Discussion

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In this paper, the authors investigate the empirical relevance of the New Keynesian Phillips curve (NKPC) for Canada. The importance of this investigation is obvious. Such empirical evidence can allow us to distinguish between various theories of inflation dynamics, which in turn have crucial policy implications. For instance, the importance of the forward-looking component of inflation determines the size of disinflation costs and how monetary policy should achieve low inflation.

As suggested by recent developments in the econometric literature, important issues are involved in the estimation of the NKPC. The paper's main contribution is to provide a careful econometric analysis—the most extensive to date in this context—that acknowledges potential shortcomings of the standard Generalized Method of Moments (GMM) estimation approach.[1] The authors provide a useful warning on the application of these techniques and document the robustness of existing results to sensible perturbations in the specification and estimation approach.

Moreover, given the amount of empirical evidence for the United States, another useful contribution of this paper is that it provides further international evidence on the NKPC. International comparisons can deliver interesting insights on the mechanisms that underlie inflation dynamics. For example, different monetary experiences across countries provide an additional source of variation that could eventually help us identify important features of inflation dynamics. The Canadian experience with inflation targeting is interesting in this regard.

1. For the estimation of the NKPC, I use "standard GMM" estimation to refer to previous implementations of GMM.

The main conclusion of this paper is that the New Keynesian Phillips curve is not supported in Canada. The goal of my discussion is to better understand what might be driving the results and their implications for the health of the NKPC in Canada. In particular, I will organize my discussion around two questions.

(i) How important are the econometric issues highlighted by the authors in explaining their results?

(ii) How should we interpret the results and the fact that a specification of the NKPC is statistically rejected?

What Is the Importance of the Econometric Issues?

As has been shown theoretically and in the context of other applications, standard GMM techniques potentially suffer from significant shortcomings. This paper sets out to address some of these in the context of the estimation of the NKPC. In the end, therefore, it is important to know how significant these econometric issues are for this application.

The authors discuss several weaknesses. First, standard GMM estimation suffers from an asymptotic bias when a large number of instruments are used to estimate overidentified models.[2] Another issue concerns the number of lags used in the construction of the Newey-West estimator of the variance-covariance matrix of the moments. In many applications, the results are sensitive to this choice. Finally, there is a power issue involved with the typical implementation of the test of overidentifying restrictions. This leads the authors—based on the results of Newey and Smith (2001)—to consider bias-corrected versions of the instrumental variable (IV) and GMM estimators, and for the non-linear specification, the bias corrected version of the continuously updating estimator of Hanson, Heaton, and Yaron (1996). Moreover, they use a modification of the test of overidentifying restrictions, proposed by Hall (2000), which is known to improve its power.

All three estimators and all specifications considered by the authors yield similar results: a large forward-looking component, between 0.582 and 0.743 depending on the specification, and a positive but statistically insignificant coefficient on the marginal cost measure. For the specification using the Cobb-Douglas production function, all three estimators give essentially the same results. The overidentifying restrictions are rejected at the 10 per cent level in all cases.

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2. The estimation of the optimal linear combinations of the moments (and weighting matrix) is an important source of bias.

How do these estimates compare with those obtained from standard GMM? Since all the estimates reported in the paper are, to some extent at least, accounting for the shortcomings of standard GMM, the answer is not clear. The authors do provide Monte Carlo results for an ARMA(1,1) process to show the adverse effect of increasing the number of instruments. They also illustrate the sensitivity of the Galí and Gertler (1999) results to alternative numbers of lags in the estimation of the Newey-West weighting matrix. But, while indicative, it is not obvious how these results extend to NKPC estimation performed in the paper. How important are the shortcomings for this specific application; which one is more important; and how unreliable would standard GMM be in this context? We therefore do not know the extent to which the authors' conclusion is the result of their more accurate econometric analysis.

Gagnon and Khan (2001), however, did estimate a similar NKPC for Canada, using similar data and the standard GMM techniques. As such, their results serve as a useful benchmark. Interestingly, they reach the same conclusion for the relationship between inflation and the output-gap measure: positive but insignificant (at the 5 per cent level).[3] The main difference is that Gagnon and Khan estimate a much smaller degree of forward-looking behaviour: their estimate of γ_f is 0.492, compared to 0.713 for the comparable specification in Guay, Luger, and Zhu. This is a sizable difference. Overall, however, it seems that, if anything, the authors' results are more favourable to the NKPC than the Gagnon and Khan results based on the standard GMM techniques.

Importantly, the authors' rejection of the NKPC does not appear to be driven by their improved econometric approach. And using standard GMM would yield the same conclusion.

How Should This Evidence Be Interpreted?

As the empirical literature has shown, inflation dynamics appear to be well approximated by a reduced-form model of distributed lags of inflation, π_t, and an output-gap measure (typically detrended GDP or cyclical unemployment), denoted by x_t:[4]

$$\pi_t = a(L)\pi_{t-1} + b(L)x_{t-1} + u_t, \quad (1)$$

3. The point estimate of λ obtained by Gagnon and Khan in the Cobb-Douglas specification ($\kappa = 1$) is 0.011, compared to 0.004 in Guay, Luger, and Zhu.

4. Other variables could also potentially be part of this reduced-form specification. See, among others, Staiger, Stock, and Watson (2001).

where $a(L)$ and $b(L)$ are p^{th} order polynomial in the lag operator, L. Interestingly, this equation is also satisfied for Canada if the marginal cost is used as the measure of the output gap. In fact, estimating equation (1) on the same data set as Guay, Luger, and Zhu and selecting the lag length using the Schwarz information criterion, $(p = 3)$, yield the following estimates in Table 1.[5]

Table 1

a_1	a_2	a_3	b_1	b_2	b_3
0.398	0.177	0.127	–0.328	0.222	0.293
(0.090)	(0.251)	(0.095)	(0.391)	(0.091)	(0.239)

In particular, the coefficient of the second lag of marginal cost, b_2, is statistically significant. More generally, this marginal-cost measure appears to Granger cause inflation: the *p*-value of the Granger causality test is 0.05. These reduced-form results provide evidence of a statistically significant relationship between inflation and marginal cost in Canada. This is an important fact that we need to keep in mind while interpreting the authors' results.

To what extent is the NKPC consistent with the reduced-form expression just estimated? The simplest version of the NKPC stipulates that the structural relationship between inflation and a measure of the output gap should take the following form:[6]

$$\pi_t = \lambda mc_t + \gamma_f E_t \pi_{t+1}, \tag{2}$$

where mc_t is the marginal cost. A key feature of this variant of the NKPC is that inflation should have no backward-looking element or equivalently, should display little sluggishness. An important policy implication is that there should be no cost associated with credible disinflation.

However, this simple specification does not adequately capture the degree of persistence that inflation displays. An empirically relevant specification requires adding backward-looking elements, which leads to the hybrid NKPC:

$$\pi_t = \lambda mc_t + \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1}. \tag{3}$$

5. Standard errors are given in parentheses.
6. See Roberts (1995), Woodford (1996), and Clarida, Galí, and Gertler (2000).

The inclusion of the last term can be theoretically motivated in various ways. One approach, as in Galí and Gertler (1999), is to assume that a fraction of the price-setters are following backward-looking rule of thumb. An alternative, as in Christiano, Eichenbaum, and Evans (2001), Woodford (2002), and Boivin and Giannoni (2003), is that price-setters are following some indexing rules when they are not selected—in the Calvo set-up—to optimally change their price.[7]

Given an estimated hybrid NKPC, the question is what constitutes evidence in favour of the NKPC? First, once we acknowledge the possibility of backward-looking elements, it is not clear how important the forward-looking component has to be to provide evidence in favour of the NKPC. But clearly, the presence of a significant forward-looking component has been interpreted in the literature as probably the most important testable implication of the NKPC. Second, the NKPC emphasizes a relationship between inflation and a measure of the marginal cost, captured by λ. Theoretically, this parameter should be positive, but there is no theoretical prediction on how large it should be. But finding a statistically significant positive estimate of λ would certainly provide support to the NKPC.

Although the authors conclude that the NKPC is not supported in Canada, I would argue that the evidence is mixed. First, looking at their Tables 3, 4, and 5, the forward-looking component is always found to be more important than the backward-looking component. In fact, in many cases the point estimate of γ_f is larger than what has been reported in previous studies.[8] Since the size of γ_f is a key discriminating implication of the NKPC, this result in itself should be seen as very good news for the NKPC in Canada. Second, the estimate of the relationship between inflation and the output-gap measure, λ, has the right sign. But the problem, as the authors emphasize, comes from the fact that the estimate of λ is not found to be significant. This, together with the rejection of the overidentifying restrictions, constitutes the basis of their rejection of the NKPC for Canada.

But this absence of a statistical relationship between inflation and the marginal cost is in itself a puzzling result. Taken literally, and assuming that the specification of the hybrid NKPC nests the truth, it implies that inflation alone should be sufficient to model its dynamics. But this seems at odds with the estimate of the reduced-form Phillips curve presented above: the estimate of equation (1) shows a significant relationship between inflation

7. The inflation indexing leads to a hybrid NKPC of exactly the same form as the backward-looking price-setters, except that the restrictions on the underlying structural parameters and on the size of $_b$ are different. But that is immaterial for our discussion.

8. As already mentioned, Gagnon and Kahn (2001) report smaller estimates of γ_b.

and lags of the same marginal-cost measure, which is further supported by the Granger causality test.

This apparent inconsistency suggests the existence of a relationship between inflation and marginal cost, but the structure of the NKPC considered does not properly capture it. Rejecting the NKPC on the basis of this evidence thus requires believing that the NKPC specification considered encompasses all sensible variants consistent with the NKPC paradigm.

But this is not obviously the case. In particular, one could think of slight and sensible perturbations of the NKPC that could favourably alter the timing between inflation and marginal cost. An example of such a perturbation would be to assume that price-setters do not have access to the most current information when re-optimizing their price, as in Rotemberg and Woodford (1997); Christiano, Eichenbaum, and Evans (2001); and Boivin and Giannoni (2003), among others. This would imply that only lags of the marginal cost and inflation should be used as instruments in the estimation.[9] Other features of the structural model could also alter the form of the Phillips curve. For instance, the presence of habit formation in consumption[10] would change the nature of the theoretical relationship between marginal cost and output gap, and some forms of habit formation could even imply the presence of leads and lags of the marginal cost in the NKPC. These are all variants that have already been considered in the literature and could arguably be part of a legitimate specification of a full-fledged New Keynesian model.

Conclusions

In the end, is the NKPC supported in Canada? If by NKPC we limit ourselves to the specific hybrid form considered in this paper, we have to concur with the authors, and conclude that there is no unambiguous support for this specification. In fact, the same conclusion emerges from other results for Canada, including those of Gagnon and Khan (2001).

However, as I have attempted to emphasize, there are interesting puzzles in the authors' results. On the one hand, they find a large forward-looking component, which is favourable evidence for the NKPC. On the other hand, the failure of the NKPC comes essentially from the lack of statistical

9. This is not the version of the NKPC discussed by the authors. However, in their implementation of the estimation, it seems they do not use current values of the instruments. So their implementation could be closer to this specification. The point, however, is that these timing assumptions are not necessarily innocuous.

10. See, for example, Amato and Laubach (2001) and Boivin and Giannoni (2003).

significance of the contemporaneous relationship between inflation and the output-gap measure.

Given the statistically significant relationship between inflation and the marginal-cost measure found in the reduced-form Phillips curve, the specific structural relationship embedded in the NKPC considered in this paper is crucial to the results. But does the New Keynesian theory hinge so dramatically on this exact relationship? This is not clear. The authors' results are thus providing an important motivation to seriously investigate the implications, for the NKPC specification, of the various ingredients that have been recently added to the workhorse New Keynesian model.

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