Discussion

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Introduction

This paper is a useful and commendable addition to the empirical literature on the New Keynesian Phillips curve (NKPC). The authors employ a method by Johansen and Swensen (1999) to estimate a hybrid version of the NKPC for Canada. This method allows detecting stochastic trends in the variables used in the estimation, as well as testing the cointegration restrictions implied by the model under rational expectations. In contrast to standard generalized method of moments and full-information maximum-likelihood methods, statistical inference remains valid when the variables used in the estimation are non-stationary.

The authors show that the hybrid NKPC provides a satisfactory description of Canadian inflation data when proxying real marginal cost by the labour share adjusted for the cost of imported inputs. The estimated weight on expected future inflation is relatively high with $\gamma_f \in [0.714, 0.729]$, confirming the importance of forward-looking price-setting behaviour on the part of firms, whereas the estimated slope coefficient is surprisingly large and varies substantially, depending on the sample period chosen with $\lambda \in [0.165, 0.415]$.[1] Moreover, the restriction that the weights on future and lagged inflation sum to unity, $\gamma_b + \gamma_f = 1$, is not rejected. As a result, the estimated relationship links changes in inflation and the level of real marginal cost. Hence, it implies a (trivial) cointegration relationship given by $[0, \lambda]$; that is, the labour share is found to be stationary, while inflation ought to follow a stochastic trend. This contrasts with the authors' initial

1. The size remains large even if one takes into account that the scale of the relevant variables has not been normalized.

finding, namely, that inflation and the labour share have a stochastic trend in common.

I focus my comments on two broader themes. First, I revisit the empirical evidence on the time-series properties of the variables used in the estimation, employing bootstrap-based inference rather than inference based on asymptotic distribution theory. Second, I provide new evidence on Canadian inflation dynamics by estimating a generalized price-setting framework, concentrating on the inflation-targeting period from 1991 to 2003, for which inflation and the labour share are found to be stationary.[2] In this context, building on Coenen and Levin (2004), I shall discern the factors that determine the slope of the price-setting equation in terms of nominal versus real rigidities. These two types of rigidities are not separately identified for the NKPC (see Eichenbaum and Fisher 2004), but they are important for gauging the particular implications of the estimated model. Moreover, I investigate whether there is a need to account for backward-looking behaviour to explain aggregate data, when the analysis is focused on the inflation-targeting period. I conclude by highlighting the importance of accounting for shifts in the monetary policy regime.

Is Inflation Really Non-Stationary?

In revisiting the time-series properties of the variables used in the estimation of the NKPC for Canada, it is useful to first take another look at the evolution of the inflation and labour-share time series, as depicted in Figure 1.

Obviously, over the full sample period from 1973 to 2003, both inflation and the labour share have been trending downwards, ruling out the possibility that inflation is stationary over that sample, but suggesting that the two variables may have possibly shared a common stochastic trend. Indeed, formal tests reported in Table 1 do not permit us to reject such a hypothesis. Here, bootstrap-based tests ought to provide more reliable inference than tests based on asymptotic distribution theory, given the unreliability of the latter in small samples.[3] However, the idea that inflation and the labour share form a cointegration relationship seems unappealing from a monetary policy perspective, to the extent that inflation should be controlled by the policy-

2. It can be shown that the generalized price-setting framework nests the standard NKPC under appropriate assumptions, notably the existence of a constant hazard rate.

3. Indeed, in the revised version (this volume) of their original paper presented at the conference, Barkbu and Batini confirm that using bootstrap-based tests tends to sharpen inference.

Figure 1
Inflation and labour-share data, 1973–2003

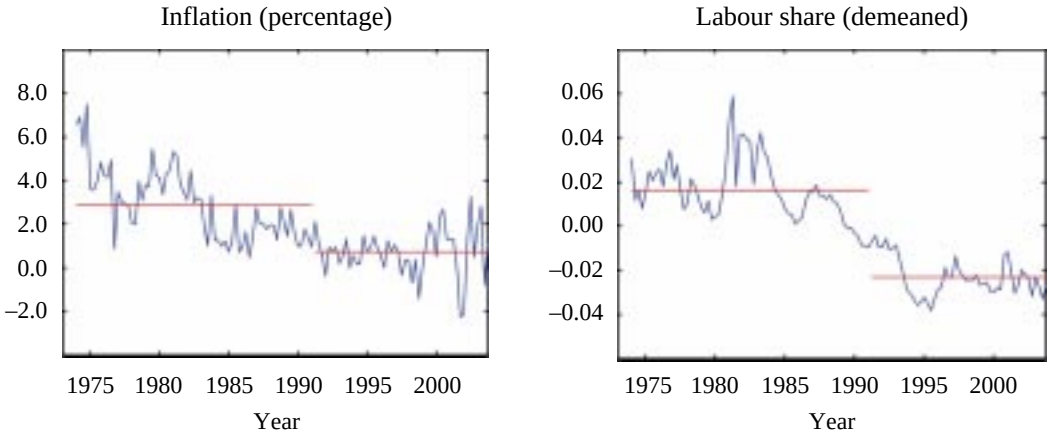


Table 1
Time-series properties of inflation, 1973–2003

Hypothesis H_0: $r = p$	Trace statistic	*p*-value (asymptotic)	*p*-value (bootstrapped)
A. Sample period 1973–2003			
$p = 0$	21.93	0.00	0.01
$p \leq 1$	2.88	0.09	0.38
B. Sample period 1973–90			
$p = 0$	13.49	0.10	0.20
$p \leq 1$	4.29	0.04	
C. Sample period 1991–2003			
$p = 0$	20.63	0.01	0.03
$p \leq 1$	6.36	0.01	0.08

Note: The asymptotic and bootstrap-based *p*-values have been computed using the program Structural VAR, Version 0.34 by Anders Warne, 2001–05.

maker, whereas the labour share is a real variable influenced by a variety of factors outside the policy-maker's realm of control.

The findings regarding the properties of the inflation and labour-share series change fundamentally when inference is confined to the subperiods from 1973 to 1990 and 1991 to 2003, respectively. For the first subsample, bootstrap-based inference lends strong support to the existence of no cointegration relationship among the series, whereas they are found to be stationary over the second subsample period. Indeed, visual inspection already tends to suggest that both inflation and the labour share have become (mean-)stationary after the move to inflation targeting in 1991 (see Figure 1). Thus, accounting for the shift in the monetary policy regime seems to be

of key importance when conducting inference with respect to the characteristics of the inflation process in Canada.

Aggregate Price-Setting Behaviour in Canada, 1991–2003

In the following section, I take another approach in analyzing the pattern of inflation dynamics in Canada, focusing on the inflation-targeting period beginning in 1991. For this period, as documented above, there appears to be rather strong evidence that both inflation and the labour share—as a proxy of real marginal cost—are stationary.

Building on Coenen and Levin (2004), I consider a generalized price-setting framework that incorporates multi-period staggered contracts of random duration and that allows identifying the influences of nominal versus real rigidities. As in Calvo (1983), every firm has the same hazard function, which determines the probability that it is permitted to reset its contract in a given period *t*. In contrast to Calvo, the hazard rate is allowed to vary with contract duration. Specifically, let ω_j denote the fraction of price contracts that have a duration of *j* periods ($j = 1, \ldots, J$), where $\omega_j \geq 0$ and $\Sigma_{j=1}^{J} \omega_j = 1$. Furthermore, assume that a firm whose contract has been in effect for *k* periods faces the probability $\Sigma_{j=1}^{k} \omega_j$ of receiving permission to reset its contract in a given period *t*; that is, the probability of receiving such permission is increasing in contract duration. Finally, for each firm that does not reset its contract in a given period *t*, its price remains unchanged; that is, there is no backward-looking element in firms' price-setting behaviour.

Starting from the standard profit-maximization condition, the price-setting decision of firms can be expressed in log-linearized form as

$$x_t = E_t\left[\sum_{i=1}^{J-1} \Phi_i \pi_{t+i} + \gamma \sum_{i=0}^{J-1} \phi_i mc_{t+i}\right] + \varepsilon_t,$$

where x_t denotes the new contract price relative to the aggregate price level, π_t is the aggregate inflation rate, while mc_t denotes the average real marginal cost across all firms in the economy (expressed as a logarithmic deviation from its steady-state value). The weights satisfy $\phi_i = \beta^i \Sigma_{j=i+1}^{J} \omega_j / (\Sigma_{j=1}^{J} \Sigma_{k=0}^{j-1} \beta^k \omega_j)$ and $\Phi_i = \Sigma_{k=i}^{J-1} \phi_k$, and β denotes the representative household's discount factor. The term ε_t represents an identically, independently distributed (i.i.d.) shock to the price-setting equation interpretable as a shock to the markup power of firms.

The slope parameter γ determines the sensitivity of the new price to aggregate real marginal cost, that is, the degree of real rigidity. Its value depends on the characteristics of the demand curve faced by price-setting

firms and the share of firm-specific inputs (see Eichenbaum and Fisher 2004). In the absence of these two sources of real rigidity, γ equals one.

The price-setting equation is complemented by the aggregate price identity, which can be expressed in log-linearized form as

$$\sum_{i=0}^{J-1} \psi_i x_{t-i} = \sum_{i=0}^{J-2} \Psi_{i+1} \pi_{t-i},$$

where the weights satisfy $\psi_i = \Sigma_{j=i+1}^{J} \omega_j / (\Sigma_{j=1}^{J} \Sigma_{k=0}^{j-1} \omega_j)$ and $\Psi_i = \Sigma_{k=i}^{J-1} \psi_k$.

I estimate this framework by applying a simulation-based indirect-inference procedure to Canadian data over the inflation-targeting period 1991–2003. Table 2 summarizes the estimation results.

The estimated distribution of contract durations reveals that aggregate price-setting behaviour is well characterized by staggered contracts with a mean duration of about two quarters. At the same time, it is found that new price contracts exhibit very low sensitivity to real marginal cost, corresponding to a high degree of real rigidity. The overidentifying restrictions imposed when estimating the generalized price-setting framework are not rejected at the 95 per cent confidence level.

To further assess the goodness of fit of the estimated model, Figure 2 presents additional diagnostics. First, as shown in the left panel of the figure, the estimated model is able to closely match the correlation structure of an unrestricted vector autoregression without including backward-looking elements. Second, as indicated in the right panel, the autocorrelogram of the price shocks does not reveal significant serial correlation, consistent with the maintained assumption of i.i.d. price shocks.

Conclusion

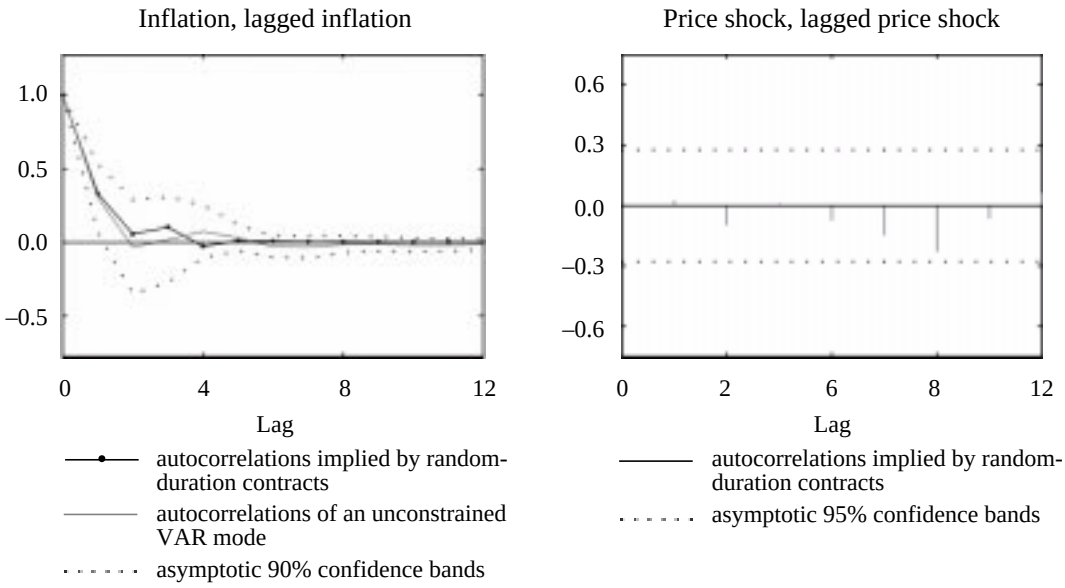
Overall, the estimates of the generalized price-setting framework with random-duration contracts confirm the main findings of the authors: Inflation dynamics in Canada is characterized by a high degree of forward-looking price-setting behaviour. In fact, backward-looking price-setting behaviour is not needed, at least in the context of a stable monetary policy regime with a transparent and credible inflation objective, as was established by the introduction of inflation targeting in 1991. Without accounting for a shift in the mean of the inflation process on that occasion, inference is likely to be misleading, since it would suggest that the degree of inflation persistence is erroneously high. At the same time, further analysis is needed

Table 2
Estimates of nominal and real rigidities, 1991–2003

Distribution of contract durations				Mean duration	Real rigidity (γ)	*p*-value
ω_1	ω_2	ω_3	ω_4			
0.29	0.49	0.06	0.16	2.09	0.0026	0.09
(0.15)	(0.19)	(0.07)	(0.11)	(0.34)	(0.0014)	

Notes: Estimated asymptotic standard errors are given in parentheses; the *p*-value refers to the asymptotic test of overidentifying restrictions.

Figure 2
Inflation dynamics and correlations of price shocks, 1991–2003



regarding the sensitivity of prices with respect to real marginal cost; that is, the slope of the NKPC.

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