above the median

$$GRY_i = 4.3001 - 0.0989\ INF_i + \varepsilon_i$$
$$(0.545)\quad (0.039)$$
$$[7.897]\quad [-2.515]$$

$$R^2 = 0.216,\ \text{Adjusted } R^2 = 0.182,\ N = 25$$

Countries with per capita GDP below the median

$$GRY_i = 5.4436 - 0.2912\ INF_i + \varepsilon_i$$
$$(0.853)\quad (0.053)$$
$$[6.379]\quad [-5.515]$$

$$R^2 = 0.569,\ \text{Adjusted } R^2 = 0.551,\ N = 25$$

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[5] For this paper, 21 of the 47 countries from the Kormendi and Meguire sample are used and chosen because of the availability and quality of data.

Both of the above estimates yield similar qualitative results in the sense that the estimated coefficients of inflation are negative and significant. The estimation for the sample of more developed countries explains about one-fifth of the variation in economic growth. The F-statistic for the regression, $F = 6.32$, rejects the null hypothesis of no explanatory power for the regression at better than the 2% level of significance. The estimated coefficient of INF_i is significantly negative and is two and one-half standard errors away from zero. Alternatively, the estimation for the sample of lesser developed countries explains over one-half of the variation in economic growth. The F-statistic, $F = 30.42$, rejects the null hypothesis at better than the 1% level of significance. In this regression, the estimated coefficient of INF_i is significantly negative and more than five standard errors away from zero.

While the estimates produce qualitatively similar results, the absolute value of the estimated coefficient of inflation is significantly larger in the estimate for lesser developed countries. Also, the R^2 is more than twice as large for the sample of lesser developed countries. This result suggests that growth in output is more sensitive to variation in the rate of inflation in lesser developed countries than it is in more highly developed countries.

Conclusion

Following its discovery in 1958, the Phillips curve has been used as both a policy and forecasting tool. However, recent experience and further research indicate that growth in output, inflation, and the unemployment rate may not be related in the manner initially proposed by Phillips. The Phillips curve predicts that an economy with strong

output growth and low unemployment will also experience high inflation. Yet, despite strong output growth and low unemployment during the last decade, the rate of inflation has declined in the United States. Robert T. Parry, President of the Federal Reserve Bank of San Francisco, remarks with regard to inflation, "...[We've] either been lucky, in which case the old relationships will reassert themselves, or [we've] got a new regime under way (Lown, 51)."

Whether the world economy is experiencing a permanent structural change, or an episode of peculiar economic behavior, the recent breakdown of the Phillips curve appears to be an empirical reality. Specifically, this paper finds a negative relationship between inflation and economic growth which suggests a positive relationship between inflation and unemployment. This conclusion, which is based on a different data set than has been examined in previous work, is consistent with much of the contemporary research on the Phillips curve.

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Appendix

Sample of 50 countries: 1978-1990

Australia	Gabon	Italy	Nigeria	St. Lucia
Canada	Gambia, The	Japan	Philippines	St. Vincent & Grens.
Congo	Germany	Kenya	Portugal	Swaziland
Cote D Ivoire	Greece	Malaysia	Rwanda	Sweden
Cyprus	Grenada	Malta	Senegal	Tanzania
Denmark	Guatemala	Morocco	Sierra Leone	United Kingdom
Dominica	Guyana	Myanmar	Singapore	United States
Egypt	Iceland	Nepal	South Africa	Uruguay
Fiji	India	Netherlands	Spain	Zambia
Finland	Ireland	Niger	Sri Lanka	Zimbabwe

Sample of 25 countries above the median level of per capita GDP

Australia	Fiji	Ireland	Netherlands	St. Vincent & Grens.
Canada	Finland	Italy	Portugal	Sweden
Cyprus	Germany	Japan	Singapore	United Kingdom
Denmark	Greece	Malaysia	Spain	United States
Dominica	Iceland	Malta	St. Lucia	Uruguay

Sample of 25 countries below the median level of per capita GDP

Congo	Grenada	Morocco	Philippines	Sri Lanka
Cote D Ivoire	Guatemala	Myanmar	Rwanda	Swaziland
Egypt	Guyana	Nepal	Senegal	Tanzania
Gabon	India	Niger	Sierra Leone	Zambia
Gambia, The	Kenya	Nigeria	South Africa	Zimbabwe