Monetary Neglect and the Canadian Phillips Curve*

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Abstract

The purpose of this paper is twofold. First, we test one aspect of the monetary neglect hypothesis (Nelson (2005)) for Canada, which attributes persistently high inflation during the 1970s to policies that were based on a non-monetary view of the inflation process. Using a variant of ToTEM, the Bank of Canada's new projection model, we perform two counterfactual experiments from 1974Q1 to 1979Q4. The first experiment simulates what inflation would have looked like had monetary policy continued to follow a stable rule, similar to that established in the previous decade. The second experiment simulates the effects of the expansionary policy shocks that occured during this period, but assumes that policy remained fully credible. In both scenerios, inflation declines quickly to a low level following its initial rise after the 1973 oil price shock, which we interepret as supportive of the monetary neglect argument. The paper's second purpose is to test the hypothesis that the appearance of high inflation persistence, a steep Phillips curve and high relative-price pass-through were also due to monetary neglect over this period and were therefore not due to structural factors. Our results suggest that policy contributed strongly to high persistence and exchange rate pass-through but had little to do with the relatively steep Phillips curve or high oil-price pass-through.

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1 Introduction and Summary

The purpose of this paper is twofold. First, we test one aspect of the *monetary neglect hypothesis* (Nelson (2005)) for Canada, which attributes the persistently-high inflation witnessed during the 1970s to fiscal and monetary policies that were based on a non-monetary view of the inflation process. In other words, the traditional Phillips-curve view of the inflation process was abandoned and several special factors were identified as the cause of high inflation. As a result, policy did not tighten sufficiently to contain rising inflation and in fact, was likely one of the root causes.

Using a variant of ToTEM[1], which allows for learning on the part of private agents in the economy, we perform two counterfactual experiments from 1974Q1 to 1979Q4 to test the hypothesis that monetary policy did indeed contribute to Canada's poor inflation performance over this period. The first experiment simulates what inflation would have looked like had monetary policy continued to adhere to a stable rule, similar to the rule established in the previous decade, with no policy shocks. The second experiment simulates the effects of the expansionary policy shocks that occurred during this period, but assumes that agents' perception of the Bank of Canada's desired inflation rate remains unchanged. In the first scenario, we find that policy did indeed significantly loosen over the 1974 to 1979 period and, according to ToTEM, this alone would have led to significantly higher, albeit highly transitory, inflation. Indeed, inflation declines quickly to a low level following its initial rise after the 1973 oil price shock, which we interpret as supportive of the monetary neglect argument. The second experiment shows that the majority of the inflation problem was due to the one-sided nature of these policy shocks, which in ToTEM causes agents to significantly revise up their expectation of the inflation target. Thus, according to our results, it was not the effect of expansionary monetary policy on the output gap that caused high inflation so much as it was the direct impact on agents' perception of the central bank's target, since policy was consistent with an acceptance of higher inflation for a prolonged period of time following the 1973 oil price shock.

The paper's second purpose is to informally test the hypothesis that several documented changes in the properties of the statistical Phillips curve for

[1] ToTEM is the Bank of Canada's new projection and policy analysis model, see Murchison and Rennison (2005).

Canada are also due to changes in the behaviour of monetary policy vis-à-vis the 1974-79 episode and therefore are not structural in nature. Numerous empirical studies, including rolling regression results from this paper, find that the persistence of inflation, the slope of the statistical Phillips curve and the extent to which relative price movements pass through to consumer prices are all lower in the 1980s and 90s, relative to the 1970s. Using the counterfactual simulated series for inflation, the output gap and the real exchange rate, we re-test the persistence of inflation, the slope of the Phillips curve and the pass-through from the exchange rate and oil prices. The evidence in these areas is mixed. While our counterfactual scenarios predict a substantial decline in the persistence of inflation and the pass-through of movements in the exchange rate into inflation, our results also indicate that a more appropriate conduct of monetary policy would not have substantially altered the measured short-run elasticities of inflation with respect to the output gap or oil prices. Thus, according to ToTEM, monetary policy contributed strongly to high persistence and exchange rate pass-through but had little to do with the relatively steep Phillips curve or high oil-price pass-through during this period.

The paper proceeds as follows: Section 2 summarizes the monetary neglect hypothesis for Canada, Section 3 provides a description of the salient features of ToTEM and briefly discusses its solution and estimation, Section 4 discusses the results of our two counterfactual experiments and Section 5 estimates a statistical Phillips curve on the counterfactual inflation, output and exchange rate data and compares it to history. Section 6 concludes.

2 The Monetary Neglect Hypothesis

Nelson (2005) summarizes the conduct of monetary policy in Canada in the 1970s using what he terms the monetary neglect hypothesis, which has two components. First, the *monetary* view of the inflation process is correct and second, the Bank of Canada (and the Federal Government) held a *non-monetary* view, beginning in the mid 1970s. In the context of a forward-looking Phillips curve such as

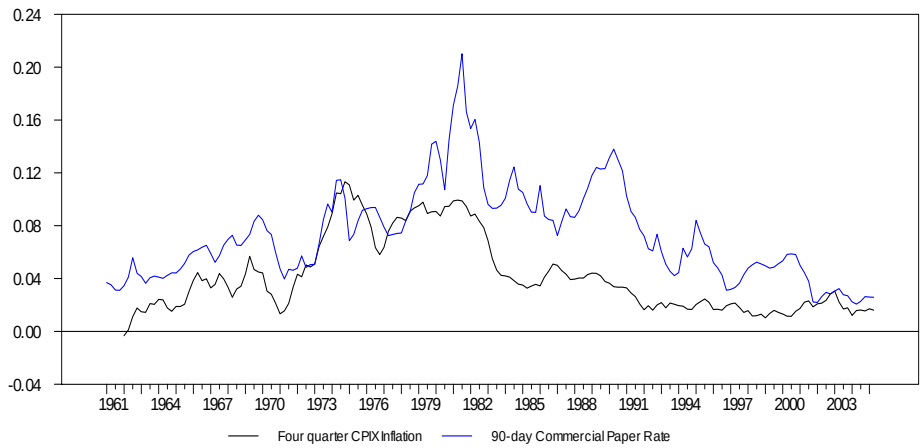
$$\pi_t = \phi_0 + \phi_1 \mathbf{E}_t \sum_{i=0}^{\infty} \beta^i \lambda_{t+i} + u_t \tag{1}$$

the non-monetary view implies that inflation is driven by persistent movements in the error term u_t and that $\phi_1 = 0$ when the output gap is negative, as it was widely believed to be in the 1970s. Therefore, the rise in inflation witnessed beginning in the early 1970s was due to cost-push factors and not excess demand and in addition, pushing the economy into excess supply through tight monetary policy would not bring about a decline in inflation. The monetary view, by contrast, maintains that $\phi_1 > 0$ and that movements in the error term represent one-time shifts in the price level but do not generate sustained changes to the inflation rate. Moreover, monetary policy can influence the activity variable λ_t through adjustments to short-term interest rates. He goes on to stress that high inflation was not a conscious choice by policy makers in Canada during this period, rather it was the outcome of basing policy on the wrong model.

At the end of the 1960s, The Bank of Canada, under the governorship of Louis Rasminsky, successfully reduced inflation from almost 6 per cent to under 2 per cent (see **Figure 1**). During this period, the Bank of Canada appeared to take a monetary view of the inflation process, as did the federal government. However, by 1974 the non-monetary view had taken hold and tight monetary policy was seen as a cause, not a remedy, for high inflation. Indeed, the accepted wisdom was that high inflation was best handled by a combination of tax cuts, tariff reductions and if necessary, direct price controls. Monetary policy's role was to stimulate the real economy to help fight high unemployment. Furthermore, while targets for M1 growth were announced at the end of 1975, these the targets did not in practice imply that interest rates had to rise during the 1970s. The net effect was that inflation rose faster than short-term nominal interest rates over the first half of the 1970s and by 1974, the ex-post real interest rate was zero and remained at about that level until 1979 when nominal rates began to rise quickly, eventually hitting 21 per cent in 1981.

Viewed from this perspective, it would seem that monetary policy itself was at least partially responsible for Canada's poor inflation performance in the 1970s. Throughout the 1960s and very early 70s, policy had systematically satisfied the Taylor condition, raising interest rates more than one-for-one in response to movements in inflation. If agents in the economy had come to believe that policy would continue to behave in this manner, then what followed in the mid-to-late 70s likely would have caused people to believe that the Bank of Canada was willing to accommodate higher inflation in response to, for example, the first oil price shock.

Figure 1: Inflation and Interest Rates



In order to quantify just how expansionary policy was beginning in 1974, relative to the previous decade, we first specify and estimate the following simple rule from 1963 to 1973 using OLS

$$R_t = \Gamma_r R_{t-1} + (1 - \Gamma_r)(R + \Gamma_\pi (\pi_{t-1} - \overline{\pi})) + \varepsilon_t \tag{2}$$

where R_t is the quarterly return on Commercial paper and π_{t-1} is the quarterly log change in the core CPI price index (see Macklem (2004)), lagged one quarter. Here we set the target equal to the sample mean inflation rate over that period, $\overline{\pi} = 0.036$ (as we do for the steady state nominal interest rate R). The two estimated parameters of the rule $\{\Gamma_r = 0.84, \Gamma_\pi = 1.52\}$ respectively capture smoothing and the long-run response of nominal rates to deviations of inflation from its mean over that period.[2] Thus, we confirm that policy did indeed respond sufficiently aggressively to inflation in the 1960s to move real interest rates in the same direction as inflation, at least in the long run. However, when we allow time variation in the parameters, we observe that Γ_π very quickly falls below one as we move in 1974 (see top graph, **Figure 3**). From 1974-79, we can reject $\Gamma_\pi = 1$ in favour of $\Gamma_\pi < 1$ at the 5 per cent level in each period. Viewed from another perspective, if we maintain the same estimated parameters as above, the policy shocks

[2] These values are very similar to those estimated for the rule in ToTEM over the same period using maximum likelihood.

implied by the rule and actual inflation outcomes are given in the bottom graph of **Figure 3**. These shocks indicate a systematic loosening of policy over the 1974-79 period, beginning with a large expansionary shock in 1974. If agents in the economy believed that policy was still following a stable rule, then given actual interest rate outcomes, they would have to conclude that the long-run inflation objective had risen. This persistent loosening of policy would have two effects. First, the expansionary shocks themselves would have the effect of raising demand and inflation in the short run. Second, given the persistent nature of these shocks, agents' perception of the inflation target would have risen, thereby raising inflation by even more and for a significantly longer period of time, provided long-run inflation expectations are themselves persistent.

3 Model of a Small Open Economy

The model presented here and used in all subsequent simulations is a scaled-down version of ToTEM (Terms of Trade Economic Model), the Bank of Canada's new projection and policy analysis model (see **Murchison and Rennison (2005)**). The ToTEM model is consistent with the New Open-Economy Model paradigm, which extends the basic closed-economy, optimizing-agent/sticky-price, or New Neoclassical Synthesis (see **Goodfriend and King 1997**), framework to allow for international trade in goods and credit.

3.1 Finished Goods Production

We begin by assuming the existence of a continuum of monopolistically-competitive firms that produce an intermediate good with a CES technology that combines capital, labour, commodities and imports. Production for the ith firm is given by

$$Z_{it}^{g} = \left(\delta_1^{\frac{1}{\sigma}}(A_t L_{it})^{\frac{\sigma-1}{\sigma}} + \delta_2^{\frac{1}{\sigma}}(u_t K_{it})^{\frac{\sigma-1}{\sigma}} + \delta_3^{\frac{1}{\sigma}} COM_{it}^{d\,\frac{\sigma-1}{\sigma}} + \delta_4^{\frac{1}{\sigma}} M_{it}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \quad (3)$$

where $\sigma \neq 1$ and u_t, K_t, L_t, A_t , are the rate of capital utilization, the level of the capital stock, labour inputs, and the level of labour-augmenting technology, respectively. A_t evolves according the unit-root process:

$$\ln(A_t) = \ln(A_{t-1}) + \varepsilon_t^A \qquad \varepsilon_t^A \sim (0, \sigma_{A^c}^2). \quad (4)$$

The firm incurs a quadratic cost when it adjusts the level of investment, which takes the form of a deadweight loss of the produced good. We also assume that the firm can vary its rate of capital utilization at the cost of foregone output. When we incorporate quadratic capital adjustment costs in addition to convex costs of capital utilization, net output of the finished good evolves according to:

$$Z_{it} = Z_{it}^{g} - \frac{\chi_k}{2}\left(\frac{I_{it}}{I_{i,t-1}} - 1\right)^2 I_{it} - \chi_u\left(1 - e^{\rho(u_{it}-1)}\right) K_{it}.$$

where χ_k determines the size of capital adjustment costs, χ_u and ρ determine the costs of variable capital utilization. Net investment is determined by:

$$K_{i,t+1} = (1-\omega)K_{it} + I_{it} \tag{5}$$

The ith firm's objective is to choose L_{it} , $K_{i,t+1}$, I_{it}, u_{it}, COM_{it}^{d},and M_{it} subject to equations (3) and (5) to maximize the value of the firm, which gives rise to the following optimality conditions[3]

$$\widehat{L}_t = \widehat{Z}_t^g + (\sigma - 1) A_t - \sigma\left(\widehat{W}_t - \widehat{\lambda}_t\right) \tag{6}$$

$$\widehat{M}_t = \widehat{Z}_t^g - \sigma\left(\widehat{p}_{m,t} - \widehat{\lambda}_t\right) \tag{7}$$

$$\widehat{COM}_t^d = \widehat{Z}_t^g - \sigma\left(\widehat{p}_{com,t} - \widehat{\lambda}_t\right) \tag{8}$$

$$\widehat{u}_t = \frac{1}{1+\rho\sigma}\left(\widehat{Z}_t^g - \widehat{K}_t\right) \tag{9}$$

$$\begin{aligned}\widehat{q}_t = {} & \frac{\omega + r}{1+r}\left(\sigma^{-1}\left(\widehat{Z}_{t+1}^g - \widehat{K}_{t+1}\right) + \widehat{\lambda}_{t+1}\right) + \\ & \frac{1}{1+r}\left(\frac{\chi_u \rho}{\Lambda}\widehat{u}_{t+1} - \widehat{r}_t + (1-\omega)\,\widehat{q}_{t+1}\right) + \varepsilon_t^q\end{aligned} \tag{10}$$

$$\widehat{I}_t = \Im\widehat{I}_{t-1} + (1-\Im)\widehat{I}_{t+1} + \frac{\Im}{\chi_k}\widehat{q}_t \tag{11}$$

where is q_t is the real shadow price of capital, $\widehat{r}_t = \widehat{R}_t - \widehat{\pi}_{t+1}$, the expected real interest rate and $\Im = \frac{1+r}{2+r} \approx 0.5$ and $\Lambda = \frac{\epsilon}{\epsilon-1} = 1.1$ is the steady-state gross markup of price over marginal cost.

[3]For the sake of brievity, we present first-order conditions after linearization around the model's non-stochastic steady state. Non-linear first-order conditions are provided in Murchison and Rennison (2005).

Turning to the firm's pricing decision, we assume a continuum of monopolistically-competitive firms that each produce a differentiated finished good and charge a price for their good that maximizes expected profits. Thus, the representative firm, i, $i \in [0,1]$, will produce Z_i and receive price P_i in return. Aggregate finished-good production, Z_t, and its corresponding deflator, P_t, are given as

$$Z_t = \left[\int_0^1 Z_{it}^{\frac{\epsilon_t - 1}{\epsilon_t}} di\right]^{\frac{\epsilon_t}{\epsilon_t - 1}} \text{ and } P_t = \left[\int_0^1 (P_{it})^{1-\epsilon} di\right]^{\frac{1}{1-\epsilon_t}}. \tag{12}$$

Note that we treat the elasticity of substitution between finished consumption goods as stochastic as in **Smets and Wouters (2003)**, **Steinsson (2003)** and **Ireland (2004)** and is generated by the following process

$$\ln(\epsilon_t) = (1-\rho_\epsilon)\ln(\epsilon) + \rho_\epsilon \ln(\epsilon_{t-1}) + \varepsilon_t^\epsilon \qquad \varepsilon_t^\epsilon \sim (0, \sigma_\epsilon^2) \tag{13}$$

Cost minimization in the production of a unit of Z by the aggregator implies that firm i faces the demand schedule

$$Z_{it} = \left(\frac{P_{it}}{P_t}\right)^{-\epsilon_t} Z_t \tag{14}$$

for its product. In addition, we assume that γ percent of firms not chosen to re-optimize their price index their price to lagged inflation, whereas the remainder index to steady-state inflation. At the firm level, this can be interpreted as the probability that, conditional on not being selected to re-optimize, the firm can index to lagged inflation. Finally, we assume, following **Calvo (1983)**, that the probability that a given firm is selected to re-optimize its price in a given period is exogenously fixed at $1-\theta$. The first-order condition for a re-optimizing firm is given as

$$\mathbf{E}_t \sum_{s=t}^{\infty} \mathcal{R}_{t,s} \theta^i Z_{is} \left(\frac{P_{it}}{P_t}\left(\frac{\Pi_{s-1,t-1}}{\Pi_{s,t}}\right)^\gamma \left(\overline{\Pi}^{s-t}\right)^{1-\gamma} - \frac{\epsilon_s}{\epsilon_s - 1}\frac{\lambda_{is}}{P_s}\right) = 0 \tag{15}$$

and the aggregate price level (for the finished-good sector) at time t is given by (using equation (12)

$$P_t = \left(\theta\left(P_{t-1}\left(\Pi_{t-1,t-2}\right)^\gamma \overline{\Pi}^{1-\gamma}\right)^{1-\epsilon_t} + (1-\theta)\left(P_{it}\right)^{1-\epsilon_t}\right)^{\frac{1}{1-\epsilon_t}} \tag{16}$$

where $\Pi^c_{s,t}$ captures the gross inflation rate between time t and s. The linearized solution to the optimal pricing problem may be written as a forward-looking Phillips curve relation of the form

$$\widehat{\pi}_t = \frac{\gamma}{1+\beta\gamma}\widehat{\pi}_{t-1} + \frac{\beta}{1+\beta\gamma}\widehat{\pi}_{t+1} + \Theta\frac{(1-\theta)(1-\beta\theta)}{(1+\beta\gamma)\theta}\widehat{\lambda}_t + \varepsilon^p_t \tag{17}$$

where the parameter Θ captures the effects of firm specific capital (see **Altig, Christiano, Eichenbaum and Linde (2004)**) such that $\Theta = 1$ under the assumption of a rental market for capital and $\Theta < 1$ if capital is firm specific. Thus, for a given average contract duration, firm-specific capital implies a wedge between average marginal cost and marginal cost for those firms chosen to reset their price.

3.2 Intermediate Inputs to Final Goods Production

3.2.1 Imports

We assume the existence of a continuum of intermediate imported goods, M_{jt}, $j \in [0,1]$, that are bundled into an aggregate import, M_t, by the aggregator and sold to final-goods producers,

$$M_t = \left[\int_0^1 (M_{jt})^{\frac{\epsilon-1}{\epsilon}} dj\right]^{\frac{\epsilon}{\epsilon-1}} \text{ with } P^m_t = \left[\int_0^1 \left(P^m_{jt}\right)^{1-\epsilon} dj\right]^{\frac{1}{1-\epsilon}}, \tag{18}$$

where P^m_t is the aggregate import-price deflator. Demand by the aggregator for the differentiated goods is given by the familiar cost-minimizing demand functions,

$$M_{jt} = \left(\frac{P^m_{jt}}{P^m_t}\right)^{-\epsilon} M_t, \tag{19}$$

We follow **Smets and Wouters (2002)** in assuming that the price of the imported good is temporarily rigid in the currency of the importing country. Consequently, exchange rate pass-through to import prices is partial in the short run and complete in the long run. Exchange rate fluctuations are absorbed by the importers' profit margins in the short run, since they purchase goods according to the law of one price. Importers therefore take into consideration the future path of foreign prices and the nominal exchange rate

when deciding on their time t price. As for the specific form of the nominal rigidity, we again follow the setup of Calvo (1983), but allow for partial indexation to lagged import-price inflation. Thus, the first-order condition for a firm chosen to re-optimize its price is quite similar to equation (15) from the previous section except for the definition of marginal cost, which is now the foreign price of the import multiplied by the nominal exchange rate

$$\mathbf{E}_t \sum_{s=t}^{\infty} \mathcal{R}_{t,s} \theta_m^{s-t} M_{js} \left(\frac{P_{jt}^m}{P_t^m} \left(\frac{\Pi_{s-1,t-1}^m}{\Pi_{s,t}^m} \right)^{\gamma_m} \left(\overline{\Pi}^{s-t} \right)^{1-\gamma_m} - \frac{\epsilon}{\epsilon - 1} \frac{e_s P_s^*}{P_s^m} \right) = 0 \quad (20)$$

and the aggregate import price level at time t is given by (using equation (12))

$$P_t^m = \left(\theta_m \left(P_{t-1}^m \left(\Pi_{t-1,t-2}^m \right)^{\gamma_{mi}} \overline{\Pi}^{1-\gamma_m} \right)^{1-\epsilon} + (1-\theta_m) \left(P_{jt}^m \right)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} \quad (21)$$

where $\Pi_{s,t}^m$ captures the gross inflation rate between time t and s. The linearized solution to the importing-firm's problem may again be expressed in the form of a forward-looking Phillips curve

$$\widehat{\pi}_t^m = \frac{\gamma^m}{1+\beta\gamma^m} \widehat{\pi}_{t-1}^m + \frac{\beta}{1+\beta\gamma^m} \widehat{\pi}_{t+1}^m + \frac{(1-\theta^m)(1-\beta\theta^m)}{(1+\beta\gamma^m)\theta^m} \left(\widehat{s}_t - \widehat{p}_t^m \right) \quad (22)$$

where $\widehat{s}_t$ and $\widehat{p}_t^m$ are respectively the real exchange rate and import prices, both deflated by the price level in the finished-good market.

3.2.2 Commodity Production

We assume a representative, perfectly competitive domestic firm produces commodities and either sells them to a distributor or exports them to the rest of world. In either case, the firm receives the rest-of-world price of commodities adjusted for by the nominal Canada/rest-of-world exchange rate for its product

$$P_t^{com} = e_t P_{com^y,t}^*. \quad (23)$$

The commodity, COM_t, is produced by combining the finished good with a fixed factor that is normalized to unity and is indexed by technology

$$COM_t = \left(Z_t^c \right)^{s_z} \left(A_t \right)^{1-s_z} - \frac{\chi_{com}}{2} \left(\frac{Z_t^c}{Z_{t-1}^c} - 1 \right)^2 Z_t^c. \quad (24)$$

In addition, we assign an adjustment cost on changes in the quantity of the finished good used in production, which is intended to capture the idea that firms can only increase or decrease production in the commodity sector at a cost in terms of lost productivity. In reality, it would take time for factors of production such as labour and capital to effectively switch from the manufacturing to the raw material sector. The adjustment cost has the effect of slowing the process in ToTEM, which would otherwise be instantaneous. Commodities are either used in the production of the finished good or exported to the rest of the world

$$COM_t = COM_t^d + X_{com,t} \tag{25}$$

Given the assumption of adjustment costs, the commodity-producing firm purchases finished-good inputs according to the partial adjustment equation

$$\widehat{Z}_t^c = \Im \widehat{Z}_{t-1}^c + (1-\Im)\,\widehat{Z}_{t+1}^c + \frac{\Im}{\chi_{com}}\left(\widehat{COM}_t - \widehat{Z}_t^c + \widehat{p}_{com,t}\right) \tag{26}$$

and chooses a production level, COM_t,to equate price with marginal cost.

3.3 Consumers

A continuum of households indexed by h , $h \in [0,1]$, purchase finished goods and consume leisure to maximize their lifetime utility. Each household is assumed to supply differentiated labour services to the intermediate-goods sector. Furthermore, the labour market is assumed to be monopolistically competitive, which motivates the existence of wage contracts. Household labour services are purchased by an aggregator and bundled into composite labour according to

$$L_t = \left[\int_0^1 L_{ht}^{\frac{\epsilon_{w,t}-1}{\epsilon_{w,t}}} dh\right]^{\frac{\epsilon_{w,t}}{\epsilon_{w,t}-1}} \text{ with wage } W_t = \left[\int_0^1 W_{ht}^{1-\epsilon_{w,t}} dh\right]^{\frac{1}{1-\epsilon_{w,t}}},$$

where we assume a time-varying mark-up for wages where $\epsilon_{w,t} \sim (\epsilon, \sigma_{\epsilon_w}^2)$. The aggregator purchases differentiated labour services to minimize costs. Thus, the demand for labour services from individual h is given as

$$L_{ht} = \left(\frac{W_{ht}}{W_t}\right)^{-\epsilon_{w,t}} L_t. \tag{27}$$

Finally, we assume that wages are reset according to the same model presented for imported and final-goods prices in the previous section. Specifically, we allow for the possibility that households fix their wages for several periods using the Calvo setup but we allow for wage indexation. Specifically, those consumers not selected to renew their wage contract receive an automatic wage increase equal to a (geometrically) weighted average of past consumer price inflation and steady-state inflation.

The instantaneous utility function for the hth household is given as[4]

$$\mathbb{U}_{ht} = \frac{\mu}{\mu - 1}(C_{ht} - \xi C_{t-1})^{\frac{\mu-1}{\mu}} \exp\left(\frac{\eta(1-\mu)}{\mu(1+\eta)} L_{ht}^{1+1/\eta}\right), \tag{28}$$

Household consumption depends positively on lagged aggregate consumption according to the parameter ξ. Thus, we assume that individuals enjoy high consumption in and of itself (provided $\xi < 1$), but that they also derive utility from high consumption relative to that of the general population. Households maximize lifetime utility according to

$$\mathbf{E}_t \sum_{s=t}^{\infty} \boldsymbol{\beta}_{t,s} \mathbb{U}_{hs}, \quad \text{with } \boldsymbol{\beta}_{t,s} \equiv \prod_{v=t}^{s-1} \beta_v \qquad \boldsymbol{\beta}_{t,t} \equiv 1. \tag{29}$$

subject to the dynamic budget constraint,[5]

$$P_t C_{ht} + \frac{e_t B^*_{h,t+1}}{(1 + R^*_t)(1 + \kappa_t)} = e_t B^*_{h,t} + W_t L_{h,t} + \Delta_t, \tag{30}$$

where B^*_{ht} and B_{ht} are, respectively, the value of foreign (domestic) currency-denominated bonds held at time t and s_t is the Canadian dollar price of unit of foreign exchange. β_t is the time-varying discount rate, which follows the process,

$$\ln(\beta_t) = (1 - \rho_\beta)\beta + \rho_\beta \ln(\beta_{t-1}) + \varepsilon^\beta_t, \qquad \varepsilon^\beta_t \sim (0, \sigma^2_{\varepsilon^\beta}) \tag{31}$$

[4]Equation (28) is non-standard primarily in the sense that consumption and leisure are not additively separable (see King, Plosser, and Rebelo 1988 and Basu and Kimball 2000; for a model application, see Smets and Wouters 2003). Consequently, the marginal utility of consumption (leisure) will depend on labour (consumption).

[5]In addition to the budget constraint, the no-Ponzi game condition is enforced for domestic and foreign bonds. Also, we assume that consumption is identical across households despite differences in wage income out of steady state.

and Δ_t represents profits paid by all firms to households. κ_t is interpreted as the country-specific risk premium and is assumed to have both a deterministic and stochastic component. More specifically, the risk premium will move with the home country's net foreign indebtedness as a share of nominal GDP, as in **Schmitt-Grohé and Uribe (2003)**, thereby ensuring a stationary dynamic path for the net-foreign-asset-to-GDP ratio about its steady-state value. In addition, we assume that the risk premium is subject to a shock process that represents unforecastable changes in investors' preferences:

$$\kappa_t = \varsigma \left[\exp\left(\frac{e_t B_t^*}{P_{dt} Y_t} \right) - 1 \right] + \varepsilon_t^{\kappa}, \tag{32}$$

$$\varepsilon_t^{\kappa} = \rho_{\kappa} \varepsilon_{t-1}^{\kappa} + \nu_{\kappa,t} \quad \nu_{\kappa,t} \sim (0, \sigma_{\kappa}^2) \tag{33}$$

Maximizing (29) with respect to C_{ht}, W_{ht}, L_{ht}, and B_{ht}^*, subject to (27) and (30) yields the following first-order conditions, again after linearization,

$$\widehat{C}_t = \frac{\xi}{1+\xi}\widehat{C}_{t-1} + \frac{1}{1+\xi}\widehat{C}_{t+1} - \frac{(1-\xi)\mu}{1+\xi}\widehat{r}_t + \frac{\mu-1}{(1+\xi)\Lambda}\Delta\widehat{L}_{t+1} + \varepsilon_t^c, \tag{34}$$

$$\begin{aligned} \widehat{\pi}_t^w = {} & \beta\widehat{\pi}_{t+1}^w - \gamma^w\left(\beta\widehat{\pi}_t - \widehat{\pi}_{t-1}\right) - \\ & \frac{(1-\theta^w)(1-\beta\theta^w)}{(1+\epsilon\eta)\theta^w}\left[\widehat{w}_t - \eta^{-1}\widehat{L}_t - (1-\xi)^{-1}\left(\widehat{C}_t - \xi\widehat{C}_{t-1}\right)\right] \\ & + \varepsilon_t^w, \end{aligned} \tag{35}$$

$$\widehat{s}_t = \widehat{s}_{t+1} + \widehat{R}_t^* - \widehat{R}_t + \widehat{\kappa}_t \tag{36}$$

3.4 Monetary Policy

Monetary policy in the model sets the nominal short-term interest rate, R_t, in response to deviations of lagged finished-good price inflation, π_{t-1}, from the target[6], π_t^*

$$R_t = \Gamma_r R_{t-1} + (1-\Gamma_r)(\overline{r} + \overline{\pi}_t + \Gamma_{\pi}(\pi_{t-1} - \pi_t^*)). \tag{37}$$

[6]The choice of one-quarter lagged inflation reflects simply the reality that data on consumer prices is available only with a one quarter lag. Alternatively, one could use $\mathbf{E}_{t-1}\pi_t$ as the variable that policy responds to, although this expectation is not observed. In practice, our main results are robust to this distinction.

As in **Erceg and Levin (2003)**, we assume that the target is comprised of two components that vary through time

$$\pi_t^* = \overline{\pi}_t + \pi_{qt} = \mathbf{H}\mathbf{Q}_t \tag{38}$$

with $\mathbf{H} = \begin{bmatrix} 1 & 1 \end{bmatrix}$. $\overline{\pi}_t$ represents changes to the target whereas π_{qt} represents purely-temporary deviations from the rule, i.e. monetary policy shocks. Furthermore, agents in the economy are assumed to observe π_t^* at time t but not its components. Thus, agents solve a signal extraction problem whereby they infer, at each point in time, the value of $\overline{\pi}_t$ based on π_t^* and their most recent forecast error of the target, the latter allowing them to update their beliefs. Formally, we have

$$\mathbf{Q}_{t+1} = \mathbf{\Psi}\mathbf{Q}_t + \boldsymbol{\varepsilon}_{t+1} \tag{39}$$

with $\mathbf{Q}_{t+1} = \begin{bmatrix} \overline{\pi}_{t+1} \\ \pi_{q,t+1} \end{bmatrix}$, $\mathbf{\Psi} = \begin{bmatrix} \rho_p & 0 \\ 0 & \rho_q \end{bmatrix}$ and $\boldsymbol{\varepsilon}_t = \begin{bmatrix} \varepsilon_{p,t} \\ \varepsilon_{q,t} \end{bmatrix}$. In addition, we assume $\rho_p = 1$ and $\rho_q = 0$. Given this structure (and the assumption of orthogonality between $\varepsilon_{p,t}$ and $\varepsilon_{q,t}$), agents update their beliefs according to the rule

$$\mathbf{E}_t\mathbf{Q}_t = \mathbf{\Psi}\mathbf{E}_{t-1}\mathbf{Q}_{t-1} + \mathbf{E}_{t-1}\mathbf{\Sigma}_t\mathbf{H}'\left(\mathbf{H}\mathbf{E}_{\mathbf{t-1}}\mathbf{\Sigma}_t\mathbf{H}'\right)^{-1}\left(\pi_t^* - \mathbf{H}\mathbf{\Psi}\mathbf{E}_{t-1}\mathbf{Q}_{t-1}\right) \tag{40}$$

where

$$\mathbf{E}_{t-1}\mathbf{\Sigma}_t = \mathbf{\Psi}\mathbf{E}_{t-1}\mathbf{\Sigma}_{t-1}\mathbf{\Psi}' + \mathbf{M}_t \qquad \mathbf{M}_t = \mathbf{E}\left(\boldsymbol{\varepsilon}_t\boldsymbol{\varepsilon}_t'\right)$$

and $\mathbf{E}_{t-1}\mathbf{\Sigma}_t\mathbf{H}'\left(\mathbf{H}\mathbf{E}_{\mathbf{t-1}}\mathbf{\Sigma}_t\mathbf{H}'\right)^{-1}$ is the Kalman gain parameter, which controls the speed with which agents update their expectation of the target based on new information. Having computed their time t expectation of the permanent and transitory components of the target, they use the structure of (39) to extrapolate forward the dynamic path of π_{t+i}^*

$$\mathbf{E}_t\pi_{t+i}^* = \mathbf{H}\mathbf{\Psi}^i\mathbf{E}_t\mathbf{Q}_t = \mathbf{E}_t\pi_{p,t} \qquad \forall i > 0 \tag{41}$$

3.5 Foreign Economy

Finally, we specify a simple reduced-form VAR model to capture the dynamics of the four foreign variables of interest, foreign demand, inflation, real interest rates and relative commodity prices

$$\begin{bmatrix} Z_t^* \\ \pi_t^* \\ r_t^* \\ \widehat{p}_t^{com} \end{bmatrix} = \mathbf{B}(L) \begin{bmatrix} Z_{t-1}^* \\ \pi_{t-1}^* \\ r_{t-1}^* \\ \widehat{p}_{t-1}^{com} \end{bmatrix} + \begin{bmatrix} u_{1t}^* \\ u_{2t}^* \\ u_{3t}^* \\ u_{4t}^* \end{bmatrix}, \qquad \mathbf{E}\left(\mathbf{u}_t \mathbf{u}_t'\right) = \mathbf{\Sigma}^*$$

which is estimated jointly with the structural model over the same sample. Demand by the foreign economy for non-commodity exports is given by the usual static demand function

$$\widehat{X}_t^{nc} = -\varphi\left(\widehat{p}_t - \widehat{s}_t - \widehat{p}_t^*\right) + \widehat{Z}_t^*, \tag{42}$$

where φ is the elasticity of substitution between foreign produced and Canadian non-commodity export goods.

3.6 Solution and Estimation

The model presented above contains five unit roots (domestic prices, foreign prices, inflation target, technology and foreign output). We can eliminate the first two by writing nominals as relative prices, the third by deflating nominal rates by the target and the last two by making foreign output and technology co-integrated and then deflating real variables by technology. The deflators will be technology and the finished-good price level. The nominal exchange rate will become the real exchange rate and the nominal wage will be the real wage deflated by technology. In addition, given that both the target and the technology process are exact unit roots, we have

$$\mathbf{E}_t A_{t+1} = A_t \quad \text{and } \mathbf{E}_t \overline{\pi}_{t+1} = \overline{\pi}_t$$

The stationary, linear model may then be written as follows

$$\mathbf{G}_0 \mathbf{X}_t = \mathbf{G}_1 \mathbf{X}_{t-1} + \mathbf{\Psi} \mathbf{z}_t + \mathbf{\Pi} \boldsymbol{\eta}_t$$

with auxiliary variables created for the 13 one-period-ahead forward looking variables. Given this form and following **Sims (2002)**, the structural solution of the model is given as

$$\mathbf{X}_t = \mathbf{A}_1 \mathbf{X}_{t-1} + \mathbf{A}_0 \mathbf{z}_t \tag{43}$$

The 13 parameters of the chosen such that the joint likelihood for the linear model is maximized over the sample 1965Q1-2005Q2. Thus, for each choice of parameters, the value of the likelihood function is computed for $\mathbf{Y}_t = \left\{\widehat{I}_t, \widehat{\pi}_t, \widehat{L}_t, \widehat{C}_t, \widehat{s}_t, \widehat{w}_t, Z_t^*, \pi_t^*, r_t^*, \widetilde{p}_t^{com}, \widehat{R}_t\right\}, \mathbf{Y}_t \subset \mathbf{X}_t$. Since the foreign activity variable Z_t^* must be deflated by domestic technology, which is not known prior to estimation, the parameters of the foreign-country VAR are estimated at the same time as the structural parameters of the domestic country model. The Broyden, Fletcher, Goldfarb and Shanno method is used to maximize the likelihood function with respect to the parameters of the model. The standard errors reported are the diagonal elements of the inverse Hessian matrix evaluated at the maximum.

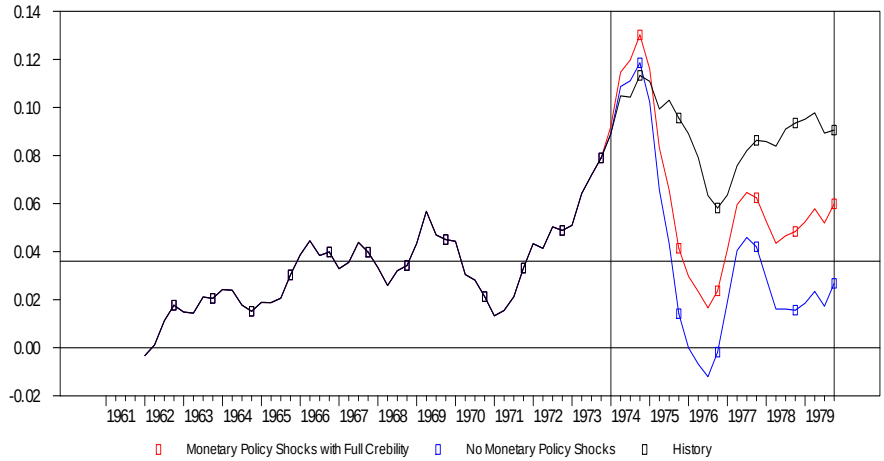
4 Counterfactual Experiments

We perform two counterfactual experiments to test the validity monetary neglect hypothesis as well as its implications for inflation over this time period. We begin with the question: to what extent did the monetary authority's failure to appropriately respond to the increase in inflation in the early 1970s contribute to the behaviour of inflation thereafter? To do so, we construct a scenario in which, beginning in 1974Q1, the monetary authority behaves according to the rule estimated up to the end of 1973.[7] In the resulting scenario we examine the path for inflation as well as the measured persistence of inflation and the relationship between inflation and some its determinants: the exchange rate, commodity prices, and an HP-filter-based output gap. The differences between actual history and the outcomes of this counterfactual scenario is a function of two factors: (i), the extent to which the monetary authority deviated from its rule, and (ii) the extent to which agents perception of the objective of the monetary authority changed as a result. To separate the two effects, we consider another counterfactual in which the historical policy shocks occurred, but without the ensuing change in the perceived target (the Kalman gain is set to one for the period of interest)[8]. More technically, given that ToTEM's solution is described by equation (43), the

[7] The parameters of the policy rule for this period are $\Gamma_r = 0.77$ and $\Gamma_\pi = 1.4$.

[8] For the sake of technical ease, we choose a constant value for the Kalman gain of 0.7 in the baseline scenario. We find that this value very closely replicates the behaviour of the perceived target over the 1970s when we allow agents to recursively update their estimate of the Kalman gain over rolling 10-year subsamples.

Figure 2: The Behaviour of Inflation: Counterfactual Experiments



first counterfactual experiment corresponds to

$$\mathbf{X}_t^1 = \mathbf{A}_1 \mathbf{X}_{t-1}^1 + \mathbf{A}_0 \left(\Phi \mathbf{z}_t \right),$$

where Φ is equal to the identity matrix except for a zero in the (n, n) position where the nominal interest rate is n^{th} variable in $\mathbf{X}_t^1$.Thus, the only difference between history and the counterfactual is the absence of monetary policy shocks. Counterfactual two corresponds to

$$\mathbf{X}_t^2 = \widetilde{\mathbf{A}}_1 \mathbf{X}_{t-1}^2 + \widetilde{\mathbf{A}}_0 \mathbf{z}_t,$$

where $\widetilde{\mathbf{A}}_0$ and $\widetilde{\mathbf{A}}_1$ correspond to the model's solution under the assumption that $\mathbf{E}_{t-1} \mathbf{\Sigma}_t \mathbf{H}' \left(\mathbf{H} \mathbf{E}_{\mathbf{t-1}} \mathbf{\Sigma}_t \mathbf{H}' \right)^{-1} = 1$.

Figure 2 displays the behaviour of inflation in the three scenarios. The blue line, which corresponds to the no-policy-shocks (NPS) case, shows a substantial and sustained reduction in inflation following the initial increase in 1974. Inflation is in fact negative for a brief period in the mid-70s. However, this reflects in large part the influence of wage and price controls which were instituted in 1975 and lasted 3 years.[9] Presumably, had monetary policy

[9] The wage and price controls applied to the public sector and to private companies with 500 or more employees. Farmers, fishermen and regulated industries were exempt from

followed the rule considered here, these control would not have been viewed as necessary and inflation would not have troughed at minus one per cent, as depicted above. Nevertheless, this scenario clearly indicates that overly stimulative policy played a large role in keeping inflation high over the latter half of the 1970s.

The red line presents the path for inflation had agents not interpreted the series of one-sided policy shocks as a change in the target (the NTC case). In this scenario the dynamic of inflation is quite similar to the NPS scenario, but the fall is less severe. The difference between the blue and red lines represents the role played by changes to the perceived inflation target in slowing the reduction in inflation; it indicates the series of one-sided policy shocks and the resulting change in the perceived target played a roughly equal role in allowing the increase in inflation to persist.

5 The Phillips Curve in Canada

There exists an ever-growing body of empirical evidence for Canada that points to three fundamental changes in the behaviour of inflation over the course of the last three decades or so (see **Longworth (2002)** for a comprehensive review). First, inflation persistence is seen to be much lower than it was in the 1970s. Second, point estimates of the coefficient on the output gap in statistical Phillips-curve equations has declined to the point where we no longer can reject the hypothesis that no such relationship exists. Third, the so-called pass-through effects of relative price changes such as the exchange rate and energy prices on the general price level are now much smaller and in most cases, not statistically different from zero. Against this backdrop, we begin our analysis of the counterfactual data by specifying a benchmark statistical Phillips curve of the form

$$\pi_t = \phi_1 + \sum_{i=1}^{2} \phi_{i+1}\pi_{t-i} + \phi_4 \widetilde{y}_{t-1} + \sum_{i=1}^{2} \phi_{i+4}\Delta s_{t-i} + \sum_{i=0}^{1} \phi_{i+7}\Delta p^{oil}_{t-i} + u_t, \quad (44)$$

the price controls. Wage increases were capped at 10% in the first year of the anti-inflation program, 8% in the second year, and 6% in the third year. Wage and price controls were phased out in 1978, and then the Anti-Inflation Board was dissolved the following year. These effects are reflected in ToTEM mainly as a series of negative wage shocks over this period of time.

where π_t is the quarterly change in the log core consumer price index, $\widetilde{y}_{t-1}$ is the one-quarter lag of the difference between log GDP and its HP-filtered value, Δs_t is the log change in the real exchange rate and Δp_t^{oil} is the log change in the U.S.-dollar price of oil deflated by the U.S. GDP deflator. This specification is similar to those typically used in empirical models of inflation, although there is no general agreement on what lag structure should be used for Δs_t and Δp_t^{oil}.

We define the persistence of inflation as the sum of the coefficients on lagged inflation in equation (44). The short-run slope of the Phillips curve is simply ϕ_4 whereas short-run and long-run exchange rate pass-through are respectively

$$\sum_{i=1}^{2} \phi_{i+4} \quad \text{and} \quad \left(\sum_{i=1}^{2} \phi_{i+4}\right)\left(1 - \left(\sum_{i=1}^{2} \phi_{i+1} - \sum_{i=1}^{2} \phi_{i+4}\right)\right)^{-1}.$$

Long-run pass-through is simply the change in the price level in period s stemming from a one per cent change to the nominal exchange rate in period t as s goes to infinity. Short and long-run oil price pass-through have similar definitions.

The first graph of Figures 4 to 7 illustrate the evolution of these parameters using rolling OLS regressions of equation (44) based on a 10-year lagging window of actual data along with estimated 5 and 95 per cent confidence levels. Beginning with **Figure 4**, we note that the coefficient on the output gap is consistently highest over the 1974Q1-79Q4 period ($\overline{\phi}_4 = 0.12$) and is statistically significant from 1976-81. Before and after this period, the point estimates are much lower and in most cases, we cannot reject at the 5 per cent level that $\phi_4 = 0$. This result is consistent with **Demers (2003),** who estimates $\phi_4 = .28$ from 1973Q2 to 1982Q1, using a specification similar to equation (44), and $\phi_4 \approx 0$ from 1982Q2 to 2002Q1. **Beaudry and Doyle (2001)**, using 15-year rolling regressions of a specification for inflation that includes a role for lagged inflation, the output gap and energy prices find that the slope of the Phillips curve was highest in the late 1970s and early 1980s and that the slope systematically falls from 1983 to 1999.

Similarly, short-run exchange rate pass-through (top graph of **Figure 5**) is highest and most statistically significant over the period, averaging about 0.2, whereas long-run pass-through is 0.36 (see **Table 2.0**). After this period, pass-through quickly falls to around zero and is not statistically different from zero in any period after about 1983. Empirical estimates of

the exchange rate pass-through to the CPI (or core CPI) in other studies are typically between 0.15 and 0.4 for samples that span the last 30 years or so. However, the parameters of the Phillips curve also change through time, and the degree of pass-through begins to fall in the 1980s. For instance, **Kichian (2001)** estimates average pass-through to be 0.42 based on a Phillips curve estimated from 1972Q3 to 1999Q4, whereas over the sub-samples 1972Q3 to 1989Q4 and 1990Q1 to 1994Q4 it is, respectively, 0.53 and 0.04. Similarly, **Gagnon and Ihrig (2002)** estimate pass-through of 0.3 from 1971 to 1984 and 0.01 from 1985 to 2000.

The story is very similar for oil-price pass-through (top graph of **Figure 6**), where again the point estimate is highest and most precisely estimated over the period of interest. This is consistent with **Stuber (2001),** who finds that pass-through of the oil-price increase witnessed from 1999 to 2001 is lower than that experienced following previous episodes of increases in Canada.

Finally, we consider the somewhat more controversial issue of inflation persistence. The top graph of **Figure 7** shows the rolling estimates of the sum of the coefficients on lagged inflation from equation (44). The controversy regarding persistence measures stems mainly from the issue of how to deal with changes in the mean of inflation. For a country like Canada, whose mean inflation rate appears to have changed several times in the last four decades, getting a robust gauge of just how persistent inflation is can be difficult. It is well known that in the presence of mean changes, fixed parameter equations such as (44) will overstate persistence. On the other hand, allowing for mean breaks when no such breaks exist will bias down our persistence measures. Nevertheless, the weight of evidence for Canada suggests that inflation persistence was higher in the 1970s and early 1980s then in the two decades that followed, particularly if one takes the view that the target for inflation did not increase with actual inflation in the 1970s, in which case inflation was persistently above its long-run value. Indeed, work by **Ricketts and Rose (1995)**, **Fillion and Leonard (1997)**, **St-Amant and Tessier (2000)**, and **Kichian (2001)**, using various statistical techniques, all reach broadly the same conclusion, inflation persistence has been lower over the last decade and a half than it was in the 1970s and 1980s.

Armed with this empirical evidence, we now consider the question: would these four stylized facts still hold if inflation had evolved according to the red or blue line in Figure 3 rather than the black line? In other words, to what extent are these reduced-form features of inflation an artifact of the

behaviour of the monetary authority over the 1974-79 period? Beginning with the slope of the Phillips curve, the bottom two graphs of **Figure 4** present the estimates of the coefficient on the output gap, ϕ_4, for the NPS and NTC scenarios. In the historical case, the estimated value is roughly 0.15 from the mid-to-late1970s. In the NPS scenario, we see a decline over this period and, on average, a slightly lower estimated value. In the NTC case, we see an even more pronounced drop, but no noticeable change in the average estimate compared to history. On this basis, we conclude that monetary neglect did not systematically change the relationship between inflation and the output gap. Indeed, the average of the rolling values of ϕ_4 from 1974-79 is slightly higher in the two counterfactual experiments.

We turn next to the pass-through of relative price movements into core inflation. We start with our measure of short run exchange rate pass-through: the sum of the coefficients ϕ_5 and ϕ_6. In the historical data, we find this coefficient to be quite stable, averaging roughly 0.2, over the 1970s before gradually falling in the 1980s and remaining close to zero for the rest of the sample. In both counterfactuals, however, exchange rate pass-through falls dramatically in the mid-1970s, remaining close enough to zero to be statistically insignificant for the rest of the sample. Average short-run pass-through over the 1974-79 period falls by at least 50 per cent in both counterfactuals. Long-run pas-through in the NPS scenario is just 1/3 its historical value. Finally, the NTC counterfactual indicates that for a sample that ranges from 1970-2005, pass-through is only statistically significant in 1973 and 74. On the other hand, **Figure 6** presents the rolling estimates of short-run oil price pass-through, and it appears that monetary neglect did not affect the measured relationship between oil prices and inflation. In all three scenarios, short run oil price pass-through is stable around 0.03 through the latter half of the 1970s.

Finally, we turn to the rolling estimates of inflation persistence as measured by the sum of coefficients ϕ_2 and ϕ_3, displayed in Figures 7 and 8. As **Figure 8** shows, the historical estimate of persistence is much higher than in either of the the two counterfactuals in the 1970s. Historical persistence fluctuates between 0.55 and 0.75, and averages roughly 0.65 over this period, whereas persistence in the NPS and NTC counterfactuals average 0.39 and 0.47. Furthermore, historical persistence is rising peaks at over 0.7 in the mid-1970s, whereas NPS persistence is falling and troughs at 0.32 over the same period. Simply put, these results indicate that a more appropriate response by the monetary authority to movements in inflation would have rendered

these movements more transitory, thereby significantly reducing persistence to a level more consistent with the 1980s.

6 Conclusion

Using an estimated version of the Bank of Canada's new projection and policy analysis model, ToTEM, we perform two counterfactual experiments to test the hypothesis that monetary policy did indeed contribute to Canada's poor inflation performance over this period, as suggested by Nelson (2005). The first experiment simulates what inflation would have looked like had monetary policy continued to adhere to a stable rule, similar to the rule established in the previous decade, with no policy shocks. The second experiment simulates the effects of the expansionary policy shocks that occurred during this period, but assumes that agents' perception of the Bank of Canada's desired inflation rate remains unchanged. In the first scenario, we find that policy did indeed significantly loosen over the 1974 to 1979 period and, according to ToTEM, this alone would have led to significantly higher, albeit highly transitory, inflation. We interpret this results supportive of the monetary neglect argument. The second experiment shows that the majority of the inflation problem was due to the one-sided nature of these policy shocks, which in ToTEM causes agents to significantly revise up their expectation of the inflation target.

In addition, we informally test the hypothesis that several documented changes in the properties of the statistical Phillips curve for Canada are also due to changes in the behaviour of monetary policy vis-à-vis the 1974-79 episode and therefore are not structural in nature. Using the counterfactual simulated series for inflation, the output gap and the real exchange rate, we re-test the persistence of inflation, the slope of the Phillips curve and the pass-through from the exchange rate and oil prices. The evidence here is mixed. While our counterfactual scenarios predict a substantial decline in the persistence of inflation and the pass-through of movements in the exchange rate into inflation, our results also indicate that a more appropriate conduct of monetary policy would not have substantially altered the measured short-run elasticities of inflation with respect to the output gap or oil prices. Thus, according to ToTEM, monetary policy contributed strongly to high persistence and exchange rate pass-through but had little to do with the relatively steep Phillips curve or high oil-price pass-through during this

period.

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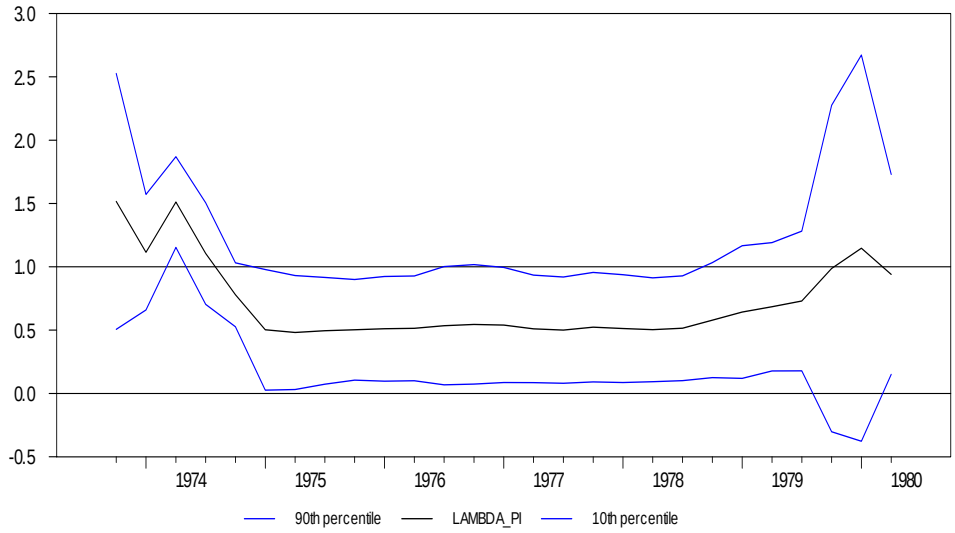
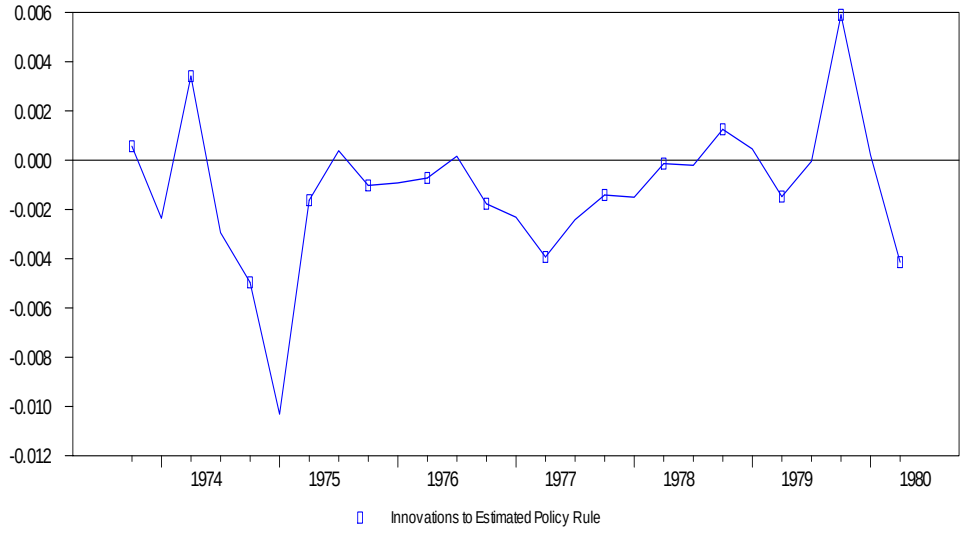
Figure 3: Rolling Estimates of Γ_π - 10-year Window





Monetary Policy Shocks from Stable Rule

Figure 4: The Evolution of ϕ_4 - The Output Gap and Inflation

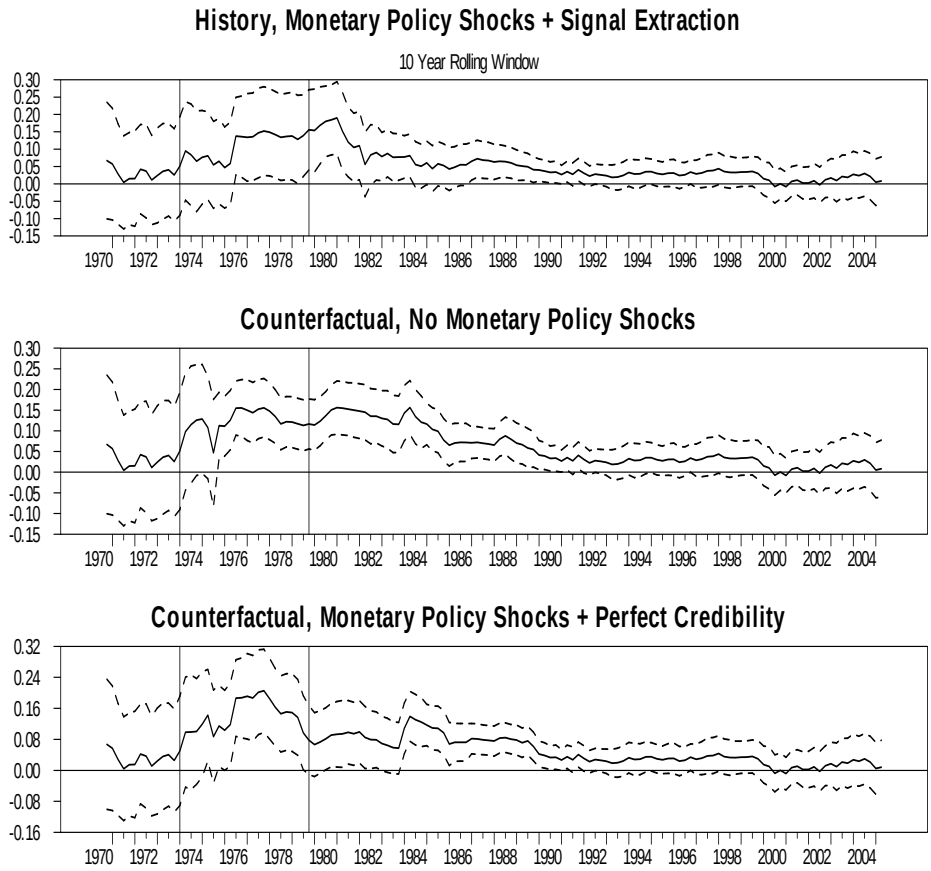


Figure 5: The Evolution of $\phi_5+\phi_6$ - Exchange Rate Pass-Through to Inflation

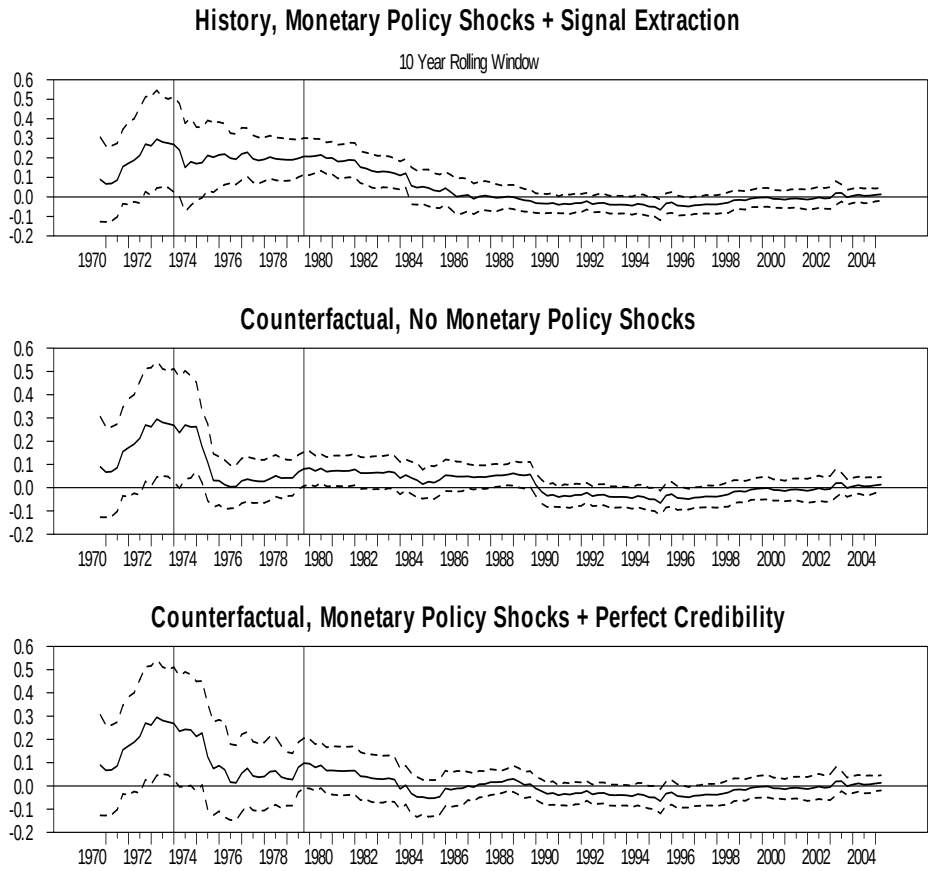


Figure 6: The Evolution of $\phi_7 + \phi_8$ - Oil Price Pass-Through to Inflation

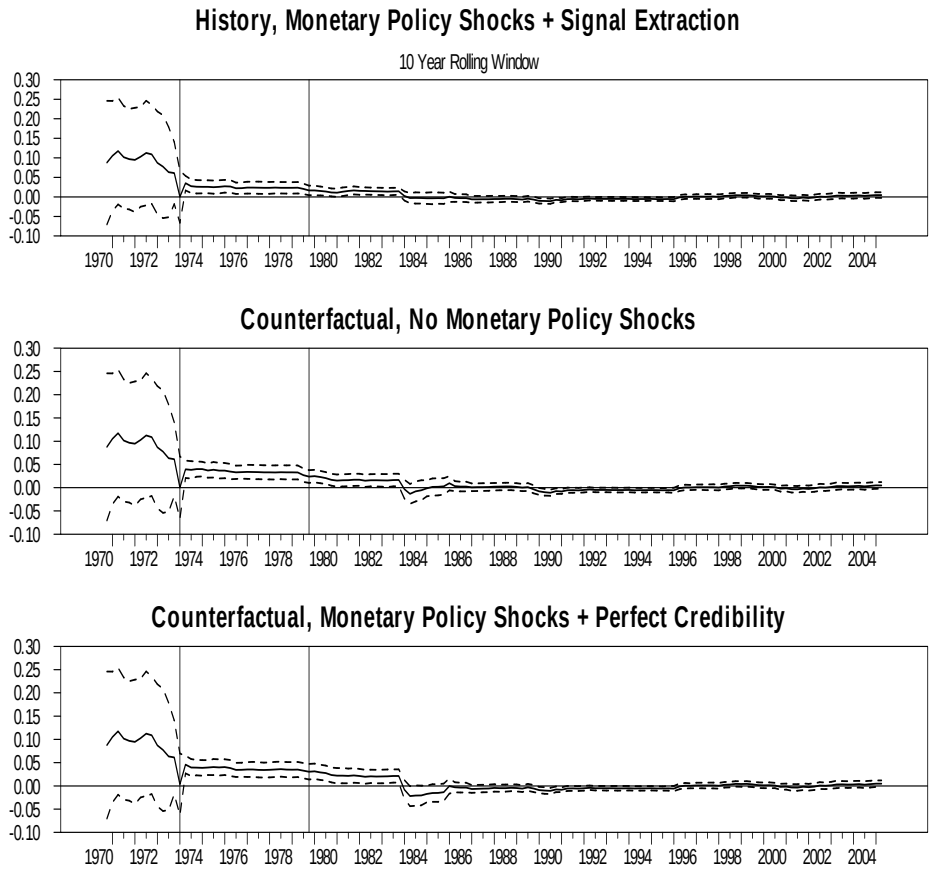


Figure 7: The Evolution of $\phi_2 + \phi_3$ - The Persistence of Inflation

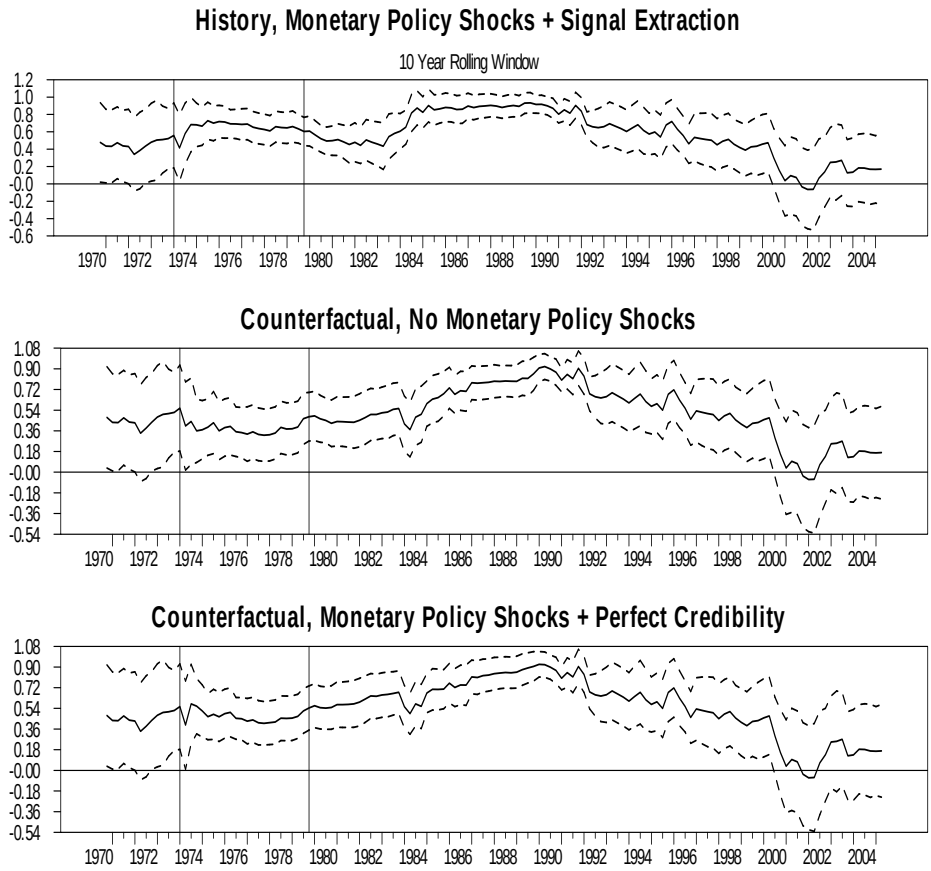


Figure 8: The Evolution of $\phi_2 + \phi_3$ - The Persistence of Inflation

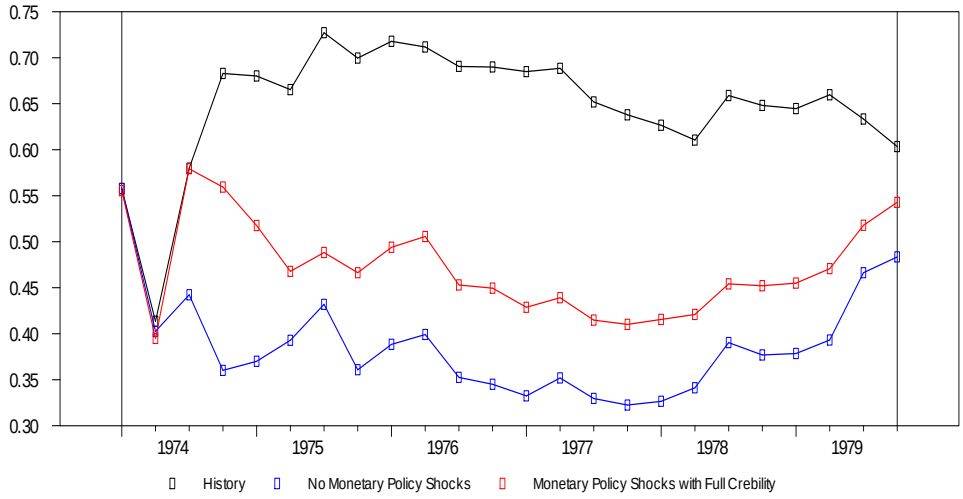


Table 1: ToTEM Parameters

Parameter	ML Estimate	Std. Error
θ	.37	0.04
θ^m	.76	0.03
θ^w	.93	0.02
γ	.70	0.04
γ^m	1.0	0.00
γ^w	.98	0.10
χ_k	61.0	0.01
χ_{com}	69.0	0.02
ξ	.80	0.04
η	.59	0.01
Γ_r	.72	0.02
Γ_π	1.61	0.06
Calibrated Parameters		
φ	1.00	-
$s_L, \Theta = \frac{\sigma \Lambda s_L}{\sigma \Lambda s_L + \epsilon(1-\Lambda s_L)}$	.50,.05	-
μ	.90	-
ρ	.10	-
σ	.50	-
ς	.01	-
ω	.025	-
$r, \beta = \frac{1}{1+r}, \Im = \frac{1+r}{2+r}$	.01,.99,0.49	-
$\epsilon, \Lambda = \frac{\epsilon}{\epsilon-1}$	11.0,1.1	-

Table 3: Rolling Phillips Curve Estimates

	Mean Rolling Estimate: 74Q1-79Q4				Long-run	
	ϕ_4	$\phi_5+\phi_6$	$\phi_7+\phi_8$	$\phi_2+\phi_3$	$\frac{\phi_5+\phi_6}{1-\Sigma\phi}$	$\frac{\phi_7+\phi_8}{1-\Sigma\phi}$
History	0.11	0.2	0.02	0.65	0.36	0.05
NPS	0.12	0.09	0.03	0.39	0.13	0.05
NTC	0.14	0.10	0.035	0.47	0.16	0.06