REAL WAGES, REAL INTEREST RATES AND THE PHILLIPS CURVE: EVIDENCE FROM CANADIAN DATA

1. Introduction

Irving Fisher (1926, 1973) was the first economist to notice an inverse relationship between the unemployment rate and inflation. A.W. Phillips (1958) later formalized it in his seminal paper in *Economica*. As for the last few decades, the sometimes apparent inverse relationship between unemployment and inflation has been termed the 'Phillips Curve' (Santoremo and Seater, 1978). The explanations about why short-run Phillips Curves may exist have centered on misperceptions of both the real wage rate and the demand for goods and services. In this paper, we show that any empirical test on the validity of the Phillips Curve should also include the real interest rate. Building on our earlier work (Gentle *et al*., 2005), we test our proposition with Canadian data.

Sections 2 and 3 of the paper present the theoretical background and graphical analysis. The fourth section of the paper provides the model, its estimation and the discussion on the findings. The last section of the paper presents the summary and conclusion.

2. Theoretical background

Since the Neo-Keynesian, Monetarist, and Rational Expectationist schools of economic thought both recognize the usefulness of Phillips Curves, we start with a brief review of these theories in order to explain the need for inclusion of a real interest rate variable in the analysis of Phillips Curve.

The Neo-Keynesians maintain that 'unanticipated policy has a larger effect on aggregate output than anticipated policy'. Yet it must be made clear that according to Neo-Keynesians, 'Anticipated policy *does* affect aggregate output and the business cycle' (Mishkin, 2002, p. 723). Neo-Keynesians point out that wages and prices can adjust slowly, which in turn can result in macroeconomic fluctuations

(Mankiw, 1989, 1993, 2002; Roberts *et al*., 1994; Roberts, 1995; Fair, 1999). Certainly some of the studies indicating evidence of a Phillips Curve with temporary tradeoffs between inflation and unemployment show rigidities for wages and prices for commodities and general goods and services (Taylor, 1980; Blinder, 1987; Koustas, 1988; Fortin, 1991; Prachowny, 1991; Gali, 1992; Fuhrer, 1995; Dutkowsky, 1996).

Concerning monetary policy and credit markets, Perry and Schultz (1993) believe that 'constraints on credit expansion' can be termed 'lesser shocks'; whereas, consumption weaknesses are the most negative shock to an economy. Romer (1993), a self described Neo-Keynesian, states 'monetary and other aggregate demand shocks are a necessary part of any complete model of macroeconomics fluctuations'. Gordon (1990) believes that increased attention to industrial organization will help economists better understand the reality that markets do not always clear quickly, both in the final product and input markets. Mishkin (1982) and Gordon (1982) provide evidence that suggests that anticipated policy does matter.

The Neo-Keynesians can understand the nature of the high real interest rates during the Great Depression, which the Monetarists have pointed out. However, the Neo-Keynesians, still think other factors are important such as fiscal policy, net exports and business and consumer confidence (Mishkin, 2006). What Neo-Keynesian views mean for this article is that they believe the real interest rate is important, yet they think the long-run Phillips Curve would describe a point where the economy rarely operates. With regard to our theory, we accept the Neo-Keynesian view that unanticipated inflation has a better chance of distorting expectations than anticipated inflation. It is true that Neo-Keynesians also believe that even anticipated inflation may have real effects on the economy (Mishkin, 2006). All that matters to us is that the real interest rate should be included with other factors in analyzing the Phillips Curve, whether they are the result of unanticipated inflation, anticipated inflation or some combination thereof. Certainly unanticipated inflation by definition is more damaging to a business's planning ability than anticipated inflation. Although even once anticipated inflation happens and affects the real interest rate, some businesses and consumers will be in a better position to adjust faster than others. So we can appreciate that even anticipated inflation has real effects, of a lesser nature than unanticipated inflation. Tobin (1981) and others have pointed out the similarities between the Monetarist and Rational Expectationist (Neo-classicals or New classicals) policy prescriptions. However, there is an important difference in methodology. Neo-Keynesians and Monetarists

both have a Marshallian heritage. 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, 1972, 1973; Sargent and Wallace, 1976; Laidler, 1981). Neo-Classicals also differ from Classicals because Neo-Classicals do allow for short deviations from full employment if economic agents have incorrect expectations (Dornbusch *et al*., 1998, pp.159-160).

The Long Run Phillips Curve is the natural rate of unemployment, according to both the Monetarist and Rational Expectationist schools (Hoover, 1984). The natural rate of unemployment (assumed in the LRPC) is (Bellante and Garrison, 1988):

"simply the market rate given frictions, mismatches, and institutional constraints, and serves as the base point from which to analyze cyclical unemployment".

Monetarist and Rational Expectationist 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. However, once prices rise there will be a temporary misperception on the part of labor concerning their real wage rate. 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; once inflation is correctly anticipated the government can no longer use inflation to mask real economic variables (Friedman, 1968, 1970, 1976, 1977). Further, as wage earners incorporate inflationary expectations into their behavior, the increasing levels of inflation would create sufficient money illusion, which brings the real wages down leading the economy to temporarily operate on the SRPC (Laidler, 1981; Perry, 1986). Friedman (1969, 1976) points out that anticipated inflation will be incorporated in interest rates so that only unanticipated inflation can affect real interest rates. Sargent (1973) has some econometric evidence supporting 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, 1972, 1973; Barro, 1977, 1984; Sargent, 1979; Lucas and Sargent, 1981; Hertzel, 2005). Rational Expectionists argue that the short-run trade off between inflation and unemployment (SRPC) is due to short-term imperfect information, which is not possible in the long run. To a lesser degree, indexed wages, when they exist, allow

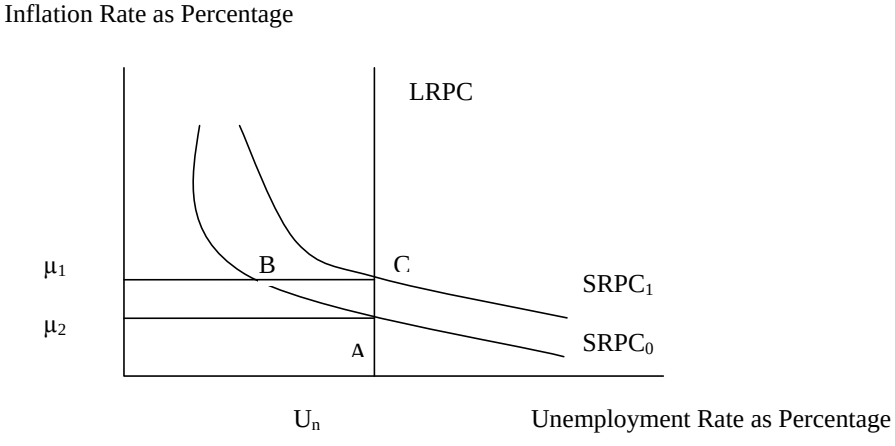
a limited amount of monetary neutrality, certainly not enough to gain monetary neutrality for the whole economy (Barro, 1977). Our theory advanced here could be embraced by either the Marshallian Neo-Keynesians, Marshallian Monetarists, or Walrasian Rational Expectationists because whether imperfect information is due to a Marshallian or a Walrasian analysis is of no consequence to the idea that real interest should be included along with other factors in analyzing the Phillips Curve. If another School of Economics were to embrace Phillips Curve analysis, then by all means we would encourage it to include the real rate of interest in their studies.

3. Graphic analysis

Mankiw (2002) describes the Phillips Curve as the short-run aggregate supply Curve (SRAC), which essentially describes the supply side of the economy. The SRAC can provide a valid description of the supply side of the economy, until the prices of all inputs increase proportionately to the same level as the output prices. For this reason, we include both the cost of labor (real wages) and capital (real interest) in the model developed here.

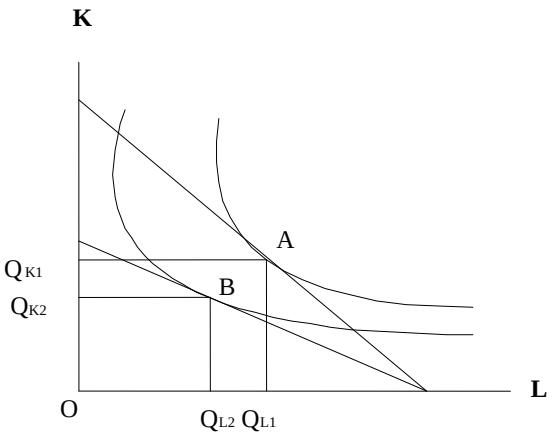
Using the Phillips Curves in Figure 1 assume that the economy is initially operating at point A on $SRPC_0$. Then the difference between μ_1 and μ_2 entails an unanticipated inflation that creates a money illusion leading the economy to move from point A to point

Figure 1 - *The Phillips Curves*



B. When economic agents realize that they failed to accurately anticipate the inflation rate the agents will make an adjustment. At that point the economy shifts to point C on the LRPC. Both temporary misconceptions allow 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. Entrepreneurs and managers concurrently realize that the increase in the cost of capital leading to a decrease in the net present value (NPVr) for capital/labor complementary projects. Managers and entrepreneurs simultaneously realize that an increase in the demand for their products has not been sustained. 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 for the following reasons: (a) some workers opting for employment; (b) some capital/labor complementary projects being curtailed; (c) with attendant layoffs; (d) decrease in aggregate demand that characteristically happens when the real interest rate is increased.

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



Through the use of isocost Curves and isoquants in Figure 2, one can see 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 there is a situation 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 is reduced because less complementary capital input is being used due to the lower level of output. Therefore the unemployment rate may increase.

4. Empirical model

We have used Canadian annual time series data for a period between 1960 and 2004. Sources and definitions of each series used in the analysis are shown in the Appendix A. A cursory glance of the summary statistics of data reported in Table 1 indicates that most of the year the economy is operated in the short-run Phillips Curve: the difference between unemployment rate and natural unemployment rate is not equal to zero.

Table 1 - *Summary Statistics of the Variables*

Variables	Mean	Median	Standard Deviation
U_d	2.249	2.344	1.150
W	0.006	0.004	0.02
μ	4.565	3.883	3.197
R	3.665	3.164	2.400

Source: Calculated by the authors.

A detailed historical review of Canada's economy during those years is beyond the scope of this paper. However, the restrictive monetary policy of the United States Federal Reserve Board in the 1980s reflected a somewhat similar policy in Canada during that time period. Yet, in the 1990s the functioning of the Bank of Canada is of particular significance since Canada chose to take a more restrictive monetary policy than the United States did during part of the 1990s. After an election resulted in a new president taking office in 1981, the Fed concentrated on using monetary policy to dampen inflation through high interest rates in the United States. It was successful

and this also resulted in the highest unemployment rates since the Great Depression. The country operated on a Short Run Phillips Curve (SRPC) before coming back to a Long Run Phillips Curve (LRPC). Continuing to look at United States data, the worst years for unemployment in that decade were between 1980 and 1986. With the year 1987, the United States economy was operating at a lower level of inflation than before and with a level of unemployment thought to be the natural rate for that time period (Gordon, 2006). Throughout much of the 1980s, both the United States and the Canadian prime interest rates were high. Canadian economists, Pierre Fortin (1996) and Douglas Curtis (2005), state that it was the interest rate differential between the United States and Canada that allowed the United States to have less unemployment during part of the 1990s compared to Canada's experience. So this was quite different than what happened in the 1980s when Canada and the United States were following similar monetary policies.

The following model provides the conceptual idea on how U_d i.e. $(U\text{-}U_n)$ relates to inflation rate (μ), real interest rate (r) and real wage (W)

$$U_d = f(\overset{+}{w}, \overset{-}{\mu}, \overset{+}{r}). \tag{1}$$

The coefficient associated with inflation rate is expected to have a negative sign, while the coefficients of real wage and real interest are expected to be of positive signs, *a priori*. Since all the variables in the model are in terms of percentage change, for the sake of consistency, we have also converted the real wage (W) in terms of percentage change in real wage (w). In other words, the real wage (W) also has been converted into growth form. Assuming that all the macroeconomic adjustments are completed in two years for each explanatory variable, their lag is also included. The statistical form of the model to be estimated is as follows:

$$U_d = \beta_0 + \beta_1 w + \beta_2 w_{-1} + \beta_3 \mu + \beta_4 \mu_{-1} + \beta_5 r + \beta_6 r_{-1} + e_t \tag{2}$$

As indicated above w, μ, and r respectively represent the rate of change in real wage, the inflation rate and the real interest rate, and e_t is the random error term. The estimated results of equation (2) and the traditional Phillips Curve model are reported in Table 2. As shown in the table, the contemporaneous effect of inflation is found to be negative and significant in both traditional and proposed Phillips Curve models. The estimated coefficients suggest that a 1% increase in inflation rate lowers the unemployment by 0.25 and 0.09 percent in the proposed and traditional model respectively. The lagged effect is not significant presumably because overtime

the agents in the economy change their behavior in accordance with the inflationary condition. The coefficient of wages (w) and its lag carries a theoretically inconsistent sign. Although its lag is not statistically significant the contemporaneous effect is significant in our proposed model. In a growing economy with the increase in productivity, the demand for labor also may increase leading to higher wages and lower unemployment. This is precisely what had happened in Canada during the economic boom of 1950s and 1960s. In the traditional model also the coefficients of real wage and its lag are negative but they are insignificant.

TABLE 2 - *Estimation of the Models*

Variables	Proposed Model		Traditional Model	
	Coefficient	t-stat	Coefficient	t-stat
Constant	2.768	5.538***	3.677	6.522
w	-10.664	2.184**	-4.658	0.598
w_{-1}	-2.752	0.845	-1.397	0.302
μ	-0.253	4.139***	-1.635	2.228***
μ_{-1}	-0.087	0.068	-0.09	1.385
r	0.185	1.934***		
r_{-1}	0.116	1.449		
AR(1)	0.729	5.744***	0.791	7.044
Adj R^2	0.371		0.337	
DW	2.003		1.981	
F-stat	3.413		3.608	
N	42		42	

Note: ***, ** and * indicate the values are significant at 1, 5 and 10% level of significance, respectively.

The main focus of this study is the coefficient of interest rate. The contemporaneous effect of a change in the interest rate *r* is positive and is significant at the conventional level of significance. Its lagged effect, however, is significant only at a 20% significance level.

When we compare the goodness of fit of a traditional model to

the proposed model, we find that the inclusion of the real interest rate has increased the predictive power of the model by approximately 4%. In addition, a likelihood test for omitted variable is also conducted. The estimated log likelihood ratio of 7.86 is significant at the 1% critical level, suggesting that exclusion of the interest rate variable would lead to an omitted variable problem in the model. This finding suggests that our proposition that any estimation of the Phillips Curve should also include the changes in the real interest rate, in addition to any changes in the real wage and inflation rates, is valid.

5. Summary and conclusion

This paper suggests that any analysis of a Phillips Curve should include the real interest rate in addition to inflation and real wages because any changes in the real interest rate impacts the labor input mix in the production process, which ultimately affects the level of employment in the economy. In order to justify 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 data from Canada for the period between 1960 and 2004. The estimated result indicates that interest rate variable is indeed significant in explaining the Phillips Curve. In order to see if the omission of real interest rate leads to misspecification of the model, a likelihood ratio test for omitted variable is conducted. The estimated likelihood ratio indicates that exclusion of real interest rate indeed leads to a misspecification (omitted variable) problem in the model. Significant coefficient of the real interest rate and a misspecification problem due to the exclusion of real interest rate provide support to our proposition that any analysis of the Phillips Curve should include the real interest rate in addition to other variables such as inflation and real wages.

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ABSTRACT

This article argues that any analysis of the Phillips Curve without the inclusion of real interest rate may generate a misleading result as any changes in the interest rate impacts the labor capital input mix in the production process, leading to a change in the level of employment in the economy. We justify this argument by developing an empirical model 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 data from Canada for the period 1960 to 2004. The estimated result indicates that interest rate variable is indeed significant in explaining the Phillips Curve. A likelihood ratio test conducted

suggests that exclusion of real interest rate leads to a misspecification (omitted variable) problem.

Key Words: Phillips Curve, aggregate supply Curve, Canada, short run, long run

JEL Codes: E12, E24

RIASSUNTO

Salari reali, tassi d'interesse reali e la curva di Phillips: evidenze dai dati canadesi

Questo lavoro argomenta che qualunque analisi della curva di Phillips che non includa i tassi d'interesse reali può generare risultati fuorvianti, poiché una modifica del tasso di interesse modifica il mix capitale-lavoro nel processo produttivo, influenzando così il livello dell'occupazione. Per verificare questa ipotesi viene formulato un modello che considera anche i tassi d'interesse reali tra le variabili esplicative, insieme a inflazione e salari reali. I dati annuali considerati sono relativi al Canada per il periodo 1960-2004. I risultati stimati indicano che la variabile tassi d'interesse è realmente significativa nella spiegazione della curva di Phillips. Il test del rapporto di verosimiglianza suggerisce che l'esclusione dei tassi d'interesse reali causa un problema di errata specificazione (variabile omessa).

APPENDIX A

Data Definition and Sources

Variable	Definition	Sources
U	Unemployment rate	Gordon (2006)
R	Nominal interest rate	Gordon (2006)
μ	Inflation rate	Gordon (2006)
r	Real interest rate $(R - \mu^e)$[1]	Estimated
W	Real wage rate[2]	www.stat.ca
w	Percentage change in W	Calculated
U_n	Natural rate of unemployment[3]	Estimated

1. μ^e = expected rate of inflation estimated regressing inflation on its past values
2. Nominal wage adjusted for changes in the price level
3. Estimated following Douglas, Stock and Watson (1997)