Discussion 1

Gregor Smith

In these comments, I shall explore a number of common themes that emerged from the conference papers. My fellow rapporteurs are experts in monetary theory and monetary policy, and so I shall focus on some of the econometric questions raised by the papers. These papers are the work of skilled econometricians; consequently, my comments are intended to suggest further research directions.

Identification

At the outset of the conference, we knew (at least) two things about inflation:

(i) It is difficult to forecast. This finding is well known to researchers who fit output gaps or Phillips curves. Whether the difficulty in forecasting inflation is due to an absence of severe shocks, poor statistical specification, or good policy, is less clear.

(ii) Theories of inflation often involve variables that are not directly observable. Examples include measures of the output gap or of marginal costs. Our uncertainty about these measures carries over to uncertainty about what drives changes in the inflation rate.

The empirical conference papers all contribute to our knowledge of price adjustment. But the process of reading them "en masse" revealed a number of pitfalls in statistical identification that may warrant further study.

First, because of inflation targeting, it might be difficult to identify any Phillips curve during the 1990s. Rowe and Yetman (2002) argue that successful inflation targeting should result in changes in the rate of inflation that are unpredictable. Under inflation targeting, there is little variation in actual inflation, and so it is difficult to identify Phillips curves. This policy

environment may thus explain some of the challenges encountered by Kozicki and Tinsley and Guay, Luger, and Zhu in their impressive papers.

Second, using first-order conditions from price-setting rules may not be enough to identify their parameters. Call π_t the inflation rate and use y_t to refer to the output gap or a measure of marginal cost. The New Keynesian Phillips curve is then:

$$\pi_t = \beta E_t \pi_{t+1} + \alpha \pi_{t-1} + \gamma y_t .$$

Kozicki-Tinsley's equation (1) or Guay-Luger-Zhu's equation (9) are of this general form.

Gregory, Pagan, and Smith (1993) show that when y_t follows a random walk, β will not be identified by using instrumental variables methods. An unindentified model can be estimated, but the estimators will be inconsistent and will have a non-standard statistical distribution. A similar problem may afflict Guay-Luger-Zhu's equation (14), since it used no additional identifying information other than the difference equation. If y_t does not follow a random walk and is still persistent, β may be only weakly identified.

Stock and Wright (2000) have provided some econometric tools for GMM estimation when identification is weak. But an appealing alternative is to use information on the process followed by y_t, whether it is marginal cost or an output gap. Michel Normandin and Jean Boivin both suggest something like this in their comments. This approach requires more statistical modelling, but it may ensure that the forward-looking part of the Phillips curve is identified. Moreover, it will add to the efficiency of the estimates.

A third example of an identification problem can be illustrated with an even simpler, traditional Phillips curve:

$$\pi_t = \gamma_t y_t + \varepsilon_t ,$$

and let us imagine that the slope varies over time like this:

$$\gamma_t = \gamma - \lambda \pi_t .$$

The idea is to explore the possibility that, as inflation fell from the 1980s to the 1990s, the Phillips curve became flatter. Several of the conference papers suggest that such a shift has occurred in Canada over time, in that the Bank of Canada's improved credibility led to an improved trade-off between inflation and unemployment. Combining the two equations gives:

$$\pi_t = \gamma y_t - [\lambda \pi_t y_t - \varepsilon_t] .$$

This combination looks like a Phillips curve with a constant slope but a composite error term (in brackets) with time-varying volatility that might even mimic ARCH. It is well known that time-varying parameters can be observationally equivalent to residual heteroscedasticity.

In this example, when inflation falls, credibility rises, and the duration of contracts may rise too. In our ersatz Phillips curve, conditional volatility will fall as well, and will be correlated with the rise in duration. Thus, this example suggests that the papers on the conditional mean of inflation (Kozicki-Tinsley and Guay-Luger-Zhu) might be related to studies that focus on the volatility of inflation (Fay-Lavoie). Moreover, this evolving credibility and contract duration may explain why it is difficult to identify a Phillips curve with stable coefficients. In this case, parameter stability tests might be informative. In some cases, however, learning from single-equation methods may be too much to ask.

Information

A second theme from the empirical work of the conference is that aggregates may not provide enough information to answer many of our questions about price adjustment.

The Fay-Lavoie study is an excellent example of combining information sources from a survey. It would be valuable to have even more information on the contracts they study. Do those firms and workers take into account the durations of contracts signed recently? Is information available on the pricing decisions of those firms, so that the real-wage costs of the firm can be tracked? What are the details of COLA clauses?

While Fay and Lavoie carefully study several measures of inflation uncertainty, another measure might be that implied by derivative prices in the fixed-income market. Using this information could add to the precision of their findings.

My guess is that industry models or models with a strategic element may be useful in characterizing price adjustment. Drawing from the perspective of various price-adjustment schemes, such as those in the Kozicki-Tinsley paper, Davis and Hamilton (2002) study wholesale gasoline prices set by dealers. They find that none of the standard price-adjustment rules describes that data well and conclude that price-setting is a game of strategy between the dealers.

Using industry models to study pricing requires that attention be paid to the cross-sectional dimension of data. Researchers at the Bank of Canada

certainly have skills in working with panel data and these skills may well become increasingly valuable in macroeconomic research.

On the subject of pass-through, some additional sources of information might be worth exploring. Time-series evidence on the persistence of exchange rate changes could be combined with the Devereux-Yetman approach, because this persistence may affect the scale of pass-through and may vary across countries. A second way of adding information to pass-through studies is to focus on the prices of specific goods (rather than CPIs) and to control for shocks to exporters' costs. Goldberg and Knetter (1997) outline this approach.

In studying pass-through, Devereux and Yetman monitor how prices change in response to changes in the nominal exchange rate. I would suppose that information on the levels of the exchange rate and prices might also be useful in future studies along these lines. For example, suppose that the price of a specific good is lower in Canada than in the United States, quoted in a common currency. Consider a compact disc that costs US$15 in the United States and Can$20 in Canada. Say that the exchange rate is 65 cents (US) so that the Canadian CD price, quoted in U.S. dollars, is US$13.

Next, suppose that the Canadian dollar appreciates in nominal terms, to 68 cents (US). If one is studying aggregate pass-through using changes, one might expect Canadian prices in general to fall, towards Can$19.11 if the pass-through coefficient were unity. A smaller drop in the Canadian price would be seen as evidence of incomplete pass-through. But if one also had information on the levels, this partial response could be viewed as evidence that prices are converging in the two countries over time (since the initial Canadian price is below the U.S. price), in keeping with an integrated goods market.

Moments

Much of the empirical work in the conference papers is presented in terms of statistical moments. Although these are natural and general ways to begin comparing models with data, some of the models do so well that further information—from sample paths—seems useful. For example, an interesting question suggested by the Fay-Lavoie paper is that there is a cycle in contract duration that would appear to merit further study. Most importantly, in the Kozicki-Tinsley paper, it would be intriguing to discover whether the sample path of inflation is explained largely by the series of inflation expectations or by the output gap. To what extent is the flat path of inflation in the 1990s the result of the series of shocks, and to what extent is it the result of policy responding to shocks or anchoring expectations?

Bowman and Doyle's excellent review of the new open-economy macroeconomics shows how it has focused on moments and on matching impulse-response functions from monetary shocks. Given the speed of progress in this field, one would expect that these models will soon yield sample paths. Bowman and Doyle also describe how the preoccupation in the new open-economy macroeconomics has been with producing realistic price and exchange rate movements in response to exogenous monetary shocks. Again, one would expect that these models will soon include other shocks, with monetary policy in part responding to them. Scott Hendry made a similar observation in his comments on the Alexopoulos paper.

Policy Effectiveness

The effectiveness of monetary policy emerges as a common theme in many of the statistical results. Fay and Lavoie conclude that contract duration has increased as inflation uncertainty has fallen. Kozicki and Tinsley find that the credibility of inflation targets appears to have increased during the 1990s. Their best-fitting Phillips curve is also quite flat. The best-fitting model in the Alexopoulos paper features partial employment insurance. In that model, a monetary policy shock produces relatively large changes in output, employment, and investment, with little response in inflation. Moreover, these results do not require an unrealistically large wage elasticity of labour supply. In a similar vein, the studies by Devereux and Yetman and by Bowman and Doyle document the surprisingly low pass-through of exchange rate changes into domestic prices. Again, this stickiness is consistent with monetary policy shocks having large real effects.

The good news is that all of these findings remind us that inflation targeting is consistent with stabilization policy—provided that there is some kind of Phillips curve—and that monetary policy certainly has real effects. The bad news is that relatively small deviations from an inflation target may be associated with relatively large movements in real activity, if the short-run Phillips curve has become flatter over time. This environment seems to demand great vigilance from policy-makers.

I will conclude on an optimistic note about research on price adjustment. It is clear from these thought-provoking conference papers that developments in applied econometrics and in general-equilibrium modelling are converging. At a Bank of Canada conference in the near future, we shall see a range of general-equilibrium models that allow welfare analysis and the calculation of optimal policies, and that also fit many key features of the time series from economic history.

References

Davis, M. and J.D. Hamilton. 2002. "Why Are Prices Sticky? The Dynamics of Wholesale Gasoline Prices." Department of Economics, University of California, San Diego. Photocopy.

Goldberg, P.K. and M.K. Knetter. 1997. "Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature* 35 (3): 1243–272.

Gregory, A.W., A.R. Pagan, and G.W. Smith. 1993. "Estimating Linear-quadratic Models with Integrated Processes." In *Models, Methods, and Applications of Econometrics*: *Essays in Honor of A.R. Bergstrom*, edited by P.C.B. Phillips, 220–39. Oxford: Blackwell.

Rowe, N. and J. Yetman. 2002. "Identifying a Policymaker's Target: An Application to the Bank of Canada." *Canadian Journal of Economics* 35 (2): 239–56.

Stock, J.H. and J.H. Wright. 2000. "GMM with Weak Identification." *Econometrica* 68 (5): 1055–96.