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Evidence from the 1990s

Loretta Nott*

Abstract

Given persistently high unemployment rates following the 1991/92 recession, the question of hysteresis in the Canadian economy has, once again, come to the forefront of academic and policy debate. This paper addresses two questions. First, does the inclusion of the 1991/92 recession, and the years following, strengthen the evidence for hysteresis found by Fortin(1991)? Second, does the presumption of a linear Phillips curve, if indeed the function is non-linear, bias previous inferences made about hysteresis? My investigation reveals that updating Fortin's study weakens the hysteresis evidence, despite the pattern of persistently high unemployment rates and stable inflation in the early 1990s. And, while I do find evidence supporting a non-linear Phillips curve using the output gap, this does not change previous findings of no hysteresis.

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I. Introduction

The labour market hysteresis hypothesis posits that the natural rate of unemployment is path dependent upon the actual rate. This theory became popular in the mid - 1980s as a way to explain persistently high unemployment rates, particularly in Europe, but also in North America. Although several theories have been proposed to explain hysteresis, none of them have been able to fully explain the stylized facts across countries. The most common explanations of hysteresis are based upon physical and human capital models, insider/outsider models, and models that explicitly embody unemployment insurance regulations[1].

Because of persistently high unemployment rates following the 1991/92 recession, the phenomenon of hysteresis is receiving a significant amount of attention in Canada. The effects of the Bank of Canada's pursuit of lower inflation has been the subject of much debate. One of the arguments advanced against such a policy, is the possibility that the Canadian labour market may be subject to hysteresis. A hysteretic natural rate of unemployment has serious implications for monetary policy. According to the natural rate hypothesis, a permanent reduction in inflation involves a *temporary* increase in unemployment. However, if it is true that the labour market is fully hysteretic, which is to say that the natural rate of unemployment is completely dependent upon past unemployment, a permanent decrease in inflation would involve a *permanent* increase in unemployment. The presence of partial hysteresis would imply that the temporary unemployment costs of inflation reduction would be greater, and more drawn out over time, than they would be if the phenomenon is totally absent.

[1] For further information see Fortin(1993) and Cross and Allan(1988).

Most studies of the Canadian labour market have found no evidence of hysteresis.[2] However, Fortin(1991) is a striking exception. He presents evidence of hysteresis in the labour market, for prime-age males, between the years 1973-1990. This finding has provoked a follow-up literature that seeks to understand whether the costs of disinflation are temporary or permanent. In a study comparing Cozier and Wilkinson(1991) and Fortin(1991), Poloz and Wilkinson(1992) find that the empirical results are extremely sensitive to alternative data specifications. They suggest that one possible reason for this sensitivity is that all previous studies have used a linear Phillips curve, while in fact, the Phillips curve may actually be non-linear. If this conjecture is true, previous inferences made about hysteresis are biased.

With the exception of Fortin(1991), the literature has thus consistently concluded that the Canadian labour market does not exhibit hysteresis, and so, academics and policymakers have tended to disregard hysteresis theory as a possible argument against the pursuit of price stability. However, as the 1990s progress, Canadian economists have yet to fully explain why unemployment rates remain persistently high in what appears to be an otherwise healthy economy. Given Fortin's findings, the phenomenon of hysteresis should not be disregarded as a possible explanation and deserves further investigation. Two important questions in the literature remain unanswered. First, does the inclusion of data from the 1990s strengthen Fortin's hysteresis results? Second, is there significant evidence of a non-linear Canadian Phillips curve, and if so, does this mis-specification overturn previous inferences made about hysteresis?

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[2] See Cozier and Wilkinson(1991), Fortin(1989), McCallum(1989), Gordon(1989), and Jones(1995).

My investigation of these questions yields two key results. First, the Fortin(1991) hysteresis results are not robust to changes in the data, and in particular, to the estimation period. Full hysteresis is found for the sub-period 1973-90 using a revised data series, similar to the Fortin(1991) findings. However, when the estimation period is extended to 1995, all evidence of hysteresis disappears, despite the presence of persistently high unemployment and low inflation in the Canadian economy during the 1990s. Second, there is significant evidence to indicate that the Canadian Phillips curve is non-linear. The tests for hysteresis, however, consistently yield no evidence of hysteresis in the Canadian economy in the context of a non-linear framework. Thus, previous inferences made about the absence of hysteresis are robust to the presence of a non-linear Phillips curve.

The rest of the paper is organized as follows. Section II gives a brief explanation of Fortin's estimation procedure and results, and then examines the evidence for hysteresis when the data series is revised and updated to 1995. Section III describes the different structural forms of non-linear Phillips curves, and reports the estimation results. Section IV tests for hysteresis in lights of these findings. Section V summarizes the paper's results.

II. The Fortin(1991) Result

Fortin's 1991 paper is the only study that finds strong evidence of hysteresis in the Canadian labour market. All subsequent work in this field has essentially been a direct or indirect response to this paper. In order to come to a better understanding of Fortin's controversial results, it is first necessary to detail the methodology and assumptions behind them.

Fortin's preferred method of testing for hysteresis is to use a linear, Phillips curve equation of the following form :

$$DPCXFE_t = CONST + ADPCXFE_{t-1} - B_1UMALE_t + B_2DUMALE_t + B_3DUMALE_{t-1} + B_4DUMALE_{t-2} + C_1DPCFPCX_{t-1} + C_2DPCEPCX_{t-1} + C_3DPMXPCX_t + C_4DRTIXFE_t + C_5CONT_t \quad (1)$$

where			
	DPCXFE	=	The annual percentage change in the CPI excluding food and energy
	CONST	=	Regression constant
	UMALE	=	Prime-age male unemployment rate
	DUMALE	=	$UMALE_t - UMALE_{t-1}$
	DPCFPCX	=	The relative annual percentage change in the CPI for food
	DPCEPCX	=	The relative annual percentage change in the CPI for energy
	DPMXPCX	=	The relative annual percentage change in a price index for merchandise imports excluding food and energy
	DRTIXFE	=	The annual change in the effective indirect tax rate on non-food-non-energy consumption
	CONT	=	A dummy variable for the 1976-78 wage price controls

A more detailed explanation of the variables is found in Appendix A. According to Fortin, the implied degree of hysteresis is given by the formula : $h = B_2/(B_1 + B_2)$[3] Thus, there is no hysteresis if the coefficient on the change in unemployment, B_2, is not significantly different from zero. In contrast, there is full hysteresis if the coefficient on the level of unemployment, B_1, is zero.[4]

When Fortin estimated equation (1) for the sample period 1957-84 and then extended the sample to 1990, he discovered a structural break in the parameter estimates after 1972. With this in mind, Fortin re-estimated equation (1) allowing the constant and

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[3] See Fortin(1991), page 787 for the derivation of this formula.

[4] These conditions are derived from the following equation:

$$\pi_t - \pi_{t-1} = c - b[(1-h)U_t + h(U_t - U_{t-1})] + X_t,$$

where π is the inflation rate, U is the unemployment rate, X is a vector of structural variables, and h is the degree of hysteresis.

all unemployment coefficients to take on different values for the two sub-periods, 1957-72 and 1973-90. Furthermore, Fortin imposed a restriction on the coefficient of inflation expectations setting it equal to one.[5] Fortin called this revised equation "the basis for hysteresis testing" (Fortin, 1991, p. 788). His estimation results revealed no evidence of hysteresis for the first sub-period, 1957-72. The second sub-period, however, exhibited strong evidence of hysteresis : the implied degree of hysteresis was calculated to be 86.5%, and perhaps more importantly, full hysteresis could not be rejected.

Fortin offered several possible explanations for this result: repeated deep recessions, the 1972 unemployment insurance reforms, events related to the post-1972 productivity slowdown, and rising union density in Canada. Any one of the above mentioned factors could be a potential cause of hysteresis, and Fortin suggested that further research on these matters was required. He, nevertheless, drew strong policy implications from the results. In particular, he claimed that "[t]argeting lower and more stable inflation makes unemployment everywhere higher and more unstable along the adjustment path to equilibrium." (Fortin, 1991, p. 776)

Given the behaviour of unemployment in the 1990s - double-digit unemployment during and after the recession - and the Bank of Canada's stabilization of the inflation rate at the same time, one might expect that updating Fortin's results would only strengthen the evidence of hysteresis. Therefore, the first contribution of this paper is to update the 1991 Fortin study. Fortin's original data set consists of annual Canadian data from 1954 to 1990. I update and extend this data set to 1995. In doing so, I address some

[5] The first and second lags for the change in unemployment ($DUMALE_{t-1}$ and $DUMALE_{t-2}$) for the 1957-72 sub-period were found insignificant, and were subsequently dropped from estimation.

consistency concerns regarding the unemployment rate, and the merchandise imports and indirect tax structural variables. In Fortin's original series, the adult male unemployment rate for 1954-65 is "the old-survey series linked to new-survey basis by the Bank of Canada" (Fortin, 1991, p. 800). For 1966-90, the variable is simply taken from Statistics Canada. Notice, however, in the first unemployment column of Table A.1 in Appendix A, that until 1982, the unemployment rate is measured to not one, but four decimal places. It may or may not be appropriate to measure such a variable to four decimal places, but surely the degree of precision to which any one variable is measured should be consistent within the entire data set. Therefore, I round the unemployment series prior to 1982 to one decimal place, in order to be consistent with the reporting practices of Statistics Canada. Furthermore, since the publication of Fortin's paper, the Statistics Canada series for prime-age male unemployment has had some minor revisions. Column 2 in Table A.1 contains my revised unemployment series.

The merchandise imports variable is defined as the annual percentage change in a price index for all merchandise imports except food and energy. In Fortin's study, the price index for 1955-82 "is calculated from value and quantity indexes for energy imports (MACE data bank), food imports and all merchandise imports" (Fortin, 1991, p. 800). For 1982-90, the price index is calculated from the indexes published by the Bank of Canada Review. Fortin's formula to calculate the price index can be found in Appendix A and is used to generate my updated import variable. The Bank of Canada indexes, however, are used beginning in 1972 rather than 1982. Although still not entirely consistent across the sample period, it is presumed that the revised measurement of this variable is a better approximation than Fortin's original variable. The differences between Fortin's original variable and my revised version can be seen in columns 3 and 4 of Table A.1.

Finally, the indirect tax variable is defined by Fortin as follows :

"Annual change in RTIXFE, where RTIXFE is the effective indirect tax rate on non-food-non-energy consumption, equal to the ratio of the non-food-non-energy indirect taxes to net-of-tax non-food-non-energy consumption" (Fortin, 1991, p. 800).

Although it is not mentioned in the data appendix of Fortin's original paper, RTIXFE is estimated for 1954-75 using pre-1985 Statistics Canada estimates for indirect taxes and consumption, where 1976-90 uses data estimated post-1985. This inconsistency in the series can now be removed, since an entirely revised series for 1954-94 is published by Statistics Canada. The formula to calculate this variable is found in Appendix A, and the newly revised series, as it appears in the estimated equation, is found in column 6 of Table A.1.

The estimated results for Fortin's equation for the sample period 1957-90 are found in Table 1. The first column displays Fortin's original results as they appear in his paper. The estimated results using the revised data are found in column 2. The point estimate of the implied degree of hysteresis is now 71%, whereas Fortin reported an estimate of 86.5% for this same period. Although the inflation expectations homogeneity assumption still cannot be rejected at the standard 5% significance level, the restriction is certainly not as strongly accepted with the revised data.[6] Notice also that the merchandise imports and indirect tax variables are no longer significant at the 5% level over this time

[6] Testing the restriction with the original data series generates a p-value of 0.30, where it drops to 0.12 with the revised series.

period when the revised data are used. Once the insignificant variables are removed (column 3), I find that full hysteresis cannot be rejected with 95% confidence, which is consistent with Fortin's original findings.[7] Therefore, although there appears to be some differences in the estimation results when improved data are used for the 1957-90 period, the conclusions about hysteresis are essentially the same.

When the estimation period is extended to 1995, one cannot simply follow the same procedures and equations as set out in Fortin(1991). Between 1990 and 1995, there were two major changes in tax policy that temporarily affected the measured CPI inflation rate. In particular, the introduction of the GST in 1991, and the decrease in tobacco taxes in 1994. In order to account for these temporary shocks to the inflation rate, two dummy variables, GST and TOBTAX, are included in the estimated equation.

Thus, the equation used to test for hysteresis for the sample period 1957-95 becomes:[8]

$$\begin{aligned} DPCXFE_t = {} & CONST + ADPCXFE_{t-1} + B_1UMALE_t + B_2DUMALE_t + B_3DUMALE_{t-1} + \\ & B_4DUMALE_{t-2} + C_1DPCFPCX_{t-1} + C_2DPCEPCX_{t-1} + C_3DPMXPCX_t + C_4DRTIXFE_t \\ & + C_5CONT_t + C6GST_t + C7TOBTAX_t \qquad (2) \end{aligned}$$

where GST = 1, if year equals 1991
0, otherwise

TOBTAX = 1, if year equals 1994
0, otherwise

Beyond the minor modifications to equation (1), all other assumptions made by Fortin, including the occurrence of a structural break in 1972, are maintained.

[7] The p-value for the joint test $H_0: const_{73} = B_{173} = B_{272} = B_{372} = C_3 = C_4 = 0$ is 0.15.

[8] Data for indirect taxes and consumption, at the time of writing, are only available up until 1994, and due to the insignificance of the indirect tax variable over the 1957-90 period, I have chosen to eliminate this variable from equation (1). The removal of the indirect tax variable does not have any effect upon the inferences made about hysteresis over the 1957-90 time period.

The estimation results for the sample period 1957-95 are found in Table 2. As can be seen in column 1, the price homogeneity restriction is rejected at a 5% significance level. Column 2, therefore, shows the results when the restriction is no longer imposed. A comparison of these two columns reveals that one's conclusions regarding hysteresis are sensitive to the restriction on inflation expectations. Under the assumption of price homogeneity, full hysteresis cannot be rejected, while without it, neither the level nor the change in male unemployment are statistically significant.

One possible reason for this result involves how inflation expectations are measured. Recall that Fortin assumed that inflation expectations are simply measured as last year's actual rate. However, if we believe that agents use other available information when forming their forecasts of inflation, our estimates of 1992 and 1995 expected inflation are incorrect. The effects of the recent tax changes were one-time, temporary shocks to the inflation rate during the year of the policy change. Therefore, an agent's expectation of 1992 inflation would not be 1991's actual rate, and similarly for 1995. In order to account for this discrepancy, I replace the inflation expectations measure for these two years with an interpolated inflation rate.[9]

The estimated results using the improved inflation expectations measure are found in columns 3-5 of Table 2. Once again, column 3 shows that the restriction on expected inflation cannot be accepted, and both the level and the change in unemployment are

[9] The 1992 observation for expected inflation becomes, instead of the actual 1991 inflation rate, an average of 1990 and 1992 actual inflation, and similarly expected inflation in 1995 becomes the average of 1993 and 1995 actual inflation. I also tried two alternative methods. The first simply replaced the 1992 and 1995 observations with 1990 and 1993's actual rates respectively. The second replaced the expectations series from 1975-95 with the Conference Board of Canada's inflation forecast survey. The hysteresis results are robust to these different specifications.

found to be statistically insignificant. When the unrestricted equation is estimated (column 4), the signs on the coefficient for the change in male unemployment (DUMALE), for both sub-periods, are wrong and statistically insignificant. Notice, however, that the estimated coefficients for the level of unemployment are the correct sign and significant at the 5% level. Once the insignificant variables are removed (column 5), the results provide strong evidence of no hysteresis, not only for the sub-period 1957-72 as Fortin found, but for 1973-95 as well.[10]

In summary, it is clear that Fortin's results are sensitive to minor revisions in the data and estimation period. When I test for hysteresis using my revised data series, over the same sample period as Fortin, 1957-90, I do find evidence consistent with full hysteresis. However, once the estimation period is extended to 1995 and exogenous factors affecting inflation are accounted for, the results provide no evidence of hysteresis of any degree. Had hysteresis been the reason for the Canadian labour market's recent poor performance, one would expect that by extending Fortin's sample period the evidence for hysteresis, would be made stronger. But in fact, all evidence for hysteresis disappears.

The evidence for hysteresis in the Canadian labour market appears to be extremely fragile. As previously mentioned, Poloz and Wilkinson(1992) find that the hysteresis results are sensitive to alternative data specifications. Further, I find that the updated Fortin hysteresis results are not robust to the estimation period. The question, therefore, remains whether or not the sensitivity of these results are due, in part, to a mis-

[10] The p-value for the joint hypothesis test $H_0 : B_{272} = B_{273} = B_{373} = C_3 = 0$ is 0.74.

specification of the Canadian Phillips curve. The remainder of this paper focuses on this issue.

III. The Presumption of Linearity

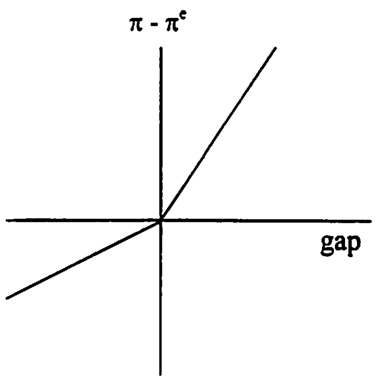
Since the Phillips curve is often employed to test for hysteresis, it is important to understand the nature of its structural form before using it to make policy inferences. The modern version of the Phillips curve is usually presumed to be a linear, negative (positive) relationship between inflation and unemployment (the output gap). This implies that the response of inflation to excess demand is identical in magnitude to the response to excess supply, independent of the size of the gap between actual and potential employment or output. In the past couple of decades, however, it has been found that in order to reverse the inflationary pressures generated during economic booms, deep recessions have been required. In a linear world, however, inflation is as easily wrung out of the economy as it was initially generated. Recently steps have been taken towards modeling non-linear Phillips curves, where excess demand raises inflation by more than excess supply lowers it.

The research in this field is preliminary. Laxton, Rose and Tetlow(1993) provide evidence of a non-linear Phillips curve for Canada. Clark, Laxton, and Rose(1995a, 199b), and Laxton, Rose and Meredith(1995) estimate non-linear structural forms of the Phillips curve for the United States and G-7 countries respectively. It is important to note that all previous studies have used the output gap, rather than the unemployment gap, to estimate various non-linear forms of the Phillips curve. In order to use the unemployment gap, one would need a much more precise measurement of the natural rate of unemployment than is now available. In light of this, this section, as well as the proceeding hysteresis section, formulates the Canadian Phillips curve as the relationship between inflation and the output gap. Little guidance is offered as to the appropriate specification of the Phillips curve, however, the literature does suggest three possible non-linear functional forms of the Phillips curve:

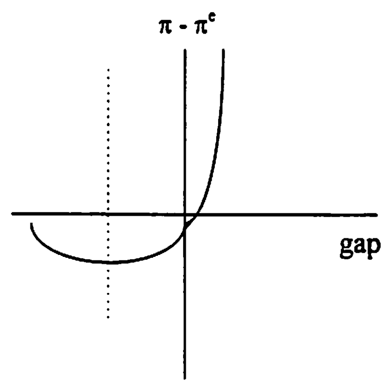
1) the "Kinked" function
2) the "Quadratic" function
3) the "Quadratic only in the area of excess demand" function (QOAED)

Figure 1. The Three Alternative Nonlinear Functional Forms

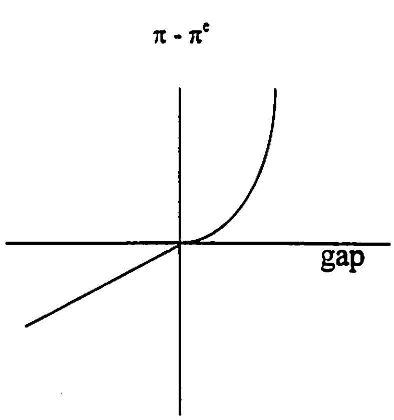
A : The Kinked Function



B: The Quadratic Function



C : The QOAED Function



As figure 1a shows, the kinked function is one of the simplest functions. It assumes that the Phillips curve becomes kinked at the point of zero excess demand, and is globally linear everywhere else. The quadratic function, figure 1b, implies a convex functional form, where as the output gap becomes negative, its effect on inflation is lessened. The problem with this specification, however, is that although it is consistent with the proposition that excess supply has a smaller effect on inflation than does excess demand, its upward-sloping region where the gap is negative (to the left of the dotted line) is considered to be implausible on conceptual and theoretical grounds. The alternative to the quadratic form is the QOAED function, shown in figure 1c, where the Phillips curve is linear when the output gap is negative, but becomes quadratic in the area of excess demand.

The preferred methodology, in light of the uncertainty surrounding the functional form, is to estimate and compare a conventional, linear function to all three suggested asymmetric structural forms :

Linear : $\pi_t = \alpha + \beta_1\pi_t^e + \beta_2\pi_{t-1} + \delta gap_t + \varepsilon_t$

Kinked : $\pi_t = \alpha + \beta_1\pi_t^e + \beta_2\pi_{t-1} + \delta gap_t + \eta posgap_t + \varepsilon_t$

QOAED : $\pi_t = \alpha + \beta_1\pi_t^e + \beta_2\pi_{t-1} + \delta gap_t + \eta sqposgap_t + \varepsilon_t$

Quadratic : $\pi_t = \alpha + \beta_1\pi_t^e + \beta_2\pi_{t-1} + \delta gap_t + \eta (gap_t)^2 + \varepsilon_t$

where
π = the percentage change in the annual GDP deflator
π^e = the Conference Board of Canada's survey of inflation forecasts
gap = the percentage difference between annual real GDP and potential output as measured by the Bank of Canada
posgap = gap, gap > 0
= 0, otherwise
sqposgap = $(posgap)^2$

I estimate these functions using annual Canadian data from 1973 to 1993. The measure of potential output is generated by the Bank of Canada's multivariate filtering technique.

Inflation expectations are measured using a direct proxy of inflation forecasts provided by the Conference Board of Canada. A unit-sum restriction is also imposed on inflation expectations to ensure no money illusion.[11] Furthermore, Laxton, Rose and Tetlow (1993b) suggest that the level of the output gap that enters the Phillips curve be lagged once, but that the non-linear gap variable enter the Phillips curve contemporaneously. This implies an additional timing dimension to the asymmetry found in the Canadian data, where excess demand acts faster to affect inflation than excess supply. Since this is an issue in the literature that has yet to be explored thoroughly, I examine the above system of non-linear equations for both the case where the level of the gap variable enters contemporaneously and lagged once. The latter case is referred to as the "LRT version".

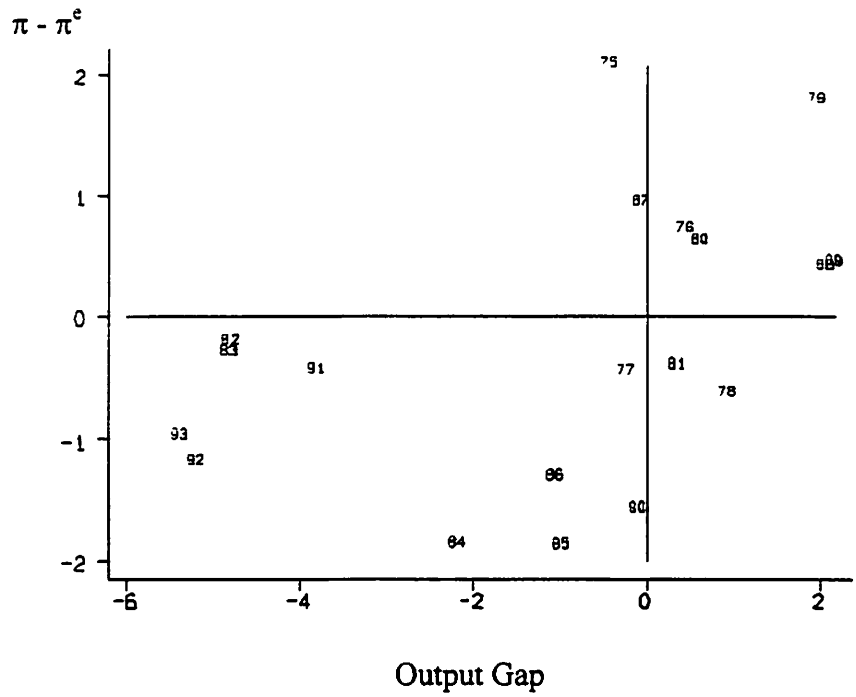
The estimation results are displayed in Table 3. There is evidence of non-linearity at the 5% significance level for the LRT versions of the QOAED and kinked models (columns 3 and 4). These results are consistent with the findings in Laxton, Rose and Tetlow(1993b). There is also, however, evidence of non-linearity for the contemporaneous version of the quadratic function (column 2). This is a very interesting result, for it brings into question the supposed timing dimension that Laxton, Rose and Tetlow suggested.

The goodness of fit tests indicate that the contemporaneous version of the quadratic model is preferred over the QOAED and kinked LRT versions. In Figure 2, the

[11] The three functional forms were also estimated using alternative variable specifications and time-period frequencies. In particular, potential output measured simply as trend output using the HP technique, inflation expectations measured by an adaptive expectations framework, no unit-sum restriction imposed and quarterly Canadian data for the same time period. The results were found to be extremely sensitive to alternative data specifications, however, this sensitivity did not effect the conclusions made about hysteresis.

annual gap measure is plotted against actual minus expected inflation. Economic theory suggests an upward sloping section to the left of the Phillips curve is implausible.

Figure 2. A Scatter Plot of the Annual Data



The scatter plot, though, clearly shows that the Canadian economy has sometimes moved into such an "implausible" region; in particular, during the periods 1983-84 and 1990-91. Thus, the data seem to prefer a specification that contradicts theory. Regardless of this rather puzzling finding, the empirical results strongly suggest evidence of non-linearities in the Canadian Phillips curve. With this result in mind, I now turn to the issue of testing for hysteresis in the presence of non-linearities.

IV. Testing for Hysteresis in a Non-linear Framework

The theory of hysteresis posits that the natural rate of unemployment is dependent upon the path of the actual rate. Although the argument follows for all of the above mentioned functional forms, in order to simplify the derivation of the equation to test for hysteresis using a non-linear Phillips curve, the discussion will focus on the quadratic structural specification, re-written in terms of the unemployment gap :

$$\pi_t = \alpha + \beta\pi_t^e - \delta(U_t - U_t^*) - \eta(U_t - U_t^*)^2 + \varepsilon_t \qquad (1)$$

where U - U* = the percentage difference between the actual rate of unemployment (U) and the natural rate (U*)
posugap = (U - U*), when U > U*
= 0, otherwise

If hysteresis exists, the natural rate of unemployment is dependent upon the actual rate of past unemployment (U), plus some vector of structural variables that affect inflation(X). A hysteretic natural rate can be characterized by the following equation :

$$U_t^* = hU_{t-1} + (1-h)X_t, \qquad 0 \leq h \leq 1 \qquad (2)$$

where h indicates the degree of hysteresis. When h = 1, it is easy to see that the natural rate is completely path dependent upon the actual rate. Substituting equation (2) into (1) yields :

$$\pi_t = \alpha + \beta\pi_t^e - \delta_1 h\Delta U_t - \delta_2 (1 - h)U_t - \eta_1 (1-h)^2 U_t^2$$
$$- \eta_2 h^2(\Delta U_t)^2 + \delta_3 (1 - h)X_t + \eta_3 (1 - h)^2 X_t^2 + \varepsilon_t, \qquad (3)$$

which says that under less than full hysteresis, both the level and the change in unemployment matter. Partial hysteresis (0 < h < 1), however, has no implications for the long-run inflation-output tradeoff. Cozier and Wilkinson(1991) go so far as to assert, "hysteresis only provides an interesting alternative to the natural-rate hypothesis under conditions of full hysteresis" (Cozier and Wilkinson. 1991, p. 9). Under the condition for full hysteresis (h = 1), the Phillips curve with a quadratic specification is simply :

$$\pi_t = \alpha + \beta\pi_t^e - \delta_1 \Delta U_t - \eta_2 (\Delta U_t)^2 + \varepsilon_t. \quad (4)$$

If this model is true, a permanent decrease in inflation will cause a larger permanent increase in unemployment than was once anticipated from a linear framework.

By Okun's Law,[12] equation (4) can be rewritten in terms of the output gap which yields :

$$\pi_t = \alpha + \beta\pi_t^e + \delta\Delta(Y_t - Y_t^*) + \eta(\Delta(Y_t - Y_t^*))^2 + \varepsilon_t. \quad (5)$$

Full hysteresis, therefore, arises when inflation depends only on the change in the output gaps. Given the difficulties in estimating non-linear Phillips curves in terms of unemployment, this section focuses on testing for full hysteresis in terms of the output gap.

In order to test for full hysteresis, the equation must include both the level and the change in the output gap. For instance, the equation to test for hysteresis with a quadratic specification yields the following :

$$\pi_t = \alpha + \beta\pi_t^e + \delta_1 (1 - h)(Y_t - Y_t^*) + \delta_2 h\Delta(Y_t - Y_t^*)$$
$$+ \eta_1 (1-h)^2(Y_t - Y_t^*)^2 + \eta_2 h^2(\Delta(Y_t - Y_t^*))^2 + \varepsilon_t. \quad (6)$$

Full hysteresis is rejected if δ_2 and η_2 are not significantly different from zero.

The estimation results are found in Table 4. For the linear equation (column 1), only the level of the output gap is found to be significant. This is consistent with the conclusion of almost all previous studies that have failed to find hysteresis using a linear

[12] Okun's Law is a proposition about the relationship between the unemployment and the output gap - the higher the level of the output gap, the lower is the unemployment rate. In order to assume an Okun's Law relationship, output is assumed to be produced by a constant returns to scale production function with exogenous technical progress and labour force.

framework. However, as shown in the remaining columns of Table 4, a non-linear framework also leads to the conclusion of no hysteresis in the Canadian economy. No matter what functional form is assumed, the results consistently show that only the level of the output gap is found to be significant. This is a very important result, for even though it has been shown that the precise form of the non-linear Phillips curve is difficult to pin down, the inferences made about hysteresis with a non-linear framework are robust against the assumed specification. It can, therefore, be concluded that, independent of the Phillips curve formulation, there is no evidence of hysteresis in the Canadian economy.

V. Conclusion

Despite several issues regarding sensitivity towards data and structural specification, the empirical results presented in this paper consistently yield evidence against the presence of hysteresis in the Canadian labour market. First, the results of the Fortin(1991) study are found to be sensitive to data revisions, and in particular, to the estimation period. Once the sample period is extended to 1995, the results overturn Fortin's original findings of hysteresis, and indicate no evidence of hysteresis in the Canadian labour market. Second, the investigation into the appropriate structural form of the Phillips curve shows significant evidence of non-linearity. The tests for hysteresis using a non-linear framework, however, consistently reveal evidence against hysteresis. From this result, it can be concluded that previous inferences made about hysteresis in the Canadian literature are robust to the assumed structural specification.

From these results, it is clear that hysteresis is not responsible for Canada's high unemployment rates in the 1990s. It is important to note, however, that the policy debates surrounding this issue do not centre around the unemployment rate alone, but rather, also with the recent stagnation of the inflation rate. Given the persistence of high unemployment rates, one has to question why Canada's inflation rate is not lower than the current level of 1.5%. A non-linear Canadian Phillips curve provides one possible explanation. The existence of a non-linear inflation-output relationship has clear implications for monetary policy. In a non-linear world, positive demand shocks raise inflation by more than negative shocks lower it. Moreover, when there is a negative demand shock, a large amount of output slack does little to lower inflation. In other words, the marginal gains to be had by inflation reduction, lessen as a recession deepens, and indeed, the 1991/92 recession was deep and drawn out. Therefore, it is perhaps not surprising that we do not see a reduction in inflation of the magnitude that one might have predicted based on a linear Phillips curve.

Table 1

The Fortin Estimation Results
1957 - 1990

Regressors	(1)	(2)	(3)
Constant			
1957-72	2.03	1.93	1.72
	(0.41)	(0.47)	(0.47)
1973-end	0.35	1.02	——
	(0.54)	(0.65)	
Dpcxfe(-1)	1.00	1.00	1.00
Umale			
1957-72	-0.42	-0.39	-0.32
	(0.10)	(0.12)	(0.11)
1973-end	-0.06	-0.16	——
	(0.08)	(0.09)	
Dumale			
1957-72	0.26	0.22	——
	(0.13)	(0.16)	
1973-end	-0.38	-0.39	-0.59
	(0.14)	(0.17)	(0.16)
Dumale(-1)			
1957-72	——	——	——
1973-end	-1.01	-1.06	-1.23
	(0.11)	(0.14)	(0.13)
Dumale(-2)			
1957-72	——	——	——
1973-end	-0.30	-0.24	-0.28
	(0.11)	(0.13)	(0.12)
Dpcfpcx(-1)	0.13	0.13	0.16
	(0.03)	(0.04)	(0.03)
Dpcepcx(-1)	0.11	0.13	0.14
	(0.03)	(0.03)	(0.03)
Dpmxpcx	0.07	0.04	——
	(0.03)	(0.03)	
Drtixfe	0.21	0.19	——
	(0.08)	(0.10)	
Cont	-1.10	-1.11	-0.81
	(0.35)	(0.41)	(0.31)
Adj. R-squared	0.98	0.98	0.97
P-value for restriction	N/A	0.12	0.05

Table 2

The Estimation Results using the Revised Data Series 1957-1995

Regressors	(1)	(2)	(3)	(4)	(5)
Constant					
1957-72	2.01	2.91	2.05	3.15	2.70
	(0.70)	(0.71)	(0.81	(0.80)	(0.70)
1973-end	0.27	2.70	0.79	3.65	2.94
	(0.85)	(1.19)	(0.98)	(1.28)	(1.06)
Dpcxfe(-1)	1.00	0.73	1.00	0.67	0.74
		(0.10)		(0.11)	(0.07)
Umale					
1957-72	-0.39	-0.44	-0.43	-0.49	-0.41
	(0.17)	(0.15)	(0.20)	(0.17)	(0.15)
1973-end	-0.01	-0.19	-0.08	-0.29	-0.23
	(0.11)	(0.12)	(0.13)	(0.13)	(0.11)
Dumale					
1957-72	0.09	0.17	0.15	0.23	____
	(0.20)	(0.18)	(0.23)	(0.20)	
1973-end	-0.57	-0.22	-0.13	0.20	____
	(0.20)	(0.22)	(0.23)	(0.23)	
Dumale(-1)					
1957-72	____	____	____	____	____
1973-end	-1.06	-0.89	-0.75	-0.62	-0.63
	(0.17)	(0.16)	(0.19)	(0.17)	(0.16)
Dumale(-2)					
1957-72	____	____	____	____	____
1973-end	-0.15	-0.02	-0.06	0.08	____
	(0.17)	(0.16)	(0.20)	(0.18)	
Dpcfpcx(-1)	0.12	0.12	0.14	0.13	0.13
	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)
Dpcepcx(-1)	0.12	0.15	0.05	0.10	0.10
	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)
Dpmxpcx	0.06	-0.02	0.07	-0.03	____
	(0.04)	(0.04)	(0.04)	(0.05)	
Drtixfe	____	____	____	____	____
Cont	-1.08	-0.88	-1.22	-0.95	-1.03
	(0.60)	(0.55)	(0.70)	(0.61)	(0.54)
Gst	3.16	1.97	2.51	1.21	1.67
	(0.72)	(0.78)	(0.84)	(0.85)	(0.64)
Tobtax	-2.67	-2.52	-2.26	-2.18	-2.27
	(0.69)	(0.62)	(0.80)	(0.70)	(0.66)
Adj. R-squared	0.95	0.96	0.93	0.95	0.95
P-value on restriction	0.013	____	0.006	____	____

Table 3

The Non-Linearity Estimation Results
1975 - 1993

Regressors	(1) Linear Model	(2) Quadratic (Contemp.)	(3) Quadratic (LRT)	(4) QOAED (Contemp.)	(5) QOAED (LRT)	(6) Kinked (Contemp.)	(7) Kinked (LRT)
Constant	-0.14	-0.44	-0.21	-0.45	-0.51	-0.57	-0.61
	(0.24)	(0.28)	(0.30)	(0.33)	(0.28)	(0.38)	(0.30)
π^e	0.74	0.71	0.84	0.72	0.77	0.71	0.75
	(0.11)	(0.11)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
π_{t-1}	0.26	0.29	0.16	0.28	0.23	0.29	0.25
	(0.11)	(0.11)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
GAP_t	0.23	0.50		0.13		0.10	
	(0.09)	(0.17)		(0.11)		(0.12)	
GAP_{t-1}			0.23		0.15		0.13
			(0.12)		(0.10)		(0.10)
$(GAP_t)^2$		0.08	0.003				
		(0.04)	(0.03)				
$POSGAP_t$						0.59	0.64
						(0.40)	(0.31)
$POSGAP_{t-1}$							
$(POSGAP_t)^2$				0.24	0.29		
				(0.18)	(0.15)		
Adj. R-squared	0.92	0.92	0.90	0.92	0.92	0.92	0.92
AIC	1.08	0.97	1.27	1.07	1.02	1.05	0.99
p-value, F test (restriction)	0.43	0.46	0.52	0.34	0.42	0.50	0.66

Table 4

The Hysteresis Results using a Non-Linear Framework
1975 - 1993

Regressors	(1) Linear Model	(2) Quadratic (Contemp.)	(3) QOAED (LRT)	(4) Kinked (LRT)
Constant	-0.13	-0.42	-0.47	-0.54
	(0.24)	(0.31)	(0.35)	(0.44)
π^e	0.78	0.75	0.82	0.80
	(0.12)	(0.12)	(0.16)	(0.15)
π_{t-1}	0.22	0.25	0.18	0.20
	(0.12)	(0.12)	(0.16)	(0.15)
GAP_t	0.26	0.53		
	(0.10)	(0.18)		
ΔGAP_t	-0.11	-0.12		
	(0.13)	(0.17)		
GAP_{t-1}			0.22	0.20
			(0.13)	(0.15)
ΔGAP_{t-1}			-0.13	-0.10
			(0.14)	(0.14)
$(GAP_t)^2$		0.08		
		(0.04)		
$(\Delta GAP)^2$		-0.003		
		(0.04)		
$POSGAP_t$				0.56
				(0.53)
$\Delta POSGAP_t$				0.08
				(0.41)
$(POSGAP_t)^2$			0.31	
			(0.16)	
$(\Delta POSGAP_t)^2$			-0.05	
			(0.17)	
Adj. R-squared	0.91	0.92	0.91	0.92
AIC	1.15	1.13	1.17	1.16
P-value on restriction	0.66	0.63	0.55	0.76

Appendix A

The Fortin(1991) Definitions and Formulas

Variable	Definition	Data Sources and Formulas
DPCXFE	The annual percentage change in the consumer price index for all items excluding food and energy (PCXFE).	100*log(PCXFE/PCXFE(-1)); For 1955-70, $pcxfe = pcxf^{1.09} pce^{-0.09}$, where pcxf is the consumer price index for all items excluding food and 0.09 is the weight of pce in pcxf obtained from regression analysis over 1971-5. For 1971-90, pcxfe is taken from Statistics Canada (62-001).
UMALE	The unemployment rate for adult males aged twenty-five years and older.	For 1954-65, UMALE is from the Bank of Canada's old-survey series linked to new-survey basis. For 1966-90, UMALE is take from Statistics Canada (71-201).
DUMALE	The annual change in UMALE.	UMALE - UMALE(-1).
DPCFPCX	The annual percentage change in the consumer price index for food (PCF).	100*log(PCF/PCF(-1)) - DPCXFE For 1954-90, PCF is taken from Statistics Canada (62-001).
DPCEPCX	The annual percentage change in the consumer price index for energy (PCE).	100*log(PCE/PCE(-1)) - DPCXFE ; For 1955-70, pce is calculated from component indexes, according to the instructions of Statistics Canada. For 1971-90, PCE is taken from Statistics Canada (62-001).
DPMXPCX	The annual percentage change in a price index for all merchandise imports except food and energy (PMXFE).	100*log(PMXFE/PMXFE(-1)) - DPCXFE ; PMXFE = (VT - VF - VE)/(QT - QF - QE), where V and Q indicate value and quantity indexes respectively. The indexes are for total merchandise (T), food (F) and energy (E) imports. For 1955-82, PMXFE is calculated from a combination of indexes from the MACE data bank and Statistics Canada (65-001). Otherwise, PMXFE is calculated from indexes published by the Bank of Canada Review (table J9).
DRTIXFE	The annual change in in the effective indirect tax rate on non-food-non-energy consumption (RTIXFE).	100*log[(1+RTIXFE)/(1+RTIXFE(-1))] ; RTIXFE = T / (C - T), where T is total indirect taxes less indirect taxes on gasoline and on misc. nat. resources, less the oil export charge, less the petroleum compensation fund levy, less the Canadian ownership charge; C is total consumption less consumption of food, electricity, natural gas, other fuels, gasoline and lubricants (Statistics Canada, 13-201).
CONT	A dummy variable for 1976-78 wage-price controls.	CONT is equal to 0.5 in 1976, and 1.0 for 1977 and 1978.

Table A.1

A Comparison Between Fortin's Original Series and the Revised Series

Year	UMALE (old)	UMALE (new)	DPMXPCX (old)	DPMXPCX (new)	DRTIXFE (old)	DRTIXFE (new)
1954	3.6309	3.6	N/A	N/A	-1.1317	26.3501
1955	3.2223	3.2	N/A	N/A	-0.3400	-0.3402
1956	2.5200	2.5	2.5408	2.5408	1.0612	1.0231
1957	3.7003	3.7	0.3850	0.3850	-0.3627	-0.3725
1958	5.5594	5.6	-1.9021	-1.9021	-0.7741	-1.3860
1959	4.5991	4.6	-3.0995	-3.0995	0.4100	1.0117
1960	5.6931	5.7	0.1127	0.1126	0.2804	0.2240
1961	5.8034	5.8	1.7126	1.7126	0.9669	0.6385
1962	4.6518	4.7	4.2712	4.2712	1.9625	1.6706
1963	4.1552	4.2	0.4364	0.4364	-0.6544	-0.7253
1964	3.4189	3.4	0.0104	0.0104	1.3155	1.2986
1965	2.8967	2.9	-0.2648	-0.2648	1.2875	1.1074
1966	2.6250	2.6	-0.7879	-0.7879	0.9121	0.7172
1967	2.9833	3.0	-2.0390	-2.0390	0.2743	0.2238
1968	3.4917	3.5	-1.8763	-1.8763	-0.9152	-0.8744
1969	3.2417	3.2	-1.4510	-1.4510	0.6683	0.2369
1970	4.0667	4.1	-2.8382	-2.8382	-0.1129	-0.0976
1971	4.3000	4.3	-2.7272	-2.7272	-0.7324	-0.1483
1972	4.0750	4.1	-1.7594	-3.6903	0.4186	0.3175
1973	3.4250	3.4	2.2170	-0.6427	-0.6566	-0.4909
1974	3.2583	3.3	9.2446	4.2642	0.2215	0.2925
1975	4.2833	4.3	5.5793	5.8780	-3.4604	-3.1888
1976	4.2333	4.3	-7.1101	-8.6280	1.0847	1.3167
1977	4.9250	5.0	3.5870	0.2429	-0.1393	-0.1393
1978	5.2	5.3	6.3926	1.5430	-1.0527	-1.0527
1979	4.55	4.6	7.1090	3.5874	-0.7043	-0.7043
1980	4.7667	4.8	5.2205	-6.4704	-0.8162	-0.8162
1981	4.8	4.9	1.4518	-9.6438	1.4901	1.4901
1982	8.2	8.2	-4.0105	-4.0887	0.0800	0.0800
1983	9.2	9.3	-9.4120	-9.4232	-0.6881	-0.6881
1984	9.0	9.0	-1.3791	-1.3808	0.0145	0.0145
1985	8.3	8.4	-1.6584	-1.6352	0.3361	0.3360
1986	7.6	7.6	-2.4828	-2.5712	1.3399	1.3399
1987	7.0	7.0	-7.3070	-7.2700	0.3598	0.5385
1988	6.0	6.1	-5.8859	-5.9263	-0.2837	0.3740
1989	6.1	6.1	-4.8806	-5.1603	0.5806	0.4618
1990	6.8	6.9	-5.1723	-5.8837	0.8000	-1.5628
1991	*******	9.2	*******	-6.8816	*******	1.3568
1992	*******	10.5	*******	-3.5144	*******	0.3899
1993	*******	10.2	*******	1.7841	*******	-0.5226
1994	*******	9.4	*******	1.7254	*******	0.1156
1995	*******	8.4	*******	0.6081	*******	*******

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