Discussion

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Introduction

New Keynesian Phillips curves are widely used to assess the effects of macroeconomic policies on inflation. The basic specification of this class of Phillips curve expresses current inflation as a linear function of expected future inflation and current output gap.

Kozicki and Tinsley (2003) argue that the basic specification predicts that inflation is not sticky, given that it excludes lagged inflation. The authors also state that this prediction is controversial, since the Canadian and U.S. empirical evidence reveals that inflation is persistent.

For this reason, Kozicki and Tinsley analyze alternative sources of the lag dynamics of inflation. These alternative specifications reflect non-rational behaviour, staggered contracts, and frictions on price adjustment. These variants enrich the basic specification by including leads and lags of expected inflation and output gap. Furthermore, the basic and alternative specifications are estimated by first using the inflation rate and then the deviation of inflation from the nominal anchor. This last measure reduces to the demeaned inflation rate when there is no shift in agents' expectations of inflation targets.

The authors mainly test the null hypothesis of no serial correlation of the residuals to determine which specifications best describe the lag dynamics of inflation. Unfortunately, no specification is statistically rejected when this econometric procedure is applied for the Canadian case. Only the basic specification is clearly rejected for the U.S. case.

This discussion will first show that the basic specification can conceptually predict sticky inflation, so that it can potentially capture the actual inflation persistence. Second, alternative econometric methods are applied to better describe inflation dynamics and discriminate among the various specifications. Third, the sensitivity of the empirical results to the constructed inflation and output-gap measures and to the selected subsamples is discussed. Most of these comments are numerically illustrated by focusing on the basic specification for the Canadian experience. In that way, this discussion explores the basic source of the lag dynamics of Canadian inflation.

1 Inflation Dynamics

Consider a simple environment where agents face a number of frictions, such that they slowly adjust their prices to various target levels. This case is described by the following intertemporal planning problem:

$$\min_{p_t} E_t \sum_{j=0}^{\infty} \beta^j [(p_{t+j} - p^*_{t+j})^2 + (p_{t+j} - p_{t+j-1})^2], \tag{1}$$

$$\text{s.t. } (p^*_t - p_t) = \gamma y_t .$$

The variable p_t is the logarithm of the price index in period *t*, p^*_t is the logarithm of the target index, y_t is the output gap, and E_t is the conditional expectation operator. Also, $0 < \beta < 1$ is the subjective discount factor, whereas $\gamma > 0$ reflects the intuition that the target price increases when the output gap increases.

The first-order condition for equation (1) yields the Euler equation:

$$\pi_t = \beta E_t \pi_{t+1} + \gamma y_t , \tag{2}$$

where $\pi_t = (p_t - p_{t-1})$ is the inflation rate. Equation (2) corresponds to the basic specification of the New Keynesian Phillips curves.

Kozicki and Tinsley use equation (2) to document the inflation dynamics predicted by the basic specification. They argue that because this specification omits lagged inflation, it cannot generate the persistence observed in actual inflation.

However, the basic specification can, in fact, produce sticky inflation. This notion is illustrated by first solving forward equation (2) to yield the decision rule:

$$\pi_t = \gamma E_t \sum_{j=0}^{\infty} \beta^j y_{t+j}, \tag{3}$$

where the inflation rate corresponds to the variable of interest and the output gap is the forcing variable.

Then, consider the unrestricted first-order vector-autoregressive (VAR) process:

$$X_t = \Phi X_{t-1} + U_t, \tag{4}$$

where $X_t = (y_t, \pi_t)'$. The process (4) states that inflation Granger-causes the output gap. Such feedback implies that agents can improve their forecasts of the future output gap by taking into account the history of inflation. This captures a rich dynamic often found in the data for forcing variables, termed external dynamics (Cogley and Nason 1995). Furthermore, external dynamics are consistent with the case where the true law of motion for the output gap corresponds to an unrestricted VAR involving both the forcing variable and an exogenous hidden variable (Boileau and Normandin 2002). For these reasons, the unrestricted VAR (4) seems appropriate to construct the agents' expectations of future output gap.

Finally, substituting the constructed expectations in the decision rule yields the restricted first-order VAR:

$$X_t = \Theta X_{t-1} + V_t. \tag{5}$$

The process (5) imposes the cross-equation restrictions:

$$e_2'\Theta = \gamma e_1'(I - \beta\Phi)^{-1}\Phi \text{ and } e_2'V = \gamma e_1'(I - \beta\Phi)^{-1}U_t,$$

where $e_1' = (1, 0)'$, $e_2' = (0, 1)'$, and I is the identity matrix. These restrictions reflect the structure of the basic specification (2).

Importantly, the notion that inflation contains relevant information to forecast the future output gap is reflected in the restricted VAR (5) by feedback from lagged inflation to current inflation. Because this process includes lagged inflation, it can potentially generate the persistence observed in actual inflation rates. Accordingly, the basic specification can predict sticky inflation.

This result can be generalized by amending equations (4) and (5) to consider p-order unrestricted and restricted VARs. In this case, current inflation is predicted to be related to the first p lagged values of inflation. Again, this can yield to a substantial inflation persistence.

2 Econometric Procedure

Kozicki and Tinsley apply an econometric procedure that can be summarized as follows. They resort to survey data on inflation expectations to approximate expected future inflation. Using this proxy, they estimate the various specifications by using instrumental variable methods. They then compute the Q-statistics to test the null hypothesis of no serial correlation of the residuals. The non-rejection of the null is interpreted as evidence that the lag dynamics of inflation are appropriately described.

For the Canadian economy, the authors cannot reject the null for the basic specification as well as for each alternative specification. This indicates that every specification adequately characterizes the lag dynamics of inflation. Hence, it becomes difficult to discriminate among the various specifications. Put differently, this suggests that the test is weak.

To circumvent this problem, an alternative econometric procedure is illustrated for the basic specification. In this procedure, an unrestricted p-order VAR like equation (4) is estimated by ordinary least squares (OLS), and a restricted p-order VAR like equation (5) is constructed. These processes are used to design several tests. First, the empirical autocorrelations of inflation computed from the unrestricted VAR or from the data are statistically compared with the predicted autocorrelations generated from the restricted VAR. This provides a direct assessment of inflation persistence. Second, the empirical impulse responses of inflation to an output-gap shock induced by the unrestricted VAR are compared with the predicted responses obtained from the restricted VAR. This yields information on inflation dynamics. Third, the cross-equation restrictions $e_2'\Theta = \gamma e_1'(I - \beta\Phi)^{-1}\Phi$ are tested. The non-rejection of the null hypothesis is clearly interpreted as evidence that the lag dynamics of inflation are appropriately described by the basic specification.

These tests are applied for the Canadian economy. The quarterly data cover the 1962Q1 to 2001Q4 period and the 1992Q1 to 2001Q4 subperiod. The demeaned inflation rate is computed from last-month, yearly growth of the total CPI index. The output gap is measured from the percentage deviation of the real GDP to its HP-filter component. Note that Kozicki and Tinsley perform their analysis by using similar data over a period corresponding to our subsample. Moreover, for this subsample, it is reasonable to assume that the policy target for inflation is time-invariant and widely known. In this context, the demeaned inflation rate corresponds to the deviation of inflation from the nominal anchor.

For the full sample, the Akaike and Schwarz criteria indicate that the appropriate lag structure for the unrestricted VAR is $p = 2$. The *p*-value for the $\chi^2(2)$ statistic associated with the joint test of zero feedback from lagged inflation to the current output gap is 0.011. This Granger-causality test implies that inflation contains useful additional information for forecasting the output gap. Likewise, for the subsample, the relevant lag structure is $p = 2$, and the *p*-value is 0.032. For the full sample and the subsample, the OLS estimates of the unrestricted VARs and the calibrated values $\beta = 0.996$ and $\gamma = 0.600$ are used to construct the coefficients of the restricted VARs. Note that the discount factor, β, is set to the standard value for quarterly data. The parameter γ is fixed to the estimated values reported in Kozicki and Tinsley.

Table 1 presents the first-, second-, and fourth-order autocorrelations of inflation found in the data and induced by the restricted VARs. This table also reports the *p*-values for the $\chi^2(1)$ statistics associated with the test that the difference between empirical and predicted autocorrelations is zero, where these statistics account for the uncertainty in estimated parameters of the unrestricted VARs. For the full sample, the empirical autocorrelations reveal that actual inflation is very sticky. The predicted autocorrelations also imply that inflation is considerably persistent, but to a lesser extent than that observed in the data. Formally, the empirical and predicted first-order autocorrelations are not statistically different, but the second- and fourth-order autocorrelations are significantly different. For the subsample, similar results hold. Hence, although the basic specification (2) numerically generates highly autocorrelated inflation, it cannot statistically replicate the substantial degree of persistence in actual inflation.

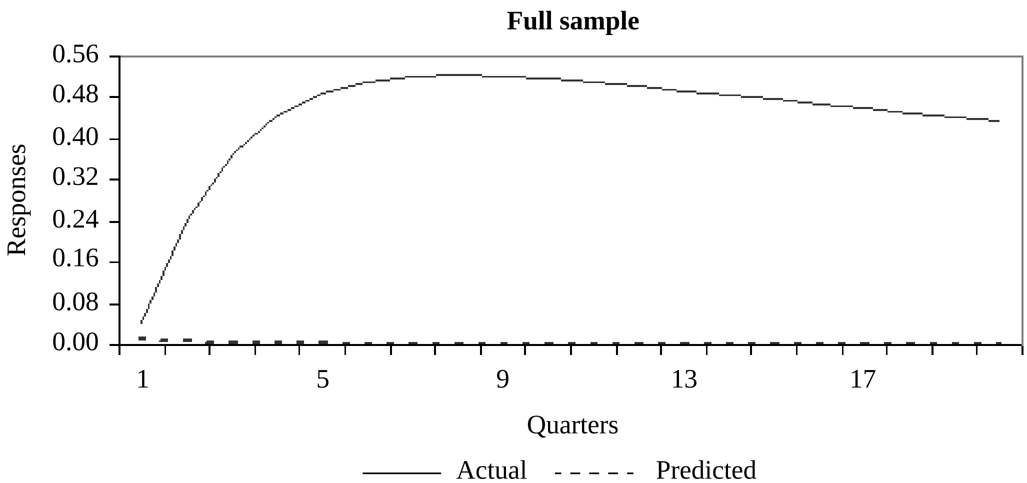
Figure 1 displays the empirical and predicted dynamic responses of inflation following a one standard-deviation output-gap shock. For the full sample, the empirical response computed from the unrestricted VAR is initially positive, increases sharply to reach a peak after eight quarters, and then declines slowly. In contrast, the predicted response obtained from the restricted VAR is close to zero for all quarters. For the subsample, similar results hold. Thus, these findings highlight that the basic specification considerably underpredicts the inflation dynamic adjustments.

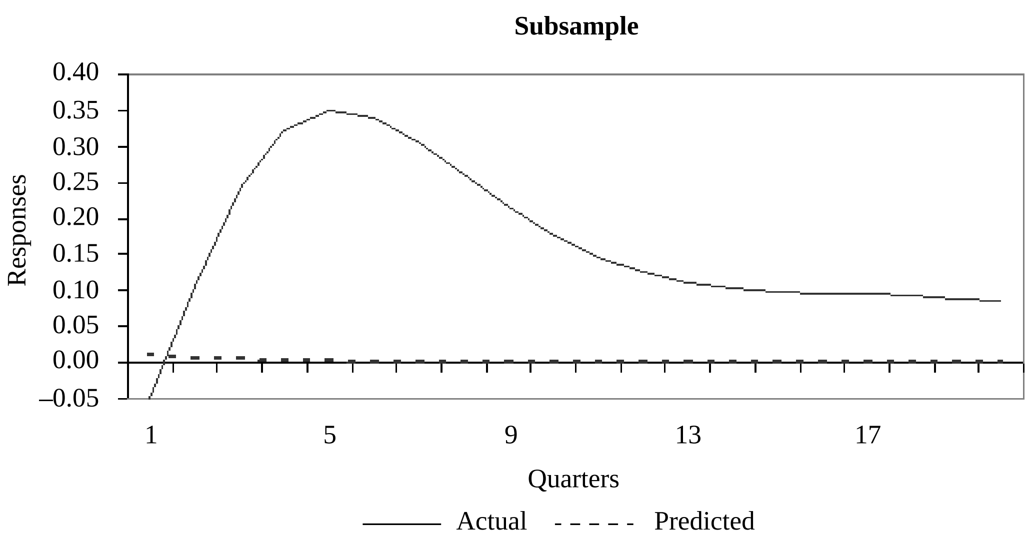
Finally, the cross-equation restrictions are tested. For the full sample, the *p*-value for the $\chi^2(8)$ statistic is 0.000. For the subsample, an identical result is obtained. Therefore, the results clearly indicate that the basic specification provides an incorrect characterization of the lag dynamics of inflation.

Table 1
Autocorrelations of inflation

	Full Sample		
	1	**2**	**4**
Empirical	0.961	0.917	0.811
Predicted	0.589	0.404	0.164
P-value	0.267	0.010	0.000
	Subsample		
	1	**2**	**4**
Empirical	0.694	0.396	–0.053
Predicted	0.483	0.342	0.087
P-value	0.737	0.336	0.001

Figure 1





Importantly, the findings reported above sharply contrast with the results found by applying the econometric procedure followed by Kozicki and Tinsley. Remember that this procedure relies mainly on testing the null hypothesis of no serial correlation in residuals. Empirically, this test never leads to the statistical rejection of the basic and alternative specifications.

3 Data

As mentioned, Kozicki and Tinsley use survey data on inflation expectations. For the Canadian case, the available data are quarterly forecasts of total CPI inflation over the post-1990 period. These data dictate which inflation measure, observation frequency, and sample period are used.

However, the selection of the measure may have important consequences for the assessment of the basic and alternative specifications. For example, it is well known that the inflation measures based on the GDP deflator and the CPI index do not conceptually reveal the same information, and as such may not exhibit similar dynamic properties. Furthermore, even the inflation measures based on the different variants of the CPI may not display the same degree of persistence. In particular, the total CPI inflation is expected to be less smooth than the core inflation, because the latter measure excludes some of the most volatile components. The core inflation seems appealing, given that this measure is used by the Bank of Canada to define the inflation targets.

The selection of the frequency may also be of interest. For example, quarterly data on inflation are presumably stickier than monthly inflation. Monthly data are likely to be more useful, given that inflation can be better monitored at this frequency by the Bank of Canada.

Moreover, the selection of the sample is important. In particular, the inflation persistence is greater for the full sample (1962Q1 to 2001Q4) than for the subsample (1992Q1 to 2001Q4). It is tempting to argue that the non-rejection of the basic and alternative specifications for the subsample occurs because it is easier to generate uncorrelated residuals when inflation is less persistent. As shown previously, however, the basic specification is clearly rejected even for the subsample, when alternative econometric tests are performed.

In brief, the selection of the inflation measure, observation frequency, and sample period is likely to affect the test results about the validity of the basic and alternative specifications. Therefore, it would appear important to document the sensitivity of the results by using several measures, frequencies, and periods. Unfortunately, the econometric procedure relying on survey data on inflation expectations confines the analysis to a unique measure, a single frequency, and a short sample. The alternative econometric method proposed above does not involve survey data, such that a sensitivity analysis can be performed.

Kozicki and Tinsley also measure the Canadian output gap as the percentage deviation of the real GDP to its HP-filter component. Strictly speaking, this measure is a proxy for marginal costs. However, the output gap is conceptually affected by both aggregate demand and supply. Furthermore, the ex post revisions of the measure of output gap are evaluated to be of the same order of magnitude as the estimated output gap itself. This problem is mainly due to the pervasive unreliability of end-of-sample estimates of the HP trend (Orphanides and van Norden 2002).

Conclusions

Kozicki and Tinsley's analysis certainly constitutes an important empirical contribution to the literature on New Keynesian Phillips curves. In particular, their study is relevant for understanding one of the most fundamental macroeconomic phenomena: the relationship between real and nominal variables. It is also most useful for macroeconomic policy-makers, and especially for monetary authorities.

In this discussion, it has been shown that the conclusions reached by Kozicki and Tinsley are sensitive to the econometric method. More explicitly, tests focusing on autocorrelations and dynamic responses of inflation as well as cross-equation restrictions seem more powerful for discriminating among the various specifications. Also, the results are potentially sensitive to the selection of the inflation and output-gap measures, observation frequency, and sample period. Overall, this strongly suggests that sensitivity analyses are required.

References

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