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A Tale of Two Studies

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Bank of Canada Banque du Canada

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Abstract

This paper replicates and extends the econometric work of two previous studies of output-inflation dynamics in Canada -- Fortin (1991) and Cozier and Wilkinson (1991) -- in an attempt to reconcile their divergent conclusions. The former paper finds that the Canadian labour market exhibited hysteresis during the 1973-90 period, while the latter paper rejects labour market hysteresis over the period 1964-88. The approach taken in this paper is to estimate alternative specifications of the key equations presented by Cozier and Wilkinson and by Fortin, so as to isolate the main factors contributing to this difference in view. The paper then asks whether this additional information enables one to accept one inference over the other. The authors find that the available evidence against labour market hysteresis in Canada is much more compelling than evidence in favour. The paper concludes with a discussion of outstanding issues that might yet have a bearing on this question.

Résumé

Dans la présente étude, les auteurs répètent puis élargissent les travaux économétriques effectués par Fortin (1991) et par Cozier et Wilkinson (1991) sur la dynamique liant la production et l'inflation au Canada, espérant ainsi concilier les conclusions divergentes auxquelles ceux-ci sont parvenus. Selon Fortin, le marché du travail au Canada a montré des signes d'hystérèse entre 1973 et 1990, tandis que Cozier et Wilkinson rejettent cette hypothèse pour la période 1964-1988. Les auteurs de la présente étude ont pris le parti d'estimer d'autres spécifications des équations clés présentées par ces chercheurs, de manière à isoler les principaux facteurs contribuant à leur divergence de vues. Ils analysent ensuite l'information supplémentaire ainsi obtenue et constatent que les résultats invalidant l'hypothèse d'hystérèse du marché du travail au Canada sont beaucoup plus robustes que ceux qui l'appuient. En terminant, les auteurs signalent certaines questions qui demeurent autour de cette problématique.

1. Introduction

A variable is said to exhibit hysteresis if there is no tendency for it to revert to some mean value after a disturbance causes it to change; in effect, the variable remains permanently at that new value until another shock disturbs it. Labour market hysteresis became a popular explanation for persistently high unemployment rates in a number of countries, particularly in Europe, during the mid-1980s. Economic explanations for hysteresis in unemployment were based on (a) human capital models, according to which the unemployed tend to remain so because their skills deteriorate, (b) insider-outsider models, in which negative shocks reduce employment and the released workers are not re-engaged because the insiders prevent the decline in real wages necessary to reabsorb them, and (c) institutional models, where restrictions on labour market behaviour may produce very slow adjustment to shocks.[1]

While any of these explanations seems capable of accounting qualitatively for slow adjustment of labour markets to shocks, many have remained skeptical of their ability to account for hysteresis in the pure sense. Indeed, one of the originators of the insider-outsider theory of labour market hysteresis has suggested more recently that one can expect certain forces eventually to bring about adjustment of even very rigid labour markets (Blanchard, 1990). According to Blanchard, these forces include the fear that, as the number of insiders declines, a future negative shock could cause even them to become unemployed, and the fact that a growing stock of unemployed workers may raise the bargaining power of firms.

Most previous studies have concluded that Canadian labour markets are not hysteretic. In particular, Cozier and Wilkinson (1991) rejected labour market hysteresis based on Phillips curve estimates over the 1964-88 period. Similarly, Fortin (1989) found no evidence of hysteresis in Canada, using data for 1956-84, and McCallum (1988) reached the same conclusion using data for 1956-87. More recently, however, Fortin (1991) argued that the Canadian labour market exhibited hysteresis over the 1973-90 subperiod, using estimates of the Phillips curve for 1957-90.

This issue is of some importance in the context of monetary policy formulation. Bringing about a gradual decline in inflation (which is the express intention of the Bank of Canada and the federal government) in an economy with a hysteretic labour market would require a permanent rise in the rate of unemployment. More generally, the more persistent or sticky labour market behaviour is, the higher the economic costs associated with disinflation will be. Hysteresis would take these costs well beyond an acceptable trade-off; such is the central policy message of Fortin (1991) who, while acknowledging the existence of model uncertainty by considering the implications of various "degrees" of hysteresis, nevertheless concludes that "the evidence on the

1. See Giersch (1985), Blanchard and Summers (1986), Layard and Nickell (1986), and the volume edited by Lawrence and Schultze (1987) for a good sampling of this literature.

existence of near-full hysteresis is quite strong" (p. 797) and draws his inferences about monetary policy accordingly.

The purpose of this paper is to reconcile the conclusions reached by Fortin (1991) (henceforth simply "Fortin") with those of Cozier and Wilkinson (1991) (henceforth simply "CW"), the two studies referred to in the title. First we replicate Fortin's study and examine the robustness of his conclusions by estimating alternative versions of his preferred equation. We then shift the focus to the study by CW and do likewise. By considering a number of permutations of both, we expect to reach a fuller understanding of the issue, and to be better able to judge which conclusions are best supported by the Canadian data.

2. *A Comparison of Methodologies*

At the core of this debate is a body of econometric evidence describing the relationship between inflation and unemployment or output in Canada. The basic equation may be expressed as follows:

$$\pi = \pi^e + \delta GAP + \beta \Delta GAP + \theta Z + \varepsilon$$

where π represents the rate of inflation, π^e the expected rate of inflation, GAP a measure of excess demand and ΔGAP its first difference, and Z a vector of other exogenous variables that may affect the inflation process.

The substantive difference between the empirical results of Fortin and CW rests on the statistical significance of the level gap variable in determining inflation. Basically, if the rate of inflation depends only on the change in the gap variable, any change in the gap will produce a permanent effect on inflation only if the change in the gap is not subsequently reversed. This is the central implication of hysteresis. If, on the contrary, the rate of inflation depends on the level of the gap variable, then a permanent effect on inflation can result from a temporary change in the gap. It is possible for both variables to be statistically significant determinants of inflation; if β were positive, for example, this would imply that the downward pressure on inflation due to a negative output gap would be reinforced while the gap was widening, and would be moderated once the gap began to narrow.[2]

CW begin by estimating a relationship between inflation and the level of the output gap, and subsequently test for the importance of the change in the gap; they find some evidence that the differenced gap matters, but the level of the gap remains statistically significant when the change is included. Fortin also includes both variables, but finds that one can eliminate the level

2. Some have described this finding of a significant role for both the level and differenced gap variables as "partial hysteresis," although, strictly speaking, the term is oxymoronic. Based on the same logic, the "full" component of the term "full hysteresis," which is sometimes used to describe the result where $\delta = 0$ and $\beta \neq 0$, is redundant. In this paper the term "hysteresis" will be used in its literal sense only.

gap variable entirely and leave only the change in that variable in the regression, at least for the 1973-90 period.

As with all issues in econometrics, there is more than one way of investigating this relationship, and there are many differences between the approaches to this question taken by Fortin and by CW. Some of the more obvious differences are as follows:

(1) Fortin uses annual data; CW use quarterly data.

(2) Fortin uses the CPI excluding food and energy; CW use the GDP deflator.

(3) Fortin's preferred GAP variable is the unemployment rate of adult males; CW use the difference between actual and potential output in their preferred equation.[3]

(4) Fortin's sample period is 1957-90; CW use 1964Q3-1988Q4.

(5) Fortin allows for a break in 1972; CW do not allow for structural breaks, but their model explicitly contains a natural-rate concept, unlike Fortin's preferred model.

It may be helpful to examine briefly some of the key data series that will be used below. Figure 1 presents several alternative measures of unemployment for Canada. The first panel compares the adult male unemployment rate, as used by Fortin, with the aggregate unemployment rate. It is interesting to note that over the course of 1982 to 1988 the aggregate unemployment rate returned essentially to its pre-recession level, whereas the unemployment rate for adult males did not. The second panel compares the three major components of the aggregate unemployment rate -- youths, adult females and adult males. The behaviour of adult females is similar to that of adult males, although somewhat less extreme. In contrast, the unemployment rate for youth fell below pre-recession levels for 1987-88.

As Fortin notes, to some extent demographic shifts may have been responsible for movements in the aggregate unemployment rate. The third panel suggests, rather, that demographic effects on the aggregate rate may have been relatively small. We have attempted to account for such effects by taking the three component unemployment rates and weighting them with constant shares, based on the 1973 composition of the labour force. Nevertheless, for the 1980s the qualitative implication is as suggested by Fortin: that the aggregate unemployment rate was pushed downward (and its return after the recession was exaggerated) by demographic effects.[4]

3. CW also provide some results that use the difference between the total unemployment rate and the natural rate as the gap variable, as well as some that use the unemployment rate alone. Likewise, Fortin refers to results based on the gap between actual and potential output, but says they are poor. In what follows we concentrate on alternative estimates of the equations that are preferred by the respective authors.

4. The 1973 weights were adult males (49.7 per cent), adult females (23.7 per cent) and youth (26.6 per cent). In 1990 these weights were 45.4, 35.7 and 18.9 per cent, respectively.

Figure 2 illustrates the other gap measures that will be used below. The top panel shows the percentage difference between the actual level of GDP and an estimate of its potential level, which is based on a Cobb-Douglas production function in the Bank of Canada model RDXF. This variable seems to distinguish reasonably well between periods associated with inflation pressures and recessionary periods. The labour market gap, which is presented in the second panel, is highly correlated with the output gap, but does offer a slightly different interpretation of some periods. The bottom panel shows the two components of the labour market gap variable. The estimated natural rate of unemployment is assumed to have shifted during 1968 and 1971, and then to have trended downward during the late 1980s.

3. Permutations of the Fortin and Cozier-Wilkinson Models

(a) Alternative Measures of the Gap Variable

Table 1 provides a number of alternative estimates of Fortin's preferred equation. The first column contains Fortin's reported parameter estimates (his equation 1-4), while the second column gives our replication thereof. The differences between the two are very minor, and evidently stem from rounding for the unemployment rate in Fortin's data towards the end of the sample period. The constant term and the parameters on the gap variables are allowed to differ between the 1957-72 (A) and 1973-90 (B) subperiods. The equation imposes a unit coefficient on lagged inflation and, in the pre-1973 subperiod, zero coefficients on two lags of the differenced gap variable. The key result of hysteresis during the second subperiod is quite evident, as the level gap variable becomes statistically insignificant, and the differenced gap variable becomes significant in that period.

The third column of Table 1 replaces the adult male unemployment rate used by Fortin with the total unemployment rate. This change leads to a very small increase in the standard error of the regression, and a reduction in the estimated effect on inflation of the 1976-78 wage-price controls. Most importantly, however, this measure of the level gap variable remains statistically significant in the post-1973 period. There is a decline in the economic importance of the level gap variable compared with the earlier period, and a corresponding rise in the importance of the differenced gap variables, but the estimates do not imply hysteresis.

Replacing the gap variable with the adult female unemployment rate reveals a slightly different pattern (column 4). The standard error of the equation rises by over 30 per cent, and the estimate of the effect on inflation of the wage-price controls is approximately zero. The level gap variable is not (quite) significant at the 0.95 level in the pre-1972 period, but neither is the differenced gap variable; in the post-1972 period both variables are significant. Thus, there is again no evidence of hysteresis using this measure of unemployment. Using instead the youth unemployment measure also provides no evidence of hysteresis (column 5).

Figure 1

Alternative Measures of Unemployment in Canada

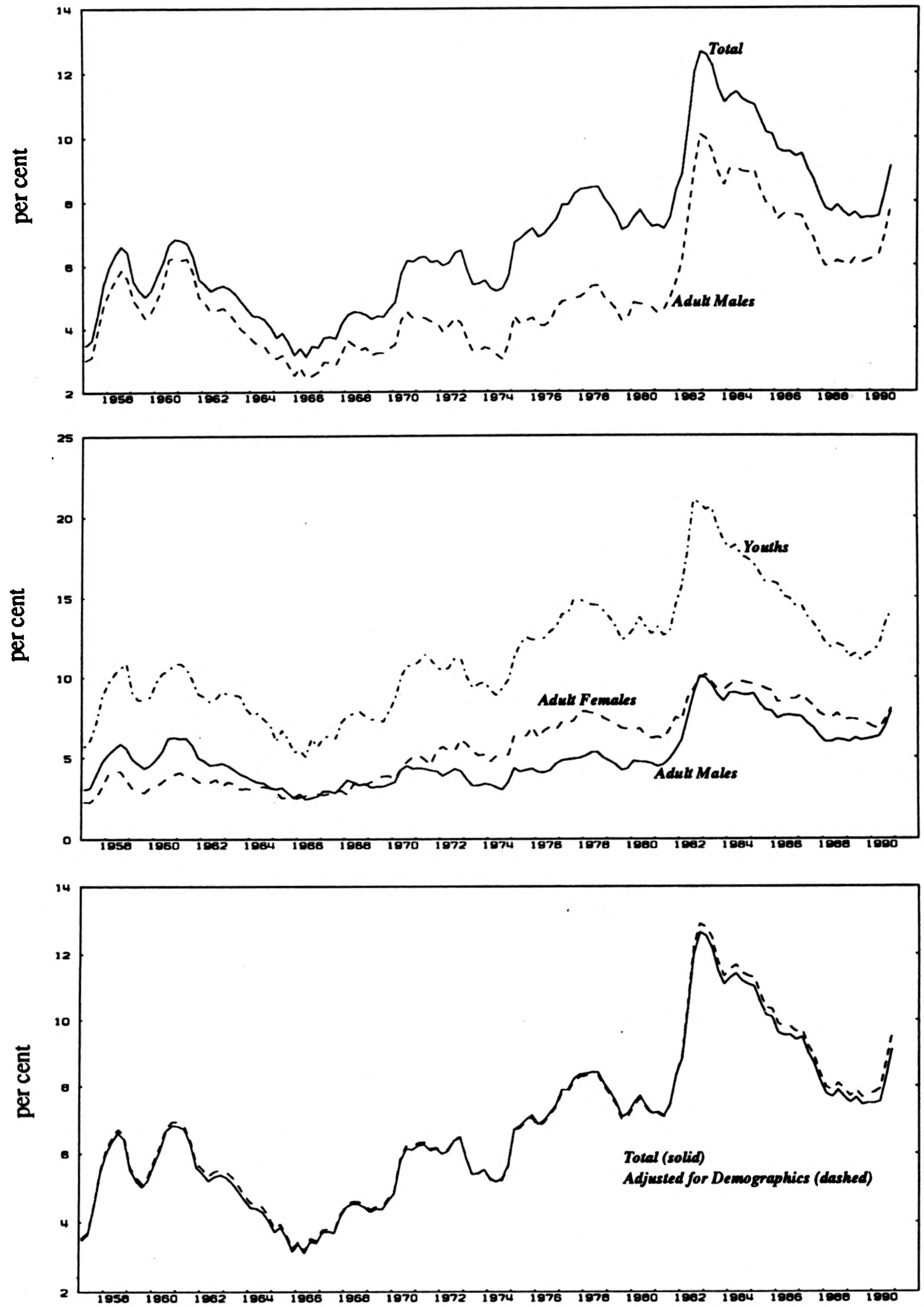
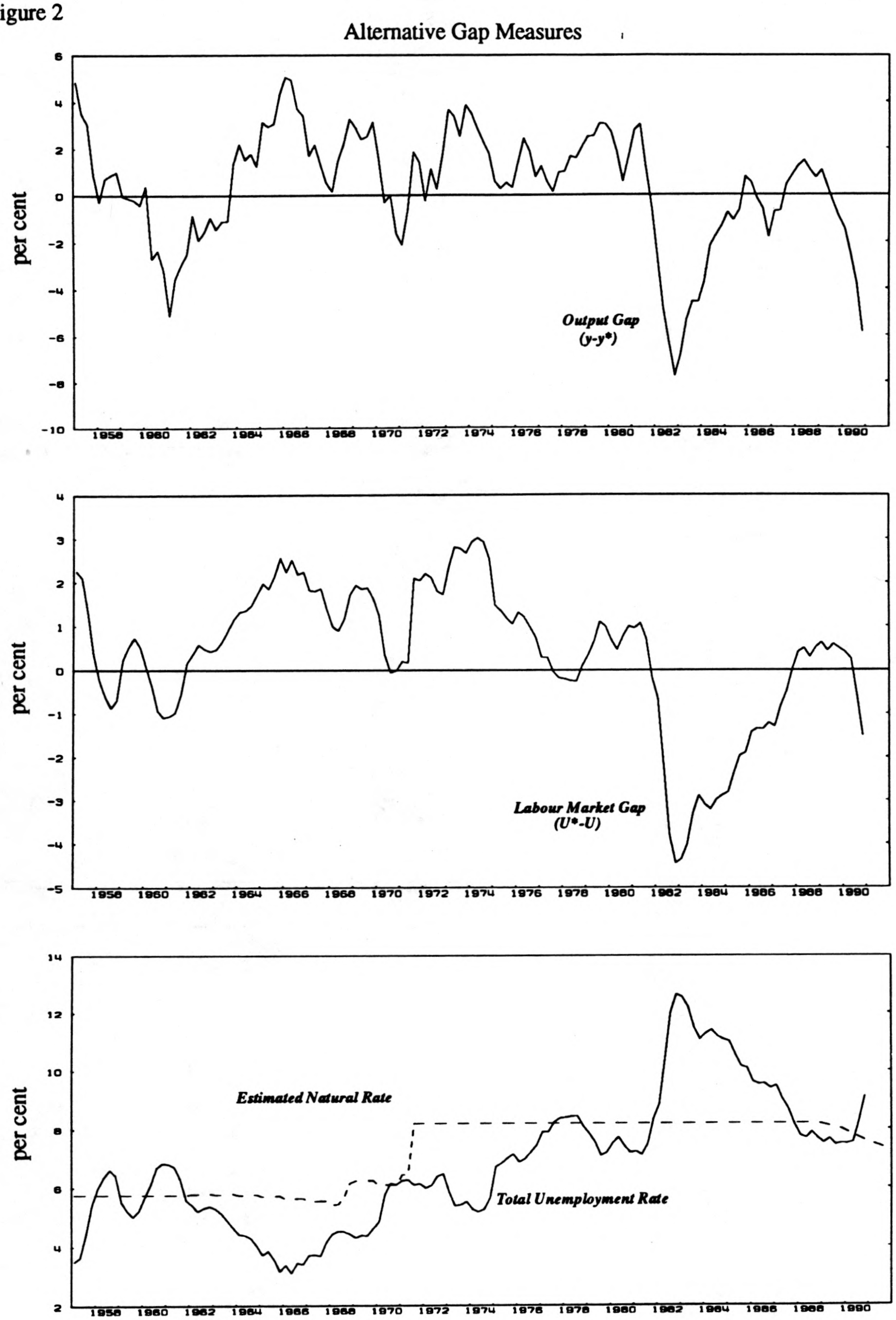


Figure 2


Alternative Gap Measures
per cent
Output Gap
(y-y*)
per cent
Labour Market Gap
(U*-U)
per cent
Estimated Natural Rate
Total Unemployment Rate
1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990

As noted above, the main reason given by Fortin for preferring to use the adult male unemployment rate as his proxy for the gap is that it avoids distortions due to demographic changes. The sixth column of Table 1 provides estimates of his equation using the aggregate unemployment rate with demographic shares frozen at 1973 levels, as illustrated above in Figure 1. The standard error of this regression is again only very slightly higher than that of Fortin's equation, and the level gap variable is statistically significant in both subperiods. Thus, these variables provide no support for hysteresis.

The last two columns of Table 1 re-estimate Fortin's equation using two alternative measures of the gap variable, the first using the unemployment gap and the second using the output gap, as plotted in Figure 2. The results based on the unemployment gap are very similar to Fortin's: the level gap variable is significant in the first subperiod, but not in the second, while the differenced output gap is not significant in the first period and is significant in the second. In short, this equation is supportive of hysteresis in the post-1972 period. The standard error of the equation is approximately 10 per cent above that of Fortin's version. In the case of the output gap, in contrast, both the level and differenced gap measures are significant in the second subperiod only, again providing no support for hysteresis. However, the standard error of the equation is significantly higher than that of the Fortin equation.

We now undertake a similar exercise using the CW model. We examine CW's preferred equation, which is estimated quarterly over 1964Q3-1988Q4 using the GDP deflator and the output gap, to see whether their rejection of hysteresis stands up to these alternative measures of the gap variable. The results are provided in Table 2.

The first column of Table 2 simply replicates CW's preferred equation. Notice that in this case the gap variable and the differenced gap variable have been lagged one quarter; as discussed in CW, this arrangement produced the most appealing results for their model. Their research demonstrated, in contrast, that the best results based on an *unemployment rate* proxy for the gap variable were obtained with a *contemporaneous* variable. The remaining results of Table 2 therefore are based on contemporaneous measures of the gap and differenced gap variables. The second column demonstrates the effect this has on the CW equation -- the coefficient on the gap variable rises slightly, and that on the differenced gap variable reverses sign. Thus, the conclusion regarding the absence of hysteresis is retained in this equation. Notice that the estimated standard error for this equation is substantially greater than reported for any of the regressions in Table 1. This is both because we are using quarterly rather than annual data, and because the GDP deflator tends to be more variable than the CPI excluding food and energy.

The third column replaces the gap variable with the unemployment rate for adult males. The coefficient on the level gap variable declines in absolute value and becomes statistically insignificant, which is consistent with Fortin's findings. However, the coefficient on the differenced gap variable also becomes insignificant. A similar pattern emerges for the total

Table 1

Alternative Measures of the Gap and the Fortin Equation

Variables	*Fortin Results*	*Adult Males*	*Total Unemp.*	*Adult Females*	*Youth Unemp.*	*Adjusted Unemp.*	*U-gap*	*Y-gap*
Constant-A	2.03	2.07	0.68	-0.75	0.04	0.87	0.11	0.19
	(0.41)	(0.42)	(0.82)	(1.15)	(0.94)	(0.81)	(0.25)	(0.28)
Constant-B	0.35	0.39	-0.09	-0.12	-0.12	-0.06	0.01	0.00
	(0.54)	(0.55)	(0.04)	(0.05)	(0.04)	(0.03)	(0.01)	(0.01)
Lagged inflation	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	-	-	-	-	-	-	-	-
Gap proxy - A	-0.42	-0.43	-0.38	-0.35	-0.22	-0.39	-0.47	0.11
	(0.10)	(0.10)	(0.10)	(0.18)	(0.06)	(0.09)	(0.12)	(0.11)
Gap proxy - B	-0.06	-0.06	-0.22	-0.36	-0.19	-0.20	-0.09	0.36
	(0.08)	(0.09)	(0.08)	(0.14)	(0.06)	(0.08)	(0.10)	(0.10)
Change in gap proxy - A	0.26	0.24	0.14	0.15	0.09	0.14	0.24	-0.04
	(0.13)	(0.14)	(0.13)	(0.29)	(0.09)	(0.13)	(0.13)	(0.10)
Change in gap proxy - B	-0.38	-0.38	-0.41	-0.75	-0.20	-0.39	-0.27	-0.19
	(0.14)	(0.14)	(0.13)	(0.25)	(0.09)	(0.13)	(0.13)	(0.08)
Change in gap proxy (-1) - A	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
Change in gap proxy (-1) - B	-1.01	-1.02	-0.95	-1.51	-0.50	-0.91	-0.90	0.28
	(0.11)	(0.12)	(0.11)	(0.23)	(0.08)	(0.11)	(0.12)	(0.08)
Change in gap proxy (-2) - A	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
Change in gap proxy (-2) - B	-0.30	-0.31	-0.21	0.23	-0.18	-0.21	-0.27	0.15
	(0.11)	(0.12)	(0.11)	(0.22)	(0.07)	(0.10)	(0.13)	(0.07)
Food prices	0.13	0.12	0.13	0.20	0.13	0.13	0.15	0.08
	(0.03)	(0.03)	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)	(0.05)
Energy prices	0.11	0.11	0.15	0.15	0.15	0.14	0.11	0.05
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Import prices	0.07	0.07	0.03	-0.05	0.04	0.03	0.05	0.03
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)
Indirect taxes	0.21	0.20	0.14	0.12	0.14	0.15	0.21	0.21
	(0.07)	(0.08)	(0.08)	(0.11)	(0.09)	(0.08)	(0.08)	(0.11)
Controls	-1.10	-1.14	-0.49	0.04	-0.22	-0.64	-0.32	-1.73
	(0.35)	(0.36)	(0.36)	(0.49)	(0.41)	(0.35)	(0.40)	(0.49)
Adjusted R^2	0.98	0.98	0.98	0.96	0.98	0.98	0.98	0.96
SER	0.35	0.35	0.36	0.49	0.41	0.36	0.39	0.47
Durbin-Watson	2.02	2.03	2.31	1.53	2.33	2.31	2.18	2.06

Notes: (1) All estimations are for 1957-90. (2) Standard errors are given in parentheses. (3) The dependent variable is the annual rate of change in the CPI excluding food and energy. (4) Gap proxies are given across the top row of the table; Fortin results are those reported as equation 1-4 of Table 1 in Fortin (1991), and are based on unemployment of adult males; "adjusted unemployment" corrects total unemployment for demographic changes; "U-gap" is the difference between the total unemployment rate and an estimate of the natural rate; "Y-gap" denotes the difference between the level of GDP and an estimate of potential output; "food prices" denotes the lagged relative rate of change between food prices and the CPI excluding food and energy; "energy prices" is defined analogously; "import prices" is the difference between inflation in prices of merchandise imports excluding food and energy and lagged inflation measured by the CPI excluding food and energy, as provided to us by Fortin; "indirect taxes" is the rate of change in an estimate of the effective indirect tax rate on non-food non-energy consumption, also provided by Fortin; "controls" denotes a dummy variable for 1976-78 to capture the period of wage-price controls, equal to 0.5 for 1976 and 1.0 in 1977 and 1978. (5) Variables distinguished by "A" and "B" have been multiplied by binary variables so that "A" pertains to the sample period 1957-72 and "B" to 1973-90.

Table 2

Alternative Measures of the Gap and the Cozier-Wilkinson Equation

Variables	*CW Results Y-Gap (-1)*	*CW Model Y-Gap*	*Adult Males*	*Total Unemp.*	*Adult Females*	*Youth Unemp.*	*Adjusted Unemp.*	*U-gap*
Constant	-0.16	-0.20	1.07	1.23	0.97	1.29	1.22	-0.11
	(0.24)	(0.24)	(0.68)	(0.77)	(0.71)	(0.82)	(0.77)	(0.24)
Lagged inflation (sum of 4)	-1.24	-1.25	-1.17	-1.19	-1.14	-1.17	-1.20	-1.26
	(0.31)	(0.32)	(0.31)	(0.31)	(0.30)	(0.32)	(0.32)	(0.32)
Gap proxy	0.27	0.31	-0.20	-0.16	-0.14	-0.10	-0.16	-0.32
	(0.11)	(0.11)	(0.13)	(0.10)	(0.11)	(0.07)	(0.10)	(0.14)
Change in gap proxy	0.57	-0.51	-1.02	-1.20	-1.81	-0.49	-1.22	-0.74
	(0.26)	(0.26)	(0.69)	(0.67)	(0.70)	(0.38)	(0.66)	(0.61)
Commodity prices (curr.& 4 lags)	0.25	0.37	0.26	0.22	0.20	0.24	0.22	0.26
	(0.13)	(0.13)	(0.14)	(0.14)	(0.13)	(0.14)	(0.14)	(0.14)
Oil prices (curr.& 1 lag)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
AIB	-2.29	-2.49	-3.10	-3.12	-3.45	-2.93	-3.10	-3.24
	(1.64)	(1.67)	(1.72)	(1.71)	(1.69)	(1.72)	(1.72)	(1.70)
Adjusted R^2	0.35	0.32	0.28	0.29	0.31	0.28	0.29	0.30
SER	2.24	2.30	2.36	2.35	2.32	2.37	2.36	2.33
DW	2.17	1.99	2.08	2.08	2.12	2.07	2.07	2.11
Q(27)	25.12	21.96	18.51	17.43	21.69	17.79	17.13	19.92

Notes: (1) All estimations are for the period 1964Q3-1988Q4, as in the original Cozier-Wilkinson study. (2) Standard errors are given in parentheses. (3) DW represents the Durbin-Watson statistic; Q(27) is the Box-Ljung Q-statistic with 27 degrees of freedom, and rejections at the 5% level are denoted with an asterisk. (4) The dependent variable is the first difference of the quarterly percentage change in the GDP deflator at annual rates, as in CW. (5) Gap proxies are as defined in Table 1; "commodity prices" is the quarterly percentage change in a real Canadian commodity price index, at annual rates, as computed by the Bank of Canada; "oil prices" is the quarterly percentage change in the average refinery acquisition cost of crude petroleum in Canada divided by the GDP deflator, at annual rates; "AIB" is a dummy variable equal to unity for the period in which the Anti-Inflation Board was in operation (1976Q1-1978Q2).

unemployment rate, the total unemployment rate adjusted for demographic shifts, and the youth unemployment rate. The only unemployment measure for which a significant gap effect is found is the adult female unemployment rate; and, as it is the differenced gap that is significant, this particular equation is supportive of the hysteresis hypothesis. The final column of the table uses the difference between the total unemployment rate and its natural rate as the gap variable. In contrast with the version of Fortin's equation that used this variable, we find that the level gap variable is significant, with a magnitude similar to that of the Y-gap model, and that the differenced gap variable is not significant. Finally, notice that all of the equations of Table 2 explain the data to a similar degree, with corrected R^2 ranging from 0.28 to 0.32 and standard errors ranging from 2.30 to 2.37.

(b) Data Frequency

As noted earlier, another major difference between the Fortin and CW studies is the use of annual data in the former and of quarterly data in the latter. Some idea of the importance of data frequency to the two sets of findings may be obtained by replicating both studies using data of the frequency opposite to that used originally. Table 3 does so for the Fortin equation. The first column presents the results of estimating Fortin's equation over the 1973-90 period, when hysteresis is found. In the second column we report a regression estimated over the same sample period using quarterly versions of all the variables, and with lags on the variables set up to span the same length of calendar time as in the annual equation. We have made some attempt to generalize the dynamics of this equation in light of the change in data frequency, by adding four lags of the change in inflation to the equation, because the exact translation of Fortin's equation into quarterly frequency resulted in poor error term properties. The resulting equation again suggests that the level gap variable is not a statistically significant determinant of inflation. Although the results of Table 3 indicate that the differenced gap variable also is insignificant, this is partly because we report the sum of the coefficients on four lags in each of three years; inspection of the individual parameter estimates reveals that the differenced gap is significant in the contemporaneous period and at lag 8, suggesting that with some modification of the lag specification, the hysteresis result could be restored.

Table 4 presents the results of a similar experiment for the CW model. There we see that moving to an annual version of the CW equation has no effect on the statistical significance of the level gap variable, and renders the differenced gap variable insignificant. Thus, based on the CW model we find that rejection of the hysteresis hypothesis is not dependent upon data frequency.

Table 3

Alternative Data Frequencies and the Fortin Equation

Variables	*Annual Results*	*Quarterly Results*
Constant	0.72	-0.03
	(0.45)	(1.23)
Lagged inflation	1.00	1.00
	-	-
Lagged change in inflation	-	-1.20
		(0.52)
Gap proxy	-0.10	-0.01
	(0.07)	(0.19)
Change in gap proxy	-0.32	-1.28
	(0.12)	(1.09)
Change in gap proxy (-1)	-0.96	-1.05
	(0.10)	(1.05)
Change in gap proxy (-2)	-0.30	-1.36
	(0.09)	(0.87)
Food prices	0.10	0.17
	(0.03)	(0.08)
Energy prices	0.10	0.05
	(0.02)	(0.05)
Import prices	0.09	0.07
	(0.02)	(0.08)
Indirect taxes	0.26	0.60
	(0.07)	(0.37)
Controls	-1.36	-0.92
	(0.30)	(0.69)
Adjusted R^2	0.99	0.58
SER	0.26	1.34
DW	2.68	2.15
Q(dof)	10.04(9)	16.23(24)

Notes: (1) The sample period for the annual regression is 1973-90; for the quarterly regression it is 1973Q1-1990Q4. (2) Quarterly regression includes four lags of the change in inflation, for which the sum of coefficients is reported; the regression also includes 12 lags on the differenced gap variable, for which the sum is reported for each year's worth of lags; each of the exogenous price series also includes four lags in order to make the correspondence with the annual regression as exact as possible. (3) As quarterly data were unavailable for the variables "import prices" and "indirect taxes", which were provided to us by Fortin, linearly interpolated series were constructed from the annual data and used instead. See also the notes to Table 1.

Table 4

Alternative Data Frequencies and the Cozier-Wilkinson Equation

Variables	*Quarterly Results*	*Annual Results*
Constant	-0.16	-0.29
	(0.24)	(0.41)
Lagged inflation	-1.24	0.01
	(0.31)	(0.27)
Output gap	0.27	0.53
	(0.11)	(0.24)
Change in output gap	0.57	-0.08
	(0.26)	(0.27)
Commodity prices	0.25	0.10
	(0.13)	(0.08)
Oil prices	0.02	0.03
	(0.01)	(0.02)
AIB	-2.29	-1.10
	(1.64)	(1.69)
Adjusted R^2	0.35	0.34
SER	2.24	1.89
DW	2.17	2.26
Q(dof)	25.12(27)	6.67(12)

Notes: (1) The quarterly regression is from 1964Q3-1988Q4; the annual one is from 1965 to 1988. (2) For the annual regression the quarterly price level data have been averaged and new inflation rates calculated on the resulting series. (3) As in the original study, the quarterly specification uses the first lag of the level and differenced gap variables, while the annual version uses contemporaneous measures of these variables. See also the notes to Table 2.

(c) Alternative Measures of Inflation

Another important difference between the Fortin and CW studies is the measure of inflation that is used: CW make use of the GDP deflator, while Fortin uses the CPI excluding food and energy. In this section we set out some alternative results to examine whether the choice of price index is playing a role in the central conclusions of the two studies.

Table 5 presents three different versions of the Fortin equation, the first column being simply our replication of Fortin's results from Table 1. The second column changes the measure of inflation to the total CPI. One effect of this change is to introduce higher-order serial correlation into the equation residuals. It also produces a much larger estimate of the coefficient on the level gap variable in both subperiods, although for the post-1972 period it is only signficant at the 10 per cent level. The estimated parameter on the differenced gap variable for the post-1972 period also becomes statistically insignificant. The third column of Table 5 repeats the estimation using the GDP deflator, with similar implications for the properties of the residuals; in this case, however, neither the level nor the differenced gap variable is significant, in either subperiod. Thus, we cannot reject hysteresis for either of the additional equations, but the results do not support the inference of hysteresis either. While the error term properties suggest that both equations might be improved by some alterations in specification, these results suggest that Fortin's result of hysteresis may be restricted to a specific measure of inflation.[5]

Table 6 provides a similar comparison for the CW model, with the results of the first column having been reproduced from Table 2. Replacing the GDP deflator by the total CPI in this model has only trivial effects on the estimated coefficients; the level gap variable remains statistically significant, as does the differenced gap variable. Although the equation has a lower estimated standard error, there is a noticeable deterioration in the properties of the residuals. Moving to the CPI excluding food and energy, in contrast, causes the differenced gap variable to drop out of the regression; also, the estimated standard error declines further, given the lower variability in the inflation series. Most importantly, the significance of the level gap variable is retained, once again rejecting the hysteresis hypothesis.

5. The equations in Table 5 were re-estimated with the inclusion of a lagged change in inflation variable, but this had only a marginal impact on the results.

Table 5

Alternative Measures of Inflation and the Fortin Equation

Variables	*CPI excl. Food&Energy*	*Total CPI*	*GDP Deflator*
Constant-A	2.07	2.96	0.97
	(0.42)	(1.26)	(1.72)
Constant-B	0.39	3.60	2.41
	(0.55)	(1.66)	(2.27)
Lagged inflation	1.00	1.00	1.00
	-	-	-
Gap proxy - A	-0.43	-0.72	-0.25
	(0.10)	(0.31)	(0.42)
Gap proxy - B	-0.06	-0.45	-0.38
	(0.09)	(0.26)	(0.35)
Change in gap proxy - A	0.24	0.86	-0.24
	(0.14)	(0.42)	(0.57)
Change in gap proxy - B	-0.38	-0.27	-0.49
	(0.14)	(0.42)	(0.58)
Change in gap proxy (-1) - A	-	-	-
	-	-	-
Change in gap proxy (-1) - B	-1.02	-0.46	-0.17
	(0.12)	(0.35)	(0.48)
Change in gap proxy (-2) - A	-	-	-
	-	-	-
Change in gap proxy (-2) - B	-0.31	-0.09	0.19
	(0.12)	(0.35)	(0.48)
Food prices	0.13	-0.17	0.13
	(0.03)	(0.10)	(0.13)
Energy prices	0.11	-0.01	-0.07
	(0.03)	(0.08)	(0.11)
Import prices	0.07	0.27	0.07
	(0.03)	(0.08)	(0.11)
Indirect taxes	0.20	0.68	0.62
	(0.08)	(0.22)	(0.31)
Controls	-1.14	-2.71	-1.24
	(0.36)	(1.07)	(1.46)
Adjusted R^2	0.98	0.89	0.79
SER	0.35	1.05	1.44
DW	2.03	2.04	1.84
Q(15)	21.41	32.38*	26.80*

Notes: See the notes to Tables 1 and 2. All three regressions use annual data for 1957-90.

Table 6

Alternative Measures of Inflation and the Cozier-Wilkinson Equation

Variables	*GDP Deflator*	*Total CPI*	*CPI excl. Food&Energy*
Constant	-0.16	-0.12	-0.16
	(0.24)	(0.20)	(0.18)
Lagged inflation (sum of 4)	-1.24	-0.87	-1.19
	(0.31)	(0.30)	(0.33)
Gap proxy	0.27	0.22	0.33
	(0.11)	(0.09)	(0.09)
Change in gap proxy	0.57	0.53	0.10
	(0.26)	(0.21)	(0.20)
Commodity prices (curr.& 4 lags)	0.25	0.15	0.14
	(0.13)	(0.11)	(0.10)
Oil prices (curr.& 1 lag)	0.02	0.00	-0.00
	(0.01)	(0.01)	(0.01)
AIB	-2.29	-1.66	-0.35
	(1.64)	(1.39)	(1.27)
Adjusted R^2	0.35	0.30	0.23
SER	2.24	1.88	1.73
DW	2.17	1.97	1.99
Q(27)	25.12	39.97*	33.03

Notes: See the notes to Table 2. All three regressions use quarterly data over 1964Q3-1988Q4.

(d) Temporal Stability

As discussed earlier, perhaps the most important finding of Fortin is that labour market behaviour shifted significantly in 1972. The CW study does not test or allow for such a shift explicitly, but is based on a gap variable that implicitly allows for such shifts; if the changes to the unemployment insurance program in 1972 served to raise the natural rate of unemployment, they would at the same time have reduced the level of potential output, and such changes are notionally captured by the CW approach. More importantly, the CW approach is able to internalize any other similar effects in the remainder of the sample period, whereas the Fortin methodology implicitly assumes that such a phenomenon occurred only once. Thus, it is of interest to test whether the Fortin equation is stable once the 1972 shift is incorporated, and whether the CW approach is sufficiently general that the model does not require such adjustments.

To investigate this issue we took Fortin's equation 1-4 with the 1972 dummy variables incorporated and conducted a series of *rolling Chow tests*.[6] Because of the need for degrees of freedom at both ends of the sample, this procedure allowed us to calculate Chow test statistics at split points from 1963 to 1979. We then conducted a sequence of *recursive Chow tests* starting in 1980, where the null that the additional data belonged to the same relationship as the preceding period was tested. These two series of tests revealed no further evidence of instability in the Fortin equation.

A similar exercise was performed with the CW model. Rolling Chow tests were conducted on the CW equation reported in the first column of Table 2, with split points every quarter from 1968Q1 to 1985Q1. The null hypothesis of stability was rejected in 1972Q4, 1973Q1 and in the four quarters 1975Q3-1976Q2. Split points during the 1977-85 period produced very small Chow statistics. We then performed a series of recursive Chow tests over the 1985-88 period and found no further evidence of instability to the end of the CW sample.

This finding of instability in 1972-73 and in 1975-76 calls into question previous inferences based on the CW equation. Ensuring that those inferences were not seriously biased by model misspecification is therefore crucial to our understanding of the hysteresis issue. Because the largest F-statistics were found during the 1975-76 period, we chose to deal with them first. This finding suggests that perhaps the AIB dummy variable that was used in the CW equation performs inadequately; in particular, the simple 0-1-0 shape of the variable may not follow the effects of the shock very closely. We tested this by increasing the number of dummy variables from 1 to 10, in effect allowing each of the observations 1976Q1-1978Q2 explicitly to be dummied out of the regression. After some experimentation, we were able to sketch a more

6. The equation in question is that of the second column of Table 1; however, the dummy variables were re-specified so that they measured the magnitude of the shift in 1972, instead of representing the new post-1972 parameter values, as in Table 1. Then, in order to perform the Chow tests, the estimated effects of the shift were subtracted from the dependent variable to produce a "shift-adjusted" equation, which replicated the other original parameter estimates exactly, and which was then tested for stability.

appropriate dynamic pattern for the dummy variable, as follows: 8.9, 4.2, 5.8, 2.9, 4.0, 3.8, 4.5, 3.4, beginning in 1976Q3 and ending in 1978Q2. Incorporating this dummy is therefore equivalent to excluding these eight observations from the sample period, a factor which was taken into account in subsequent hypothesis tests.

This procedure produced an equation that was structurally stable throughout the sample period with the exception of 1973Q1, where rejections of the null still occurred. Since this suggested that the equation did not fully incorporate the effects of the 1972 reform to unemployment insurance, we added dummy variables to the constant term, the gap variable, the differenced gap variable, and the four lagged inflation terms, to see which of the key parameters might have been affected by the reform.

The results of this test are given in Table 7. The first column reports the new estimates of the CW equation, making use of the alternative form of the AIB dummy variable described above. The last row of the table gives the largest Chow test statistic that emerges from the rolling and recursive Chow tests (with the sample split at 1973Q1). The null hypothesis of stability is rejected at the 0.95 level. The second column adds constant and slope dummy variables to capture the 1972 shift, with the slope dummies applied to the gap variables and the lagged inflation variables. Inspection of these results shows, first, that the equation has been rendered stable, and second, that the most likely source of the break is the inflation expectations parameters. Interestingly, the pattern of results is exactly opposite to what one would have expected on the basis of Fortin's analysis of the same episode: at the shift point the coefficient on the level gap variable changes from insignificance to significance at the 0.95 level, while that on the differenced gap variable does the reverse. The largest change in coefficient estimate (relative to the estimated standard error) occurs for the second lag on inflation. Indeed, if the equation is respecified so that instead of providing separate parameter estimates for the two subperiods it gives estimates for the entire period, with the dummies capturing the additive effect of the 1972 shift, only that dummy on the second lag of inflation is statistically significant.

The third column of Table 7 takes the slope dummies off the lagged inflation terms, leaving shifts in the gap variables and the constant term to attempt to explain the shift alone, as in the work of Fortin. As may be seen from the table, the equation is barely able to internalize the shift under this assumption. In contrast, the fourth column of the table presents a version of the equation where slope dummies are applied to the lagged inflation terms but left off the gap variables; this equation passes the stability test easily and has a lower estimated standard error than the equation with all dummies included. These tests indicate quite clearly that the parameters of the equation most affected by the 1972 shift were those on lagged inflation.

While the equations reported in the second and fourth columns of Table 7 could be made more compact by eliminating some of the statistically insignificant dummies, this is not particularly relevant to the issue at hand. The key point is that both of these equations are

Table 7

The 1972 UI Reform and the Cozier-Wilkinson Equation

Variables	*Respecified Equation*	*Full Set of Dummies*	*Dummies on Gap Variables*	*Dummies on Lagged Inflation*
Constant-A	-0.16	-0.11	-0.15	-0.19
	(0.21)	(0.49)	(0.50)	(0.37)
Constant-B	-	-0.11	-0.12	-0.12
	-	(0.24)	(0.25)	(0.24)
Inflation (-1)-A	-0.47	-0.48	-0.47	-0.54
	(0.09)	(0.21)	(0.09)	(0.19)
Inflation (-1)-B	-	-0.47	-	-0.45
	-	(0.11)	-	(0.11)
Inflation (-2)-A	-0.38	-0.64	-0.37	-0.67
	(0.10)	(0.24)	(0.10)	(0.23)
Inflation (-2)-B	-	-0.17	-	-0.17
	-	(0.12)	-	(0.12)
Inflation (-3)-A	-0.15	-0.21	-0.15	-0.24
	(0.10)	(0.24)	(0.10)	(0.23)
Inflation (-3)-B	-	-0.14	-	-0.15
	-	(0.11)	-	(0.11)
Inflation (-4)-A	-0.13	-0.06	-0.13	-0.05
	(0.08)	(0.21)	(0.09)	(0.21)
Inflation (-4)-B	-	-0.26	-	-0.27
	-	(0.10)	-	(0.10)
Gap (-1)-A	0.26	0.21	0.22	0.26
	(0.09)	(0.22)	(0.22)	(0.09)
Gap (-1)-B	-	0.27	0.28	-
	-	(0.10)	(0.11)	-
Change in	0.72	0.91	0.98	0.67
gap (-1)-A	(0.23)	(0.38)	(0.36)	(0.23)
Change in	-	0.53	0.55	-
gap (-1)-B	-	(0.29)	(0.30)	-
Commodity prices	0.24	0.17	0.25	0.15
(curr. & 4 lags)	(0.12)	(0.13)	(0.12)	(0.13)
Oil prices	0.02	0.02	0.02	0.02
(curr. & 1 lag)	(0.01)	(0.01)	(0.01)	(0.01)
AIB (new)	-1.0	-0.86	-0.99	-0.87
	(0.19)	(0.19)	(0.19)	(0.19)
Adjusted R^2	0.51	0.53	0.49	0.54
SER	1.96	1.91	1.98	1.90
DW	2.18	2.15	2.23	2.12
Q(27)	21.75	15.72	20.54	15.31
Chow-73Q1(F_c)	1.88 *(1.85)*	1.04 *(1.88)*	1.81 *(1.86)*	1.08 *(1.88)*

Notes: See the notes to Table 2. All regressions are estimated over 1964Q3-1988Q4. AIB (new) is of the following form: 8.94, 4.15. 5.80. 2.94, 4.01, 3.78, 4.50, 3.38, beginning in 1976Q3 and ending in 1978Q2. Critical values for the Chow test take into account the fact that AIB (new) utilizes eight degrees of freedom rather than one.

statistically stable, and both find solid evidence of a link between level gap variables and inflation in the post-1972 period. Thus, the rejection of hysteresis by CW stands up after all sources of instability have been accounted for in their model.

The finding that the 1972 shift in the CW model was probably in the parameters on lagged inflation prompted us to go back and take a second look at the modelling of the 1972 shift in the Fortin equation. As noted earlier, Fortin incorporates the shift in his equation by applying dummy variables to the constant term and to the level and differenced gap variables, and maintains a constant parameter on lagged inflation. To check this assumption, we re-estimated the equation in the second column of Table 1, while allowing the parameter on lagged inflation to shift as well. Consistent with our estimates of the CW equation, this addition is strongly supported by the data; the t-statistic on the added variable is approximately 3, and the equation standard error is reduced by nearly 20 per cent. The estimated coefficient on lagged inflation rises from 0.63 in the first subperiod to 1.02 in the second period, perhaps reflecting a change in the fundamental inflation process in the early 1970s. This change in Fortin's equation has relatively minor implications for the parameters on the gap variables; in particular, it does not affect Fortin's finding of hysteresis in the post-1972 period. However, it does suggest that a more appropriate set of results to use when discussing Fortin's model may be those given in Table 3, where the estimation period is restricted to the period 1973-90.

4. Discussion

The Phillips curves estimated in this paper each yield three possible conclusions regarding labour market hysteresis: hysteresis is rejected if the level gap variable is a significant determinant of inflation; hysteresis is indicated if the level gap variable is not significant but the differenced gap variable is an important determinant of inflation; and no inference may be made if neither variable is found to drive inflation. It is useful, given the numerous permutations examined above, to classify the various results in this way.

Let us begin with the results that allow us to reject labour market hysteresis. Hysteresis was rejected for versions of Fortin's equation based on the total unemployment rate, the adult female unemployment rate, the youth unemployment rate, an unemployment rate adjusted for demographic trends, and the output gap. Hysteresis was rejected for the CW model, in versions using both the output gap and the unemployment gap; as well, with the gap variable represented by the output gap, hysteresis was rejected for versions of the model that used the CPI and the CPI excluding food and energy. Finally, hysteresis was rejected in a version of the CW model that was based on annual data.

There were far fewer instances where one could infer that hysteresis characterized the Canadian labour market. In the Fortin model, hysteresis was found when the gap variable used was the adult male unemployment rate (Fortin's own result), in both annual and quarterly estimation. As well, hysteresis was found in an annual version of Fortin's model based on the unemployment gap. Using the CW model, hysteresis was found only when using the adult female unemployment rate as the gap variable.

In a large number of cases we were unable to make an inference concerning hysteresis. This was true of the versions of the Fortin equation that were fitted for the CPI and the GDP deflator. For the CW model, versions based on the total unemployment rate, the youth rate and the rate adjusted for demographic shifts all provided no inference. It is of course the case that these equations might have enabled us to make more useful inferences with some additional specification testing. However, with the existing examples of both rejection and acceptance of hysteresis, further examples of one or the other might have done little to sway the reader.

Our principal finding, therefore, is that the hysteresis result is not very general. Many of the permutations examined seem as plausible, *a priori*, as Fortin's. The contradictory results, combined with the importance of the implications of adopting hysteresis as a working hypothesis, should be sufficient to give one pause.

Naturally, all of the permutations examined above will not be considered equally reasonable by all readers. Now that the various estimation results are at hand, it is worth considering briefly whether each should be given similar weight in shaping our conclusions.

First, the evidence supporting hysteresis is strongest in the annual data. The only evidence found in favour of hysteresis using quarterly data was in a quarterly version of Fortin's original equation, and in the CW model based on the adult female unemployment rate. Fortin argues that annual data are more appropriate for the analysis of wage and price behaviour, since most wages are revised annually and a large proportion of prices are also reconsidered only annually. He also argues that there may be statistical problems for quarterly empirical work posed by overlapping wage contracts, and that statistical power is raised more by the length of time actually spanned by the data set than by the frequency of observations within that span.

In response, it should be acknowledged that wages and prices are not all reconsidered at the same point in time within the calendar year. In principle, therefore, changes in economic conditions through the course of the year can lead to significant shifts in behaviour that might be lost by aggregating up to annual frequency. Also, since wage contracts often exceed one year in duration in Canada (recent averages are in the order of two years), the argument concerning overlapping wage contracts may affect both quarterly and annual data in a similar way. With regard to Fortin's point about the length of time spanned by the data set, most statisticians would agree, provided that the data are all drawn from the same regime. However, a key finding of Fortin's work is that they are not, as an important shift in behaviour occurred in 1972. Indeed, Fortin's finding of hysteresis applies only to the period 1972-90. In contrast, the rejections of hysteresis based on the CW model pertain to the 24-year period from 1964 to 1988, and stand up even after the shift in 1972 has been accounted for in the equation.

The finding that equations based on the adult male unemployment rate consistently reveal support for hysteresis is also deserving of further scrutiny. One can see quite readily in Figure 1 that the reason why this gap measure is most supportive of hysteresis is that after the 1981-82 recession, it did not return to its pre-recession level. In contrast, the total unemployment rate returned to its pre-recession level by 1988-89, while the youth unemployment rate actually fell to a level below that of 1980. In part, population aging would have played a role in these movements. However, a further explanation is offered by inspection of the *regional* unemployment data. In fact, in central Canada the adult male unemployment rate did return to its pre-recession level by 1988-89, but in regions where resource industries constitute a greater proportion of overall economic activity, unemployment remained high by pre-recession standards. At the same time, the youth unemployment rate fell below its pre-recession level in central Canada, while remaining above this level in the western regions.

It seems likely that depressed prices in world commodity markets throughout the 1981-85 period contributed to this outcome. As Canada is a net exporter of such products, a decline in world commodity prices constitutes a negative terms-of-trade shock, which in turn would be expected to lead to a reallocation of economic activity from the resource-based sector to the manufacturing sector. The associated reallocation of labour between regions might be slowed by, among other things, Canada's geography, disincentive effects built into unemployment insurance policies, and uncertainty about the duration of the shock. While any of these factors might generate a hysteretic outcome after a terms-of-trade shock, however, such hysteresis would be quite independent of the path taken for inflation at the national level. Consequently, such a finding would not have implications for the costs of disinflation.

In this regard it is also worth noting that, to the extent that demographic factors do play a role in determing the paths of the various unemployment measures, there is little reason to believe that the adult male unemployment rate would be free of such effects. Indeed, the only gap measure used here that can be assumed to be unaffected by demographic shifts is the output gap for the economy as a whole, and hysteresis was rejected in every model that made use of this variable.

On the basis of the evidence presented here, then, we would discount very heavily the hysteresis hypothesis for Canada, and would suggest that the relative merits of improving Canada's inflation performance be judged accordingly. Based on the shift-adjusted quarterly Phillips curve linking the GDP deflator and the output gap, our preferred estimate implies that reducing inflation permanently by one percentage point would require an output gap of 1.9 per cent, on average, over a period of four quarters.

5. Concluding Remarks

This paper has attempted to resolve an inconsistency in the literature on labour market hysteresis in Canada, focussing on the work of Fortin (1991), who finds evidence of hysteresis, and that of Cozier and Wilkinson (1991), who conclude the contrary. Our additional labours have uncovered very little evidence in favour of hysteresis and a good deal of evidence against. The lack of generality of the hysteresis result would make many reluctant to accept its validity, even in the absence of reasonable arguments in favour of certain approaches over others. However, the evidence in support of hysteresis appears even less compelling after a review of other possible explanations for the findings.

As noted earlier, there are a number of important issues left untouched by Fortin, Cozier and Wilkinson, and the present paper, many of which might affect inferences concerning hysteresis. A brief review of some of these issues seems an appropriate way of concluding this discussion.

One issue relates to potential nonlinearities in the Phillips curve. All of the work presented in this paper is, of course, based on linear estimates. CW provided some tests for nonlinearity and concluded that the costs of disinflation are not dependent upon the degree of excess supply. This contrasts with the findings of McCallum (1988), who found some evidence, albeit weak, of a nonlinear relationship between the rate of unemployment and the rate of change in wages for Canada, for the period 1956-81. Ignoring a nonlinearity would, of course, bias the parameter estimates and one's inferences concerning hysteresis.

Another issue concerns the measure of inflation appropriate for investigating the hysteresis issue. There is of course good reason to focus on the CPI excluding food and energy, as it is now an important variable in the conduct of Canadian monetary policy. Also, its lower volatility relative to the overall CPI and the GDP deflator was quite evident in the empirical results. However, is this really the most representative measure of economy-wide inflation that is available? There are a number of important issues relating to changing component weights, the implications of indirect taxes, and so on, that suggest that economic relationships might best be modelled using a broader concept such as the GDP deflator. This argument is distinct from those that one would invoke when choosing a variable around which to orient policy. Frequency of publication, infrequency of revision, easy recognition, and infrequent changes in component weights -- all features of the CPI data -- might then be regarded as more important. All this to say that it would be difficult to argue that Phillips curve estimates based on the CPI excluding food and energy would be uniquely appropriate to testing the notion of labour market hysteresis. In any case, Dupasquier and Girouard (1992) estimate a quarterly output gap-price Phillips curve for the CPI excluding food and energy, taking full account of indirect tax changes and exchange rate movements, and are able to reject hysteresis.

Finally, the crucial role played by the measure of inflationary pressure in such models cannot be overemphasized. All inferences are based on one's assumptions in this regard. The importance of this point is demonstrated in Laxton, Shoom and Tetlow (1992), who investigate the implications of mismeasuring potential output for estimates of the Phillips curve. In particular, they find that standard approaches to estimating potential output -- such as the method used to construct the output gap variable used here and by Cozier and Wilkinson -- are likely to bias the results *in favour* of hysteresis. Ideally, therefore, a model of potential output would be developed alongside one's model of inflation, with full interdependence of inferences. These, and other issues, remain the subject for future research.

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