THE INFLATION-UNEMPLOYMENT TRADE-OFF AND THE SIGNIFICANCE OF THE INTEREST RATE: SOME EVIDENCE FROM UNITED STATES DATA FROM 1939 THROUGH 2007

1. INTRODUCTION

The Phillips Curve received its appellation from Phillips' (1958, 1961) seminal work in *Economica* though this sometimes apparent inverse relationship between unemployment and inflation has intrigued many economists (Snowdon and Vane, 2005; Gordon, 2009b). Explanations about why short-run Phillips curves could exist have focused on misperceptions of both the real wage rate and the demand for goods and services. In this paper we show that any empirical test work on the unemployment-inflation trade-off using Phillips Curve requires the inclusion of the real interest rate. Building on our earlier works (Gentle and Novak, 1995; Gentle *et al.*, 2005, 2007; Chen *et al.*, 2010), we test our hypothesis using data from the United States. Although Gentle *et al.* (2005) also uses the United States data, this paper has twenty more observations, a more focused literature review and an economic history summary of the data period, which makes connections with the paper's theory. The theoretical background and graphical analysis are presented in the second sections of this paper. The model, its estimation and the discussion of the findings are given in the third and fourth section. Econometric results reveal that the inclusion of the real interest variable, along with the wage rate, play an important role in explaining the inflation-unemployment relationship. The last section shows the summary and conclusion.

2. THEORETICAL BACKGROUND

New-Keynesians Mankiw (1993, 2006a), Gordon (1990, 2009a), and Taylor (1980) point out that wages and prices can adjust slowly, thus, affecting the macroeconomic fluctuations, such as Phillips

Curve changes. Furthermore, Mishkin (2006) notes that the New Keynesians and other Schools of thought agree that unanticipated government policy will have the significant influence on the economy; however, the New Keynesians also proclaim that anticipated policy may affect the economy, which is more likely to be reflected in the Short Run Phillips Curve (SRPC). Mankiw (2006a) and Gordon (2009a) describe the Phillips Curve as the short-run aggregate supply curve (SRAS). Gordon (2009a) explains that positive supply shocks cause the SRPC to shift downward and negative supply shocks cause the SRPC to shift upward. In this paper's context we are solely looking at a model where labor inputs are being used in a complementary way with capital. We include real wages (the real cost of labor) and real interest (the real cost of capital) in the model. Business and consumer confidence uncertainties, characteristics of the New Keynesian model, can also lead to the economy more likely operating on the SRPC (Mankiw, 2006a; Gordon, 2009a). Gentle (2005, 2007) and Chen (2010) acknowledge that there are different schools of thought regarding the Phillips Curve. The Marshallian Monetarist School advocates the partitioning of time into short-run and long-run periods; whereas, the Walrasian Rational Expectationists do not divide time into short-run and long-run time periods. They instead recreate the Phillips Curve, terming it the 'Lucas short-run aggregate supply function' (Lucas, 1973; Sargent and Wallace, 1976). Neo-Classical also differs from Classical because Neo-Classical allows for short deviations from full employment if economic agents have incorrect expectations (Dornbusch *et al.*, 1998). A limited amount of monetary neutrality is certainly not enough to gain monetary neutrality for the whole economy (Barro, 1984). Our theory presented in this paper could be embraced by either the Marshallian Neo-Keynesians, Marshallian Monetarists, or the Walrasian New Classical, because all of those Schools have views concerning imperfect information and Phillips Curves. If another School of Economics were to include real interest in the analysis, then that is also an area that should be studied.

The Long Run Phillips Curve is the natural rate of unemployment, according to both the Monetarist and Rational Expectationist schools. The natural rate of unemployment (assumed in the LRPC) is

> "simply the market rate given frictions, mismatches, and institutional constraints, and serves as the base point from which to analyze cyclical unemployment" (Bellante and Garrison, 1988).

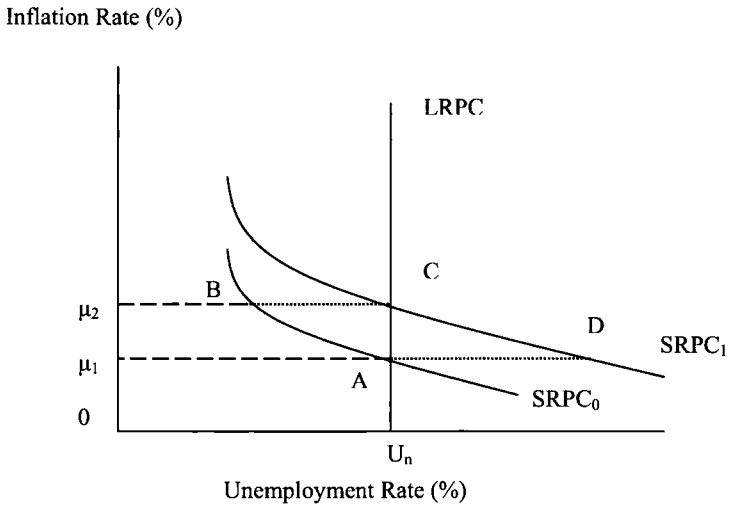
Monetarists and New Classicals argue that an expansionary monetary policy can produce only a temporary decrease in the

unemployment rate due to the misperception on the part of producers. Because there will be a temporary misperception on the part of labor concerning their real wage rate once prices rise. Central to the existence of the Short Run Phillips Curve (SRPC) is the fact that the labor agents do not immediately realize a decrease in their real wage in comparison to government benefits for the unemployed. If inflation is correctly anticipated, the government can no longer use inflation to mask real economic variables (Friedman, 1968, 1970, 1976, 1977). Moreover, as wage earners incorporate inflationary expectations into their behavior, the increasing levels of inflation would cause a sufficient-money illusion, which brings the real wages down and leads the economy to temporarily operating on the SRPC (Perry, 1986). Friedman (1969, 1976) points out that anticipated inflation will be reflected in interest rates so that only unanticipated inflation can affect real interest rates. Sargent (1973) has some econometric evidence to support Friedman's view. A Phillips Curve based on complete rational expectations would be vertical even in the short-run, because only 'surprise' or unexpected inflation can have an impact on the economy. Otherwise there is money neutrality (Lucas, 1973; Barro, 1984; Sargent, 1979; Hertzel, 2005). New Classical argues that the SRPC is attributable to short-term imperfect information, which is not possible in the long run. To a lesser degree, indexed wages, when they are allowed to result in a limited amount of monetary neutrality, are certainly not enough to gain monetary neutrality for the whole economy (Barro, 1997).

3. Graphic analysis

Mankiw (2006a) describes the Phillips Curve and the short-run aggregate supply curve (SRAC), which essentially describes the supply side of the economy. As mentioned above, New Classicals believe that the Short Run Phillips Curve can occur only with surprise amounts of inflation. We are solely looking at a model where labor inputs are being used in a complementary way with capital. Using the Phillips Curves in Figure 1, we assume that the economy is initially operating at point A on $SRPC_0$. Then the difference between μ_2 and μ_1, an unanticipated inflation creates a money illusion, which leads the economy to move from point A to point B. When economic agents realize that they fail to accurately anticipate the inflation rate, the agents would make an adjustment. At that point the economy shifts to point C on the LRPC. Both temporary

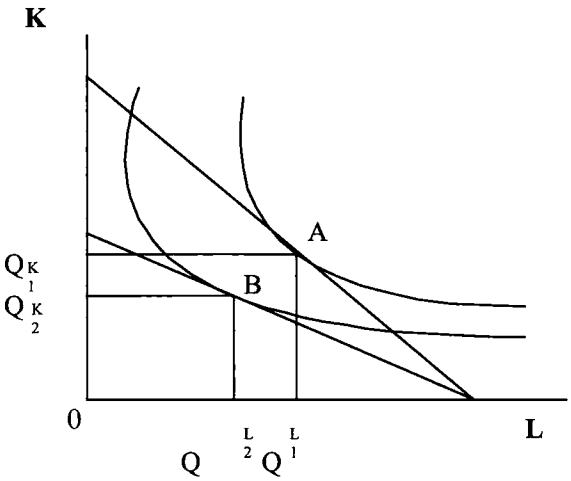
FIGURE 1 - *Phillips Curves*



misconceptions regarding employees' knowledge of the real wage and entrepreneurs' and managers' knowledge of the real net present value (NPV) allows the economy to operate on a SRPC. After a period of time, labor agents realize the increase in their cost of living compared to a decline in real wage. Concurrently entrepreneurs and managers realize the increase in the cost of capital and land, which leads to a decrease in the NPV for capital/labor complementary projects. Managers and entrepreneurs are also aware at this same time that an increase in the demand for their products has not been sustained. At this time, the ability of policy makers to use money illusion to operate on $SRPC_0$ is lost. Therefore, the economy comes back to natural unemployment rate on the LRPC, due to some workers opting for employment, some capital/labor complementary projects being curtailed, with attendant layoffs and a decrease in aggregate demand that characteristically happens when the real interest rate is increased (Phelps 1967, 1968; Gentle and Novak, 1995; Gentle *et al.*, 2005, 2007; Gordon, 2009a; Chen *et al.*, 2010). Furthermore, labor, capital, and land may be used as complements as well. In our model in this paper, land could be thought of as a type of capital. The isocost curves and isoquants in Figure 2 show the effect of a change in the real interest rate on the capital and labor inputs used by a firm and its output. If the firm is initially operating at point A, the tangent point between the highest isoquant and highest isocost

curves in the diagram, this is based upon a set of input costs. If the scenario is where the price of labor, the real wage, is constant and the price of capital, the real interest rate, is increased, then the isocost line will shift inward leading to the firm to operate at point B, which produces a lower level of output. An examination of Figure 2 reveals that the firm now reduces both the use of capital inputs due to the higher cost of capital and the use of labor input because less complementary capital input is being used due to the lower level of output. Thus the unemployment rate may increase. We note here and in Chen *et al.* (2010), that Gordon (2009b) and Mankiw (2006b) are still publishing work on Phillip's Curves (see Mankiw and Reis, 2010). Furthermore, Lucas is pursuing his own research agenda (see Golosov and Lucas, 2007). In addition Sargent (1999) has outlined many models about Phillips Curves. More important to us than any of the differences between these economists, is for any and all schools of economic thought to just consider the inclusion of the real interest rate in Phillips Curve analysis.

FIGURE 2 - *Effects of Real Interest Rate Change on Capital K and Labor L Use*



4. EMPIRICAL FRAMEWORK

This analysis is based on the annual time series data from the United States from 1939 through 2007. The real wage data is derived from the U.S. Bureau of Labor Statistics (BLS). Robert

Gordon (2009a) provides the other data. Sources and definitions of each series used in the analysis are shown in the appendix. Some facts merit mention at this point.

4.1 Some Relevant Highlights of U.S. Economic History in 1939-2007

We choose these years since all variables are available from Gordon (2009a) and the BLS. Covering all the events and including all the recessions of the economic history of the time period from 1939-2007, are obviously not possible in our paper, due to space limitations. Thus we will look only at some of remarkable economic events that are related to the theories in our paper. The most significant one that had happened in the U.S. in the years just prior to 1939 was the Great Depression. Friedman and Schwartz (1963a, 1963b) state that the 'Great Contraction', part of the Great Depression, is the period from 1929 to 1933, when the money supply was most severely reduced, a point agreed upon by the majority of economists (Stiglitz, 2010; Gordon, 2009a). The deflation, measured on the vertical axis, below the horizontal axis, would have placed the economy to the right-side of the LRPC and onto a downward slopping SRPC. Just as the deflation causes the real interest rate to hike so much, the real wage also rises. The highest point of unemployment in U.S. history was in 1933, at 25.2% (Gordon, 2009a). Both the Glass-Steagull Act of 1933, which prohibited banks from underwriting or dealing with corporate securities, and the FDIC act of 1933, which insured deposits, helped the economy (Mishkin, 2006). Additionally the money supply and velocity of money decrease due to bank failures since the 'Great Contraction', were never fully made up for (Friedman and Schwartz, 1963a; Gordon, 2009a). The National Recovery Administration, which lasted two years from 1933 to 1935, complicated the situation, since it led prices and wages to be much stickier (Bordo *et al.*, 2000). During the Great Depression, there was expanded federal government involvement in agriculture (Cunfer, 2010). High tariff rates in the U.S. were in place during the Great Depression. This factor caused retaliatory high tariff rates in other countries, lowering GDP for the U.S. (Meltzer, 1976). Fiscal policy stimulus was relied in the Great Depression, as advised by Keynes (1936). Unfortunately, there was an erroneous concern for inflation in 1936, which led to policies of reducing both monetary and fiscal expansion (Velde, 2009). Since during the Great Depression the economy never operated at the natural rate of unemployment,

this worsening of the economy in 1938, compared to 1936, would be reflected by the economy operating to the right of the LRPC, at a point, further to the right, of where it operated in 1936. All of the time period of the Great Depression would be at points to the right of the LRPC. Despite federal government efforts, unemployment was still high, 17.2% in 1939, the first year of data for our study (Gordon, 2009a).

During World War II, unemployment fell to low rates, below the natural unemployment rate. However, due to stringent price controls, prices did not rise. But after World War II, the lack of price controls was blamed to a 'soaring' inflation rate; U.S. Treasury bond-holders took a loss (Gordon, 2009a). After the Korean War in 1953, adjusting to a peacetime economy included the Fed's plan to raise interest rates and rein in inflation, known as a policy of disinflation, there was a recession from July 1953 to May 1954 (Holmans, 1958; Labonte and Makinen, 2002). As was stated, disinflation would be shown in Phillips Curve analysis, with the economy operating at point D, to the right of the LRPC for some time, in order to decrease the inflation rate. During part of 1957 and 1958, the U.K. and the U.S. experienced a short recession that was quelled with an expansionary monetary policy. During the 1958 recession, the U.S. economy was taken onto a Short Run Phillips Curve (SRPC), to the right of the LRPC. President Kennedy and President Lyndon Johnson relied heavily on fiscal policies (Finklestein, 1992; Gordon, 2009a). The U.S. had been on the gold standard, according to the Bretton Woods agreement, and was taken off of that by President Nixon, in 1971 (Mishkin, 2006). Thornton (2004) views this as sometimes contributing to inflation in the United States. In the 1970s, OPEC greatly raised oil prices. The supply shocks of OPEC can be described by a shift up of the SRPC. At some times during the 1970s, the U.S would try to accommodate the supply shocks by increasing the money supply, which was a factor to drive inflationary pressures. Rising prices and rising unemployment may cause stagflation, which would be shown as a point to the right of the LRPC at a high inflation level (Knoopy, 2004; Gordon, 2009a). The U.K. was put through some times of high unemployment, as the inflation rate was lowered with the disinflation that started in 1979. A government policy that purposely puts the country through such a disinflationary time, takes the nation onto a SRPC to the right side of the LRPC temporarily, as in the direction of point D of Figure 1. Eventually the economy will settle back on the LRPC (Gordon, 2009a).

Eventually the British economy was brought back to the Long Run Phillips Curve (LRPC), after going down the right side of the LRPC and down the downward sloping portion of an SRPC (Dell, 1996; Carlin and Sokice, 2006). However, the Fed in the U.S. handled this a bit differently, slowing down inflation in two bouts. Upon becoming Chair of the Fed in 1979, Paul Volker decided to lower the inflation rate by putting the country through a recession, which indeed happened in 1980 (Mishkin, 2006). Once inflation seemed to be somewhat in control, the Fed eased up on interest rates. But inflation had not been controlled. After that Fed Chair Paul Volker had to earn more credibility. This was achieved and the U.S. was put through a tough recession in 1981-1982. Finally inflation was brought under control until high inflation was squeezed out of the economy. Then in 1983, Paul Volker was able to allow some expansion of credit back into the economy, without risking inflation (Mishkin, 2006). In the context of this paper, we would see the economy leaving point 'A' in Figure 1 and going up to point 'B', which denotes higher inflation and lower unemployment. That was a place where the trade-off between inflation and unemployment was apparent. Yet, the familiar trade-off was very short lived. And then the economy went to point 'C', a place that signifies high inflation without any trade-off of low unemployment. Subsequently, Fed Chair Paul Volker thought that he had to bring the U.S. through a disinflation time to get to 'D', showing low inflation and high unemployment, a recession. Eventually the economy will come back to 'A', a natural unemployment rate with an acceptable level of inflation. The U.S. was put through some times of high unemployment, as the inflation rate was lowered. Eventually the nation's economy was brought back to the Long Run Phillips Curve (Gordon, 2009a).

The so called 'New Economy' of the latter part of the 1990s is well described by Gordon (2009a). The U.S. economy had the lowest unemployment rate in 30 years, combined with a relatively low inflation rate that allowed the Fed to keep interest rates low. This resulted in a rightward shift of the aggregate supply and aggregate demand curves. The aggregate supply curve shifted due to a productivity gain, achieved through the use of advances in computers and the Internet. A source in aggregate demand rightward shifting was attributable to an increase in consumption spending brought on by increases in the stock market (Gordon, 2009a).

> "While the economic expansion of the 1990 started off slowly, everything seemed to accelerate at the beginning in 1995" (Gordon, 2009a).

Then prices for computers and related equipment accelerated, causing an increase in buying of these items by both businesses and consumers. Suppliers responded and that was followed by the market being flooded. A similar situation happened in the fiber-optic cable market,

> "intended to tie together all the office and home computers in a vast broadband network" (Gordon, 2009a).

A good way to see the impact of all this is the fact that the

> "value of the NASDAQ stock market index that specialized in high-tech stocks crashed, losing two thirds of its value between March 2000 and March 2001" (Gordon, 2009a).

The cycles of too much investment in computers and telecommunications affects other markets such as office buildings, stores and apartments (Gordon, 2009a).

According to Bernanke (2010), the U.S. economy, experienced a recession between March and November 2001. This was largely due to four factors. One was the ending of the dot.com boom, with its resultant great decline in some stock prices. The second one was the 'geopolitical uncertainties' that came to fruition due to the terrorist attacks against the U.S. on September 11, 2001. A third one was the corporate scandals such as those that happened with Enron and Anderson (Graham *et al.*, 2002; Bernanke, 2010). And a fourth is the invasion of Iraq (Bernanke, 2010). These factors led the FED to pursue such an expansionary monetary policy, without the Taylor Rule being observed. The Federal Reserve wishes to keep inflation and GDP at reasonable levels (Bernanke, 2010). The Taylor Rule guides central banks to

> "move the real short-term interest rate away from its desired long-term value in response to any deviation of actual inflation from desired inflation and in reaction to any deviation of real GDP from natural real GDP" (Gordon, 2009a).

Using the Taylor Rule as a guidepost for monetary policy, both Gordon (2009a) and Bernanke (2010) state that the Fed allowed the federal fund rate to be too low during a portion of the first half of the first decade of the 21st century.

Increasing the money supply caused inflation and an appreciation of housing prices and eventually a housing bubble (Gordon, 2009a). Houses were bought for both dwelling and speculative purposes, in the hope that prices would go up in the future, as they had been

doing. Furthermore, in order to sell the surplus of houses, normal procedures were done away with, resulting in some agents selling houses to people who could not afford to make the payments. These buyers are known as 'subprime' buyers, and in August 2007, trouble began for securities backed by Adjustable Rate Mortgages (Gordon, 2009a). In 2001, there were 1.6 million housing starts; in 2005 there were 2.1 million housing starts; in 2007 there were 1.5 million housing starts (Gordon, 2009a). The data for our paper extend to 2007. The stock market crashed in October of 2008 and is attributable to this housing bubble and housing crises. The economic crisis spread throughout the World. Furthermore, low interest rates have not proven sufficient to pull America out of the recession. In 1999 there was the repeal of the Glass-Steagull Act of 1933. Many economists believe this added to current economic woes, since some conflicts of interest came about with the repeal of that Act (Stiglitz, 2010). Moreover, policy-makers in Washington debate tax cuts, tax hikes, spending cuts and spending increases in the U.S. federal budget. Complete reform of the U.S. financial system is still in debate. As stated, we are cognizant of the real wage factor affecting the U.S. economy. We have chosen to point out real interest factors that were occurring as well, during the decades of economic history just described.

4.2 The Econometric Model

We choose the multiple-equation model to specify the relationship between unemployment and inflation. Both of them are influential in the literature to study how unemployment rate (u), inflation rate (f), interest rate (i), and wage rate (w) interact with each other. Within the equation system, the first model developed by Samuelson and Solow (1960) describes the traditional Phillips curve in a permanently exploitable way. Compared to the original model in the above paper, we incorporate the interest rate and the wage rate to suggest the following specification:

$$f_t = \beta_1(L)(U_t - U_t^*) + \beta_2(L) i_t + \beta_3(L) w_t + \varepsilon_{1t} \quad (1)$$

where f_t represents the inflation rate; U_t represents the unemployment rate; U_t^* represents the natural unemployment rate; i_t represents the interest rate; w_t represents the wage rate respectively. $\beta_1(L)$, $\beta_2(L)$, and $\beta_3(L)$ are the lagged polynomial operators. ε_{1t} is an independent and identically-distributed disturbance error to follow normal distribution with mean zero and variance σ_1^2. In addition, ε_{1t} is assumed to be orthogonal to all the explanatory variables which contain current unemployment rate. Following Samuelson and Solow

(1960), this model allows a long-term and stable trade-off between unemployment and inflation.

As suggested by Kreps (1998) and Sargent (1999), the U.S. monetary authority is assumed to be an adaptive decision maker in the context of models of Phillips curve. In light of Sargent's monograph work, a natural rate version of a Phillips curve relates unemployment to surprise inflation. Therefore, the unemployment rate in Equation (1) is endogenous, reacting to changes in the inflation rate. To take into account the potential endogeneity issue between different macroeconomic variable and obtain a reliable result, we follow Sargent (1999) to build up the below model to associate the natural unemployment rate and the inflation rate, the interest rate and the wage rate. Concretely, our basic model designed by Sargent (1999) can be specified as follows:

$$U_t - U_t^* = \lambda_1 f_{t-1} + \lambda_2(L) i_{t-1} + \lambda_3(L) w_{t-1} + \varepsilon_{2t} \quad (2)$$

where U_t reflects the unemployment rate; U_t^* reflects the natural unemployment rate; f_{t-1} reflects the inflation rate; i_{t-1} represents the interest rate; w_{t-1} reflects the wage rate. $\lambda_1(L)$, $\lambda_2(L)$, and $\lambda_3(L)$ are the lagged polynomial operators ε_{2t} is iid N(0, σ_2^2).

5. Estimation results

Before estimating the multiple-equation model, we intend to take a look at the distribution property of the key variables. Table 1 reports some general descriptive statistics (mean, standard deviation, minimum, 25th percentile, median, 75th percentile, maximum) for inflation rate, unemployment gap, interest rate, and wage rate, which

Table 1 - *Descriptive Statistics*

	f	*U-U**	*i*	*W*
Obs	68	68	68	68
Mean	3.80	-0.11	6.35	2.22
SD	2.70	1.97	3.01	2.87
Min	0.00	-3.80	2.50	-3.88
25th	1.78	-1.10	3.60	0.59
50th	2.99	-0.20	6.35	2.48
75th	5.30	0.75	8.25	3.57
Max	12.00	9.70	14.20	13.21

Note: this table presents some basic statistics of four concerned variables. They include number of observation, mean, standard deviation, minimum, 25th percentile, Median, 75th percentile, Maximum. The definitions of above variables are shown in the Appendix 1.

are in the percentage term. In addition, we construct a correlation matrix to examine the relationship between inflation, unemployment gap, interest rate, and wage rate. In table 2, the Spearman and Pearson correlations between variables of interest are computerized to seek some preliminary evidences whether the association we try to argue exists or not. The calculated Pearson correlation tabulated in Table 2 indicates that a negative interaction is found between inflation and unemployment gap under the 1% significance level. This is in line with the prediction of the traditional Phillips curve. In contrast, both inflation and unemployment gap are positively and significantly related to the interest rate, whose signs agree with our expectation. Albeit the Spearman correlation shows a negative interdependence between interest rate and unemployment gap, which is at odds with the previous findings, yet it is insignificant. Moreover, the correlation matrix shows a positive relation between wage and inflation.

TABLE 2 - *Correlation Matrix*

	F	*U-U**	*i*	*W*
F		0.0485	0.3118	0.2289
		(0.6947)	(0.0097)	(0.0604)
*U-U**	-0.4168		0.4202	-0.1953
	(0.0000)		(0.0004)	(0.1105)
I	0.2222	-0.1204		-0.1261
	(0.0161)	(0.1941)		(0.3055)
W	0.2881	0.0832	-0.1253	
	(0.0172)	(0.5000)	(0.3086)	

Note: this table shows the correlation matrix between inflation rate, unemployment gap, interest rate, and wage rate. The upper triangle presents the Spearman correlation between key variables, while the lower triangle shows the Pearson correlation among key variables. Their corresponding P-values are reported below in the parenthesis of individual correlation. The definitions of above variables are shown in the Appendix 1.

Next, we turn to evidence of a more complex model which takes into account the endogeneity of these variables. Unlike single-equation model, here we use three-stage least square to estimate our model regarding the relation between unemployment gap and inflation. The results of multiple-equation model are summarized in Table 3. Irrespective of which equations we investigate in the system, evidence shows that the interest rate and wage rate do play an important role in explaining both the unemployment gap and inflation rate after controlling the effect of other variables, respectively. If the inflation

rate is viewed as the dependent variable, the coefficient of interest rate (0.4622) is positive and statistically significant, implying that an increase in the interest rate would improve the inflation rate. When the unemployment gap is regarded as the dependent variable, such positive impact of interest is still found. Furthermore, a negative relation is present between unemployment gap and inflation, in line with the traditional Phillips curve. Overall, the significant Chi-Square statistics imply that the model setting is somewhat correct and able to explain a considerable variation in the inflation rate and unemployment gap. All in all, the findings of multiple-equation model retain the same as those obtained from correlation matrix. This is also consistent with Gentle *et al.* (2005, 2007) and Chen *et al.* (2010), all of which claim that the real interest rate should be considered in Phillips Curve analysis.

TABLE 3 - *Estimation of Multiple-equation Model*

Dependent Variable	F	U-U^*
f_{t-1}		-0.1437**
		(0.0655)
U_t-U_t^*	-1.0959***	
	(0.3302)	
i_t	0.4622***	
	(0.0534)	
i_{t-1}		0.1288***
		(0.0405)
w_t	0.3218***	
	(0.1019)	
w_{t-1}		-0.1293**
		(0.0604)
Obs	67	67
Adjusted R^2	0.6039	0.0920
Chi-Square	164.07	16.73

Note: this table reports the empirical results of multiple-equation Model. The estimated coefficient as well as the corresponding standard error in the parenthesis is shown. ***, ** and * indicate the values are significant at 1, 5 and 10% level of significance. The definitions of above variables are shown in the Appendix 1.

6. SUMMARY AND CONCLUSION

This paper suggests that any analysis of a Phillips Curve should include the real interest rate, as well as inflation because any changes in the real interest rate changes the labor input mix in the

production process, which ultimately affects the level of employment in the economy. In order to justify this argument, multiple-equation empirical models are estimated, which include the interest rate as one of the key explanatory variables in addition to inflation. The model is estimated using the annual data in the U.S. from 1939 through 2007. The estimated result indicates that the interest rate variable is indeed significant in explaining the Phillips Curve. This American study provides an especially interesting study, in view of the fact that it is over a period of 68 years, with some periods of steady growth and some times of recessions on people both in the U.S. and abroad.

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ABSTRACT

This article argues that any empirical study on the inflation-unemployment trade-off requires the inclusion of the real interest rate in the model as any changes in the interest rate affects the capital used by the firms and thus leads to an effect on the level of employment in the economy. To test the validity of this argument, an empirical model is developed which includes the real interest rate as one of the explanatory variables in addition to inflation and real wages. The model is estimated using the annual time series data from the United States for the period from 1939 through 2007, which is available from Gordon (2009a) and the U.S. Bureau of Labor Statistics. The estimated results indicate that the interest rate variable is indeed significant in explaining the Phillips Curve.

Keywords: Phillips Curve, Short Run, Long Run, Aggregate Supply Curve, United States of America Economic History

JEL Classification: E12, E24, E40, N12

RIASSUNTO

Il trade-off tra disoccupazione e inflazione e il ruolo del tasso di interesse: evidenze dagli USA nel periodo 1939-2007

Questo articolo argomenta che qualunque studio empirico sul *trade-off* tra disoccupazione e inflazione richiede l'inclusione del tasso di interesse reale, poiché qualunque modifica nei tassi di interesse influenza la quantità di capitale utilizzato e, di conseguenza, i livelli occupazionali. Per verificare questa affermazione viene sviluppato un modello empirico che include anche il tasso d'interesse reale come variabile esplicativa, oltre a inflazione e salari. Tale modello viene stimato utilizzando dati annuali per gli USA nel periodo 1939-2007. I risultati evidenziano che la variabile tasso d'interesse è realmente significativa per spiegare la curva di Phillips.

APPENDIX 1
Data Definition and Sources

Variable	Definition	Period	Sources
F	Inflation rate	1890-2007	Gordon 2009a
U	Unemployment rate	1890-2007	Gordon 2009a
U^*	Natural Unemployment rate	1890-2007	Gordon 2009a
I	Interest rate	1890-2007	Gordon 2009a
W	Hourly wage rate	1939-2007	Bureau of Labor Statistics