Cost of Disnflation: Case Study for Canada

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Essay Question

Select a country that has gone through a period of significant disinflation. Collect and plot data on its inflation and employment during that period and discuss the costs of disinflation. Using the IS-PC-MR model, discuss how the concept of anchored expectations can be used to reduce the costs associated with disinflation.

Disinflation has been an issue most developed economies have encountered in the past and became an important topic of macroeconomics in the late 1980s. This is due to the fact that the monetarist approach to reducing output gap has not only failed at its objective, but also caused inflation spikes leading to economic instability and lowering output. Once an economy reached such point, there was need to reestablish low and preferably constant inflation. That is where the search for a new theoretical framework for monetary policy began. (Carlin & Soskice 2014)

This essay firstly uses an econometric case study of Phillips curve and sacrifice ratio in Canadian economy over the period of 1980-2005, illustrating how introduction of inflation targeting affected it. Then, it explains resulting observations using the three equation model of economy as presented by Carlin & Soskice (2014).

First of all, it is necessary to define the relationship between inflation and the major cause of output loss - unemployment. Using a representative range of the dataset on Canada, obtained from OECD (2017*a*,*b*), figure 1 estimates a quadratic relationship between values of inflation and unemployment for each year. It can be observed, that for years with low level of unemployment, inflation tends to be higher. This suggests that a trade-off between output gap and the rate of inflation exists.

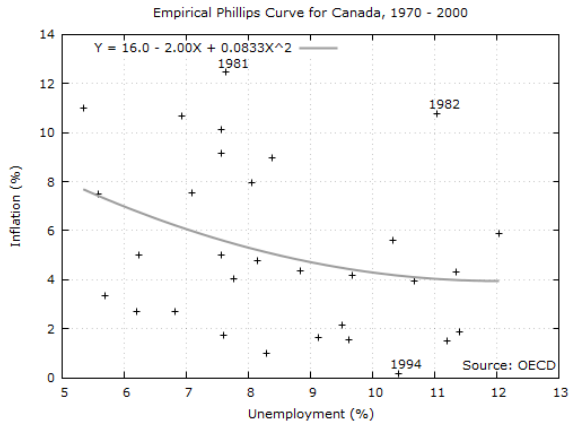


Figure 1: Phillips curve estimate for Canada, 1970 - 2000

Such relationship results from the behavior of agents in the labor market. The workforce demands a constant real wage $\frac{W}{P}$, for which a contract is signed for one year in advance. The employers, or price-setters, then adjust the prices of their products so as they retain the same profit per worker. If price level is expected to increase, workers demand nominal wage increased to compensate for the current years unanticipated inflation and further based on the expectation of future inflation. This causes an upward shift in the wage setting curve WS. Depending on the shift in the price setting curve PS caused by compensation of the employers, the level of employment then changes, as shown in figure 2. The latter shift in then determines the actual inflation between periods 1 and 2 and hence the level of involuntary unemployment U_f. Higher than expected inflation causes unemployment to decrease, while lower inflation presents with a decrease.

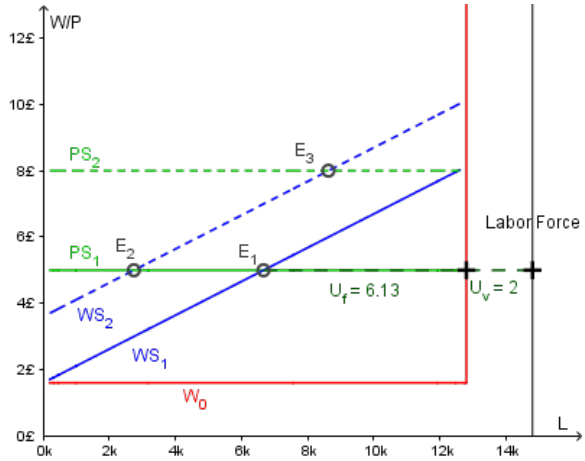


Figure 2: Labor market equilibrium

Expressing this mathematically, the general formula of linear adaptive expectations Phillips curve denoted in equation (1) shall be used. Its variables $\pi_t - \pi_{t-1} \equiv \Delta\pi$ represent year on year difference in inflation rate, U_t is current, while U_n natural level of unemployment, and α the sensitivity of unemployment towards $\pi_t - \pi_{t-1}$ (Carlin & Soskice 2014).

$$\pi_t - \pi_{t-1} = \alpha(U_t - U_n) \tag{1}$$

In order to test the hypothesis implied in equation (1) empirically, while estimating the value of α i.e. the percentage point difference resulting from 1 percentage point change in inflation difference, the relationship is transformed in equation (2) to suit needs of linear regression. Then, the values of constant U_t and the coefficient of $\Delta\pi$, which is $\frac{1}{\alpha}$, are estimated using the dataset from Canada OECD (2017*a*,*b*), plotted in figure 3. Representative ranges are used, to illustrate the changes in estimates over different periods.

$$U_t = U_n + \frac{1}{\alpha}\Delta\pi \tag{2}$$

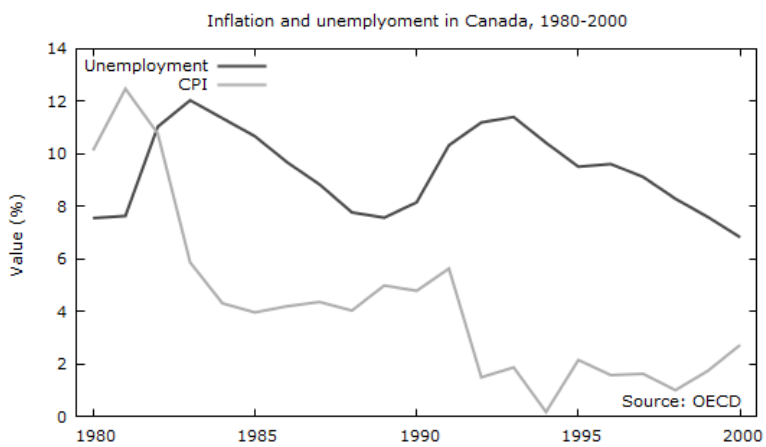


Figure 3: Time-series plot of unemployment and inflation rate in Canada, 1980 - 2000

Results of linear regression on effects of unemployment rate towards the change in inflation conducted in Gretl are shown in table 1. These are then rewritten into functional form (3) and transformed to suit the theoretical relationship (4).

$$t \in < 1980,\ 2005 > \rightarrow U_t = 8.796 - 0.611\Delta\pi \tag{3}$$

$$U_t = 8.796 - \frac{1}{1.637}\Delta\pi \implies \Delta\pi = -1.637(U_t - 8.796) \tag{4}$$

Dependent	Unemployment (%)		
Period	1980 - 2005	1980 - 1995	1995 - 2005
Intercept	8.796 0.000	9.460 0.000	7.916 0.000
$\Delta\pi$	-0.611 0.002	-0.535 0.004	-0.128 0.761
p-value(F)	0.001	0.004	**0.761**
RESET	Pass	Pass	Pass
QLR	**Fail**	Pass	**Fail**
Autocorrelation	**Present**	Not present	**Present**
α	1.637	1.869	-
α_y	-2.586	-2.953	-

Table 1: Linear regressions of Phillips Curves

The results for the period between 1980 and 2005 suggest that $\alpha \doteq -1.637 \wedge U_n \doteq 8.8\%$, which agreeably imposes the need for reinterpretation. Firstly, the estimated natural rate of unemployment at 8.8%, may seem too high, as Canada has experienced significantly lower unemployment prior to the analyzed time-frame (OECD 2017*a*). Therefore, it should only be viewed as a typical unemployment rate for given period, from which the individual observations deviate. Secondly, the value of α remains unaffected by the change in interpretation of $\bar{U_n}$ and implies that for 1 percentage point disinflation $\Delta\pi = -1$, U_t increases by 1.637 percentage points, expressing the cost of disinflation in one year. Using Okun's coefficient estimate for Canada $O = -1.58$ (Adanu 2002), a relative change in output α_y can then be calculated as shown in equation (5). Note that unlike the change in unemployment, this number represents a relative change, therefore with 1 percentage point disinflation, the output shrinks by 2.6% (Adanu 2002, Carlin & Soskice 2014).

$$\alpha_y = -1.58\alpha = 2.6\% \tag{5}$$

In order to assess the cost of disinflationary policy imposed over a period of multiple years, the sacrifice ratio is calculated using formula (6). Here, O is the Okun Coefficient, lower index t represents the number of years from the start of the analyzed period, N is the length of this period in years, and π_1 the inflation at the beginning. Considering an example period of disinflation Canada encountered between years 1981 and 1985, formula (7) estimates the sacrifice ratio while assuming that

$U_n = U_0 = U_{1980} = 7.55\%$. The result suggests that for each percentage point decrease in inflation, 2.78% of the potential output was given up.

The sacrifice ratio then suggests that so-called cold turkey approach in lowering inflation presents with lower loss per percentage point of disinflation.

$$S = \frac{\sum_{t=1}^{N}(y_e - y_t)}{\pi_1 - \pi_N} \equiv O \times \frac{\sum_{t=1}^{N}(U_n - U_t)}{\pi_1 - \pi_N} \tag{6}$$

$$S = -1.58 \times \frac{-(0.08 + 3.48 + 4.48 + 3.80 + 3.12)}{12.47 - 3.96} = 2.78 \tag{7}$$

Returning to the result of the first linear regression, the failed QLR test points out a structural break in the relationship around year 1995. Looking at the last column of table 1, it becomes clear that since 1995 the estimate of $\frac{1}{\alpha}$ is no longer significant. This is explained by the fact that Canadian central bank adopted inflation targeting monetary policy (Longworth 2002), gradually changing the way expectations of inflation were formed. This finding is consistent with the theory of anchored expectations.

Anchored expectations provide a more sophisticated, yet still mathematically simple way of explaining this relationship. The hypothesis could be further expanded to include more factors that influence inflation in order to enable practical use of rational expectations hypothesis in practice. That, however, is beyond the scope of this essay.

Utilizing the three equation model, this theory includes the effect of central bank inflation target π_T into the original linear Phillips curve equation, while assigning it a weight χ. This amendment is expressed by equation (8), which uses output gap instead of cyclical unemployment to determine the level of inflation. In order to interpret the coefficient χ correctly, it is necessary to understand that it defines how much is the calculated π_t incline towards the central bank's inflation target. $(\chi - 1)$ is then the remaining effect, which is in this case attributed to the backward-looking behavior. (Carlin & Soskice 2014)

$$\pi_t = [\chi\pi_T + (1-\chi)\pi_{t-1}] + \alpha_y(y_t - y_e) \tag{8}$$

$$\chi = 0 \rightarrow \pi_t = \pi_{t-1} + \alpha_y(y_t - y_e) \tag{9}$$

$$\chi = 1 \rightarrow \pi_t = \pi_T + \alpha_y(y_t - y_e) + \epsilon_t \tag{10}$$

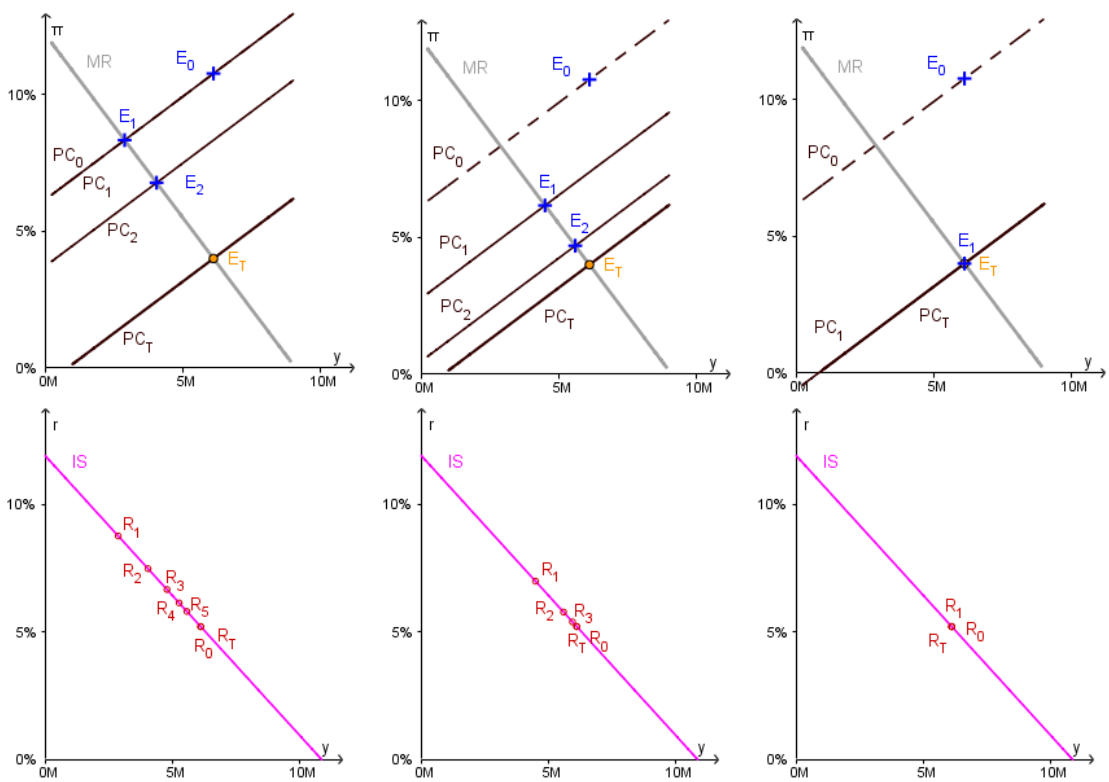
Because χ does only influence the constant in this equation, the trade-off between inflation and output within one period remains the same, characterized by the slope resulting from the value of α_y. However, what χ changes is the magnitude of shifts in the Phillips curve between two periods.

Supposing that $\chi = 0$, i.e. expectations of agents in the labor market are adaptive, the process of price level restabilization after an inflation shock will progress as illustrated in figure 4a. Firstly, the central bank adjusts the period 1 interest rate in order to satisfy their monetary rule MR constraint, forcing real output y to decrease, reaching point E_1. Then, wage-setters, expecting the same level of inflation in period 2, demand higher real wage in the next round of contracts, which shifts the WS curve upwards

resulting in the Phillips curve changing to PC_2. The central bank reacts by decreasing the interest in order to satisfy MR again, which results in reaching point E_2. As this process repeats, the inflation converges towards the central bank's target, y towards the potential output, and r towards the stabilizing interest rate.

Should the agents have partially anchored expectations, $\therefore \chi = 0.5$, the process of recovery will not only proceed at a higher rate than in the previous case, but the output gap in period 1 will be lower as well. As figure 4b suggests, after a shock, the workers demand compensation in form of increased real wage, causing an upward shift of PC to position PC_0. In period 1, they expect inflation $[\chi\pi_T + (1-\chi)\pi_{t-1}]$, meaning that the intercept of the next periods Phillips curve $PC_1(0) = 0.5\pi_T + 0.5\pi_0$ lies within (π_T, π_{t-1}), rather than being equal to π_{t-1}. Therefore, the resulting combination of output and inflation rate E_1 will be closer to the targeted combination E_T. Analogically, all following short-run equilibrium values of π and y will converge towards E_T.

In case of firmly anchored expectations, i.e. when $\chi = 1$, demonstrated by figure 4c, agents have strong faith in the central bank's target inflation rate being restored. Firstly, in result of an inflation shock, a shift of the Phillips curve to position PC_0 occurs. Workers however expect inflation to return to the central bank's target in period 1, which causes $PC_1 = PC_T$. In result of this, there is no need of the central bank to adjust inflation rate. At the end of year 0, labor market will clear at the natural level of unemployment, resulting in zero output gap, effectively rendering the disinflation costless (Carlin & Soskice 2014). In reality, this scenario occurs rarely, which is why it only acts as an extreme case for demonstration of theory.

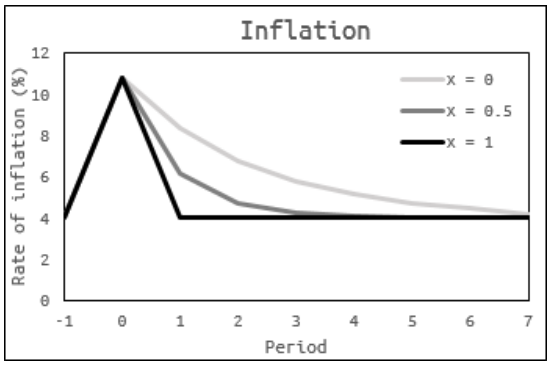


(a) Adaptive - $\chi = 0$ (b) Partially anchored - $\chi = 0.5$ (c) Firmly anchored - χ=1

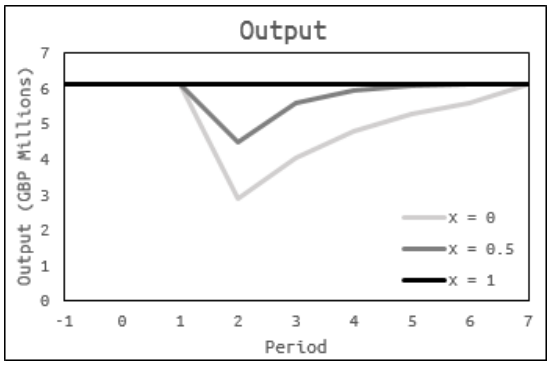
Figure 4: PC-MR model for different values of χ

Relating this concept back to the medium-run cost of disinflation as expressed by the sacrifice ratio, which has been mathematically adjusted for simpler comparison, time-series plots in figure 5 may act as a tool for forming conclusions. As equation (11) implies, the sacrifice ratio may be expressed as the area between each curve corresponding to a value of χ and the natural level of employment divided by the difference between inflation at the point of shock and the value towards which it converges. Because the value of $\pi_0 - \lim_{t\to\infty}(\pi_t)$ is constant, and identical for all three cases, it can be concluded that the higher the numerator, the higher the sacrifice ratio is. Finally, observing figure 5b, it can be said that at higher central bank credibility χ, the cost of disinflation is lower.

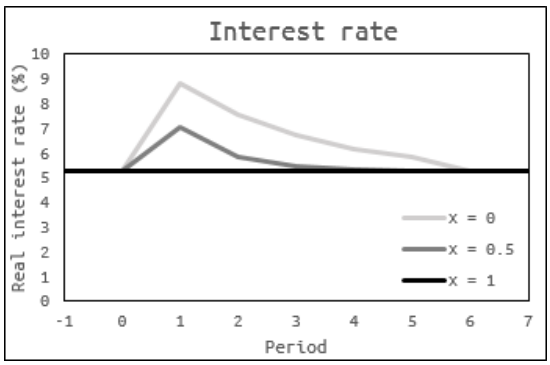
$$y(t) \wedge \pi(t) \wedge N \to \infty \implies S = \frac{\sum_{t=1}^{N}(y_e - y_t)}{\pi_1 - \pi_N} \approx \frac{\int_0^\infty (y_e - y(t))dy}{\pi_0 - \lim_{t\to\infty}(\pi(t))} \tag{11}$$



(a) inflation π_t



(b) real output y_t



(c) real interest rate r_t

Figure 5: Short-run equilibrium values in PC-MR model at different χ

Based on this theory, it can be stated that having a central bank with high credibility generally causes the losses associated with stabilization of the economy to decrease. Furthermore, according to Ball (1993), the costs of disinflation tend to decrease with increasing flexibility of the labor market contracts.

Achieving this state results from a complex process, however as review of recent research by Carlin & Soskice (2014) suggests, the level at which expectations are anchored is mostly shaped through the central bank's transparency and independence. Independence ensures the agents in the economy that the central bank will act in the interest of the whole economy, rather than just the government. Efficient communication of the central bank's goal and the proceedings related to reaching it then provides information to the agents to support their expectations.

Study conducted by Ito & Gonzalez-Hermosillo (1997) shows a solid evidence, that at the point of their work, the credibility of Canadian central bank's inflation target has been to some extent established in result of improvements in its transparency. This, together with econometric results presented herein, implies that the coefficient χ has increased significantly in the 1990s, causing a structural break in the long timeframe estimate of Phillips curve.

In conclusion, this work has used empirical data on Canada to study the trade-offs between inflation and unemployment this economy has faced in the short run through estimating a linear formula of a Phillips curve, as well as in the medium-run by utilizing the theory of sacrifice ratio. Then, structural break in estimate of the short-run Phillips curve formula was identified at year 1995 and explained by inflation targeting Bank of Canada adopted in 1991. In relation to this, the theory of anchored expectations was introduced and demonstrated using the three equation model, as used by Carlin & Soskice (2014). Finally, the importance and causes of central bank credibility were pointed out and briefly explained.

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Written in LyX

Graphs generated using GeoGebra, Gretl, and Microsoft Office Excel 2016