Old and New Phillips Curves

Bengt Assarsson 2008-09-22

Old Phillips curves

As much else in macroeconomics the development of theory started up with some empirical observations, as was originally the case with Phillips observations from 1954. We can do a similar exercise with data from the Swedish economy, showing the rate of inflation and the unemployment rate for the period 1981-2007.

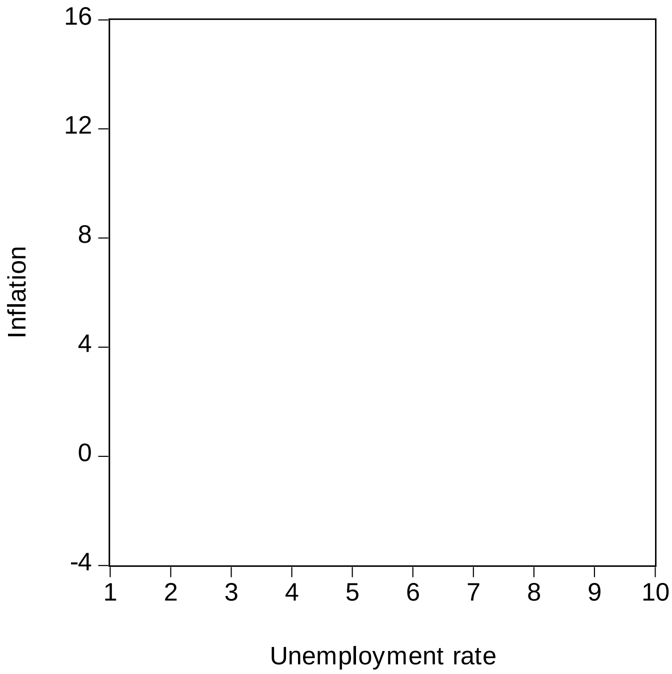

Diagram 1. Inflation (CPI) and the open unemployment rate in Sweden 1981-2007.

A regression line has been fitted to the observations and as can be seen (though not obvious upon eye inspection) there is a negative relationship, as was recognized by Phillips and others. However, Friedman and Phelps brought expectations into the picture and unemployment were merely affected by unexpected inflation. Fully expected inflation would have small or no effect on real variables.

A general specification would be the curve $\pi_t = E_{t-1}\{\pi_t\} + \lambda\left(Y_t - \overline{Y}_t\right) + z_t$, where $\overline{Y}_t$ is potential output and z_t a supply shock.

The New Keynesian Phillips Curve (NKPC)

The distinguishing feature of the NKPC is that it is derived from first principles, from the optimizing behavior of representative agents, households and firms. The basic model is based on the (Calvo, G. A. 1983) pricing scheme in which in period t a fraction $1-\theta$ of the firms reset the optimal price P_t^* and the fraction θ keeps the price fixed $P_t = P_{t-1}$. The optimizing firm resetting its price chooses its price such that the expected future profits during the time the price is expected to be kept fixed are maximized, where the period profits are weighted by the probability that the price is kept fixed, weights that are declining with the (infinite) horizon. The basic model is described by (Gali, J. and M. Gertler 1999) and (Clarida, R., J. Gali and M. Gertler 1999) and is developed for a closed economy and with sticky prices only for product prices while wages are assumed flexible. The resulting Phillips curve is

$$\pi_t = \beta E_t \left\{ \pi_{t+1} \right\} + \lambda \left(mc_t - mc \right) \tag{1}$$

where β is the discount rate, α the capital share and ε the price elasticity of demand

$$\lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta} \frac{(1-\alpha)}{(1-\alpha+\alpha\varepsilon)} = \frac{(1-0.67)(1-0.99\cdot 0.67)}{0.67} \frac{(1-0.33)}{(1-0.33+0.33\cdot 6)} = 0.085$$

with the parameters assumed numerical values are according to (Gali, J. 2008). The marginal cost term refer to the nominal marginal cost minus the price level (in logarithms), $mc_t = mc_t^n - p_t$, and *mc* refer to the marginal cost in steady state so that all variables are expressed as deviations from this steady state, which in the basic model also means stable prices, i.e. $\pi = 0$. With the simple production structure that is usually assumed in these models one can also show that there is a simple linear relationship between the marginal cost term and the output gap

$$mc_t - mc = \left(\sigma + \frac{\varphi + \alpha}{1-\alpha} \right) \left(y_t - y_t^n \right) \tag{2}$$

where σ and φ are defined by the specific period utility function $U(C_t, N_t) = \frac{C_t^{1-\sigma}}{1-\sigma} \frac{N_t^{1+\varphi}}{1+\varphi}$ where C_t is the consumption level and N_t is the number of hours worked. Substituting (2) into (1) we get the alternative specification of the Phillips curve as

$$\pi_t = \beta E_t \left\{ \pi_{t+1} \right\} + \kappa \left(y_t - y_t^n \right) \tag{3}$$

where

$$\kappa \equiv \lambda \left(\sigma + \frac{\alpha + \varphi}{1-\alpha} \right) = 0.254$$

when it is assumed that $\sigma = \varphi = 1$ meaning log utility and a unitary Frisch elasticity of labor supply. So we can note that the use of the output gap instead of the real marginal cost gap gives a parameter for the latter that can be assumed to be considerably smaller than when the output gap is used instead. If we assume rational expectations all information is used and the unexpected rate of inflation can be assumed to be an unpredictable stochastic variable u_t with zero mean. That means

$$E_t \left\{ \pi_{t+1} \right\} = \pi_{t+1} - u_t \tag{4}$$

and if we substitute (4) into (3) we obtain

$$\pi_t = \beta\pi_{t+1} + \kappa\left(y_t - y_t^n\right) - \beta u_t \tag{5}$$

which could be estimated with some suitable econometric technique. A number of studies have done that. The specification (5) has been criticized since it doesn't fit the stylized facts obtained e.g. by estimating VAR models. In particular, it seems as if the forward-looking specification does not account for the persistence in inflation actually found in the data. Some simulations show that there is too little persistence in inflation after the economy is hit by a nominal shock. In the paper by (Gali, J. and M. Gertler 1999) a lagged inflation term is added to the basic model and their model becomes

$$\pi_t = \beta\pi_{t+1} + \gamma\pi_{t-1} + \lambda\left(mc_t - mc\right) - \beta u_t \tag{6}$$

(Gali, J. and M. Gertler 1999) also emphasize that the gap term should be estimated as the marginal cost gap and not as the output gap. They also conclude that though the lagged term appears statistically significant, it lacks economic importance since it appears much smaller than the forward-looking term.

There has been a discussion about the forward-looking or backward-looking aspects of the Phillips curve and the results in the empirical papers are mixed, some in favor of the forward and others in favor of the backward looking specification. While the (Gali, J. and M. Gertler 1999) paper introduces the backward-looking aspects as "rule-of-thumb" behavior in an *ad hoc* manner, the paper by (Mankiw, N. G. and R. Reis 2002) explains it by "sticky information" in a way very similar to the concept of "sticky prices" of the (Calvo, G. A. 1983) style as in the basic model.

Papers that favors the forward-looking model as compared to the backward-looking model are (Benati, L. 2008), (Brissimis, S. N. and N. S. Magginas 2008), (Cogley, T. and A. M. Sbordone 2006), (Gali, J. and M. Gertler 1999), (Gali, J., M. Gertler and J. D. Lopez-Salido 2005), (Dupuis, D. 2004), (Sbordone, A. M. 2005), (Yazgan, M. E. and H. Yilmazkuday 2005),

Papers that favors the backward-looking model as compared to the backward-looking model are (Andres, J., J. D. Lopez-Salido and E. Nelson 2005), (Henzel, S. and T. Wollmershauser 2006), (Klenow, P. J. and J. L. Willis 2007), (Nason, J. M. and G. W. Smith 2005), (O'Reilly, G. and K. Whelan 2005), (Rudd, J. and K. Whelan 2005),

(Jondeau, E. and H. Le Bihan 2005) and (Benigno, P. and J. D. Lopez-Salido 2006) show that the forward-looking component is dominant in some countries while the backward-looking component is dominant in other countries while others, e.g. (Linde, J. 2005) or (Paloviita, M. 2006), accounts for both backward and forward-looking components. (Zhang, C., D. R. Osborn and D. H. Kim 2008) find evidence of structural shifts in US data, such that the NKPC fits more or less good during different time periods.

To summarize, the empirical evidence is certainly mixed favoring one or the other or possibly both of the backward and forward looking components.

The sticky information Phillips curve

We now turn to a theory of the backward looking Phillips curve, proposed by (Mankiw, N. G. and R. Reis 2002) and and denoted the sticky information Phillips curve (SIPC).

(Mankiw, N. G. and R. Reis 2002) assumed that each period a fraction of the firms updates on the current state of the economy and computes optimal prices based on that information. The rest of the firms continues to set prices based on old plans and outdated information. As in the (Fischer, S. 1977) model with long-term contracts, the current price level depends on expectations of the current price level formed far in the past. In the Fischer model, those expectations mattered because they were built into contracts. In the Mankiw/Reis model, they matter because some price setters are still setting prices based on old decisions and old information.

In the SIPC model every firm sets its price every period, but firms gather information and recompute optimal prices slowly over time. In each period, a fraction γ of firms obtains new information about the state of the economy and computes a new path of optimal prices. Other firms continue to set prices based on old plans and outdated information. It is also assumed that each firm has the same probability of being one of the firms updating their pricing plans, regardless of how long it has been since its last update, which is in analogy with the assumption in the Calvo model regarding the fraction of firms that reset their prices.

As in the NKPC, a firm's optimal price is

$$p_t^* = p_t + \lambda\left(y_t - y_t^n\right) \qquad (7)$$

A firm that last updated its plans j periods ago sets the price

$$x_t^j = E_{t-j}\left\{p_t^*\right\} \qquad (8)$$

Aggregating over all firms yields

$$p_t = \gamma \sum_{j=0}^{\infty} (1-\gamma)^j x_t^j \qquad (9)$$

and the three equations taken together gives

$$p_t = \gamma \sum_{j=0}^{\infty} (1-\gamma)^j E_{t-j}\left\{p_t + \lambda(y_t - y_t^n\right\} \qquad (10)$$

which can be transformed to the SIPC Phillips curve

$$\pi_t = \left[\frac{\gamma\lambda}{1-\gamma}\right]\left(y_t - y_t^n\right) + \gamma \sum_{j=0}^{\infty} (1-\gamma)^j E_{t-1-j}\left\{\pi_t + \lambda\Delta\left(y_t - y_t^n\right)\right\} \qquad (11)$$

Inflation depends on output, expectations of inflation, and expectations of output growth. Though the same arguments as in the NKPC, now the timing of expectations is different, since it is the past expectations of current economic conditions that govern behavior. This yields large differences in the dynamic pattern of prices and output in response to monetary policy.

According to Mankiw/Reis there are several advantages with this backward-looking Phillips curve. One advantage is that the dynamics in the curve is more consistent with the dynamics found in data, in particular with the persistence in inflation. This has been confirmed by other authors, see e.g. (Klenow, P. J. and J. L. Willis 2007), though not by all, see for instance (Yazgan, M. E. and H. Yilmazkuday 2005).

(Gali, J. and M. Gertler 1999, Mash, R. 2002, McAdam, P. and A. Willman 2007, Mehra, Y. P. 2004, Rumler, F. 2007) use specifications that nests the forward and backward looking models, such that tests of the models can be done. Though not the case in (Mankiw, N. G. and R. Reis 2002) they suggest four advantages with the SIPC, based on the fit with data: First, disinflations are always contractionary (although announced disinflations are less contractionary than surprise ones). Second, monetary policy shocks have their maximum impact on inflation with a substantial delay (yields persistence in inflation in accordance with stylized facts). Third, the change in inflation is positively correlated with the level of economic activity. Fourth, the SIPC is consistent with the natural rate hypothesis, i.e. monetary shocks cannot affect real variables in the long run (the McCallum critique, see (McCallum, B. T. 1998)).

(Mankiw, N. G. and R. Reis 2002) run simulations based on the sticky price model (3), the sticky information model (11) and the conventional backward-looking model

$$\pi_t = \pi_{t-1} + \kappa\left(y_t - y_t^n\right) \tag{12}$$

They run simulations with the three models, assuming parameter values in line with the ones assumed in the basic new Keynesian model simulated in (Gali, J. 2008). (Mankiw, N. G. and R. Reis 2002) assume $\kappa = 0.0083$ (for simulated quarterly data), which is based on the assumption that firms update their information/resets their price once a year, which is consistent with the results earlier presented from micro studies such as (Blinder, A. S. and et al. 1998).

The results from their simulations are presented in diagram 1. The impact of the fall in demand on output dies off after sixteen quarters. The backward-looking model generates an oscillatory pattern, whereas the other two models yield monotonic paths. Otherwise, the models seem to yield similar results.

The differences between the models are then illuminated when the response of inflation in the bottom of Diagram 1 is studied. The greatest impact of the fall in demand on inflation occurs immediately in the sticky price model. The other two models show a more gradual response. In the sticky-information model, the maximum impact of the fall in demand on inflation occurs at seven quarters.

The inertial behavior of inflation in the sticky-information model requires the parameter λ to be less than one. If $\lambda = 1$, then the desired price moves only with aggregate demand. In this case, firms adjust their prices immediately upon learning of the change in policy; as a result, inflation responds quickly (much as it does in the sticky-price model). By contrast, if $\lambda < 1$, then firms also care about the overall price level and, therefore, need to consider what information other firms have. For small λ, even an informed firm will not adjust its price much to the change in aggregate demand until many other firms have also learned of it. A small value of a can be interpreted as a high degree of real rigidity (to use the terminology of Ball and Romer [1990]??) or a high degree of strategic complementarity (to use the terminology of

Cooper and John [1988]??). In the sticky-information model, this real rigidity (or strategic complementarity) is a source of inflation inertia.

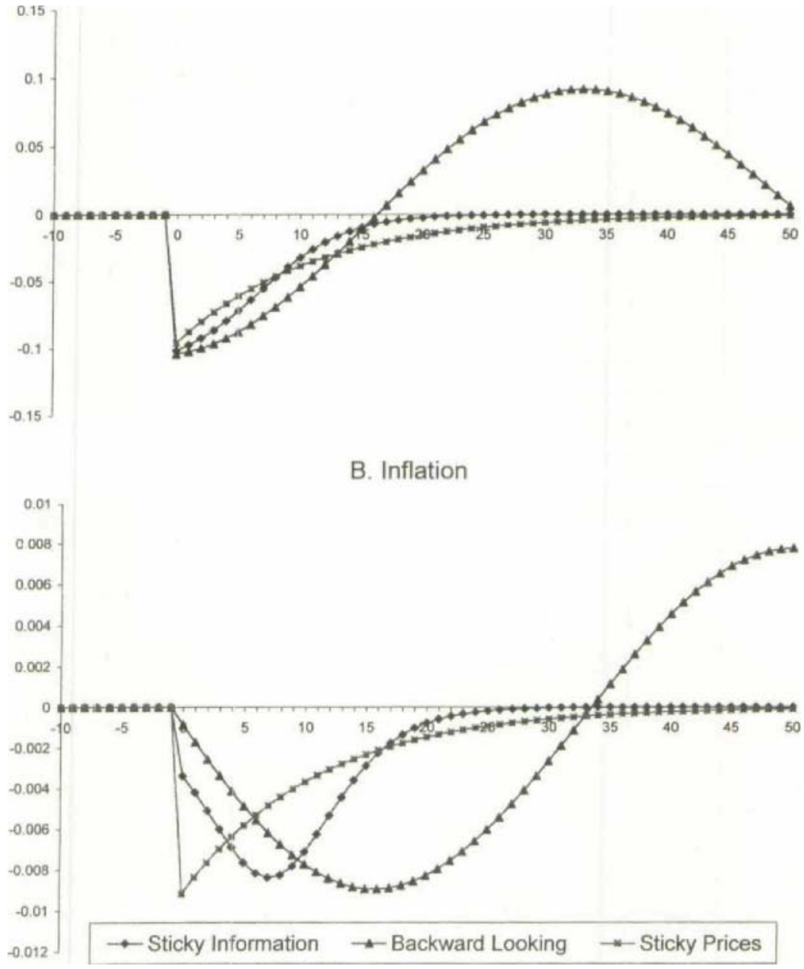

Diagram 1. Dynamic Paths after a 10 Percent Fall in the Level of Aggregate Demand at Time 0. Source: (Mankiw, N. G. and R. Reis 2002).

Mankiw and Reis then perform a number of simulations based on more realistic shock patterns, such as more or less persistent monetary policy shocks of the type performed by (Gali, J. 2008). Their conclusion is that the sticky price model yields more realistic effects, particularly in the inflation response and therefore is more consistent with data.

Phillips curve estimation

The old and new Phillips curve have been estimated in a large number of empirical studies through the years since Phillips own study in 1954. It is an important task since the particular estimates can be used in policy analysis and simulations and has been shown to be very important for instance when determining optimal monetary policy rules. Whether the obtained estimates are robust or not is therefore also an important question. Sad to say, the overall picture of the estimations done so far is that the picture is very mixed and that there does not seem to be a particular models that clearly beat all other models.

We now turn to the more explicit question of how to estimate the Phillips curves that we have just discussed. Let us recall and start with the hybrid curve discussed by several authors:

$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} + \gamma E_{t-1}\left\{\pi_t\right\} + \lambda\left(mc_t - mc\right) \quad (13)$$

which can also be approximated with

$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} + \gamma E_{t-1}\left\{\pi_t\right\} + \kappa\left(y_t - y_t^n\right) \quad (13')$$

with the marginal cost gap replaced by the output gap. As noted above, assuming rational expectations we could estimate the NKPC in (5). Both the NKPC and the SIPC use the hypothesis of rational expectations and we could use that assumption in (13) as well.

A generalized so called hybrid model proposed by (Gali, J. and M. Gertler 1999) and extensively estimated by (Gali, J., M. Gertler and J. D. Lopez-Salido 2005) is based on the (Calvo, G. A. 1983) model but in addition assumes that from the fraction $1-\theta$ firms that are able to reset their price only a fraction $1-\varpi$ will do so while a fraction ϖ instead use a rule-of-thumb that makes them set the price equal to the average of recently (last period) adjusted prices plus an adjustment for expected inflation, based on lagged inflation π_{t-1}. This reasoning yields the hybrid curve

$$\pi_t = \lambda\left(mc_t - mc\right) + \gamma_f E_t\left\{\pi_{t+1}\right\} + \gamma_b \pi_{t-1} + \varepsilon_t \quad (14)$$

where

$$\begin{aligned} \lambda &= (1-\varpi)(1-\theta)(1-\beta\theta)\phi^{-1} \\ \gamma_f &= \beta\theta\phi^{-1} \\ \gamma_b &= \varpi\phi^{-1} \end{aligned}$$

and $\phi = \theta + \varpi\left[1-\theta(1-\beta)\right]$ with ε_t an error term.

(Gali, J. and M. Gertler 1999) estimate (14) and find the coefficient λ on real marginal cost positive and statistically significant. They also find the coefficient γ_b statistically greater than zero, implying that the pure forward-looking model is rejected by the data and finally that forward-looking behavior is dominant since the sum of the coefficients γ_f and γ_b is close to unity, with the coefficient on lagged inflation, γ_b,in the interval 0.2 to 0.4. These estimates suggest that the influence of backward-looking behavior on inflation, while statistically significant, is nonetheless quantitatively modest and that the New Keynesian Phillips curve provides useful insights into the nature of inflation dynamics.

A significant corollary result is that the use of real marginal cost as the relevant real sector forcing variable in the hybrid NKPC (as the theory suggests) is critical to the empirical success. Specifications based instead on ad-hoc “output gap” measures (e.g., detrended log GDP) do not perform well: The coefficient on the output variable is either insignificant or significant but with the wrong sign. The reason for the lack of success of this formulation could be that detrended output is a bad proxy for real marginal cost.

Most authors estimate the Phillips curve as a single equation. However, since the marginal cost (or the output gap) are endogenous variables, determined in the basic Keynesian macro model, they cannot use the most simple estimator (Ordinary Least Squares) but instead use an instrumental variables technique (such as General Methods of Moments or 2 Stage Least Squares) in which variables that determine the output gap are included in the list of instruments (typically variables in the dynamic IS curve and in the monetary policy rule).

However, this procedure could be felt too restrictive and some authors instead prefer to estimate the Phillips curve simultaneously with other equations (which then perhaps could be the IS curve and the monetary policy rule). One such attempt is (Linde, J. 2005). He estimates a 3-equation model with a dynamic IS curve as well as a simple monetary policy rule:

$$\pi_t = \omega_f \mathrm{E}_t \pi_{t+1} + (1-\omega_f)\pi_{t-1} + \gamma y_t + \varepsilon_{\pi,t},$$

$$y_t = \beta_f \mathrm{E}_t y_{t+1} + (1-\beta_f)\Sigma_{i=1}^{4}\beta_{y,i} y_{t-i} - \beta_r(R_t - \mathrm{E}_t \pi_{t+1}) + \varepsilon_{y,t},$$

$$R_t = (1 - \Sigma_{i=1}^{3}\rho_i)(\gamma_\pi \pi_t + \gamma_y y_t) + \Sigma_{i=1}^{3}\rho_i R_{t-i} + \varepsilon_{R,t}$$

with more or less obvious notations, and finds that in this case the backward-looking term is more important than the forward-looking component. However, Linde uses a simple trend (HP-gap) for the output gap and some authors have found the output gap to be a poor approximation to the marginal cost gap, as noted above.

How this well may be, here is another argument in favor of the simultaneous approach. It is often assumed that the forms of the utility and production functions are very simple in the new Keynesian models, as described above. Many authors have stressed the importance of using the marginal cost gap rather than the output gap. However, the marginal cost gap is then, due to the simple production structure, simply estimated as the labor share, see for instance (Batini, N., B. Jackson and S. Nickell 2005, Gali, J. and M. Gertler 1999). Another possibility would be to use a more flexible production structure, as stressed in the literature on estimating demand systems, production functions, etc. A natural starting point is then the firms' cost function, $C(Y,\Omega)$, where Ω is a vector with input prices. For a flexible functional form we then know that the marginal cost is the partial derivative $\dfrac{\partial C(Y,\Omega)}{\partial Y} = C_Y^{'}(Y,\Omega)$ and the demand for input *i* the partial derivative $\dfrac{\partial C(Y,\Omega)}{\partial \Omega_i} = q_i = C_{\Omega_i}^{'}(Y,\Omega)$. Through estimating the Phillips curve simultaneously with the factor demand functions the specific cross-equation restrictions implied by flexible functional forms can be used. A popular and empirically successful form is the Translog cost function (see for instance (Berndt, E. R. and L. R. Christensen 1973))

$$c = a_0 + \sum_i a_i\omega_i + \frac{1}{2}\sum_i\sum_j a_{ij}\omega_i\omega_j + \sum_i b_i\omega_i y + 0.5gy^2 \tag{15}$$

where all variables are expressed in logs and ω_i is the log of the ith input price. Marginal cost is

$$mc^n = \left[\sum_i b_i\omega_i + gy\right]\frac{C}{Y} \tag{16}$$

and the demand functions

$$S_i = a_i + \sum_j a_{ij}\omega_j + b_i y \qquad (17)$$

where S_i is the share of the ith input. The *b* parameters appear in both the Phillips curve and the factor demand functions.

These functions could be estimated in levels form instead of as deviations from steady state, which is the dominant procedure. This has been shown by (McAdam, P. and A. Willman 2007). The interested reader is also recommended to see the special issue of *Journal of Monetary Economics,* 2005, especially devoted to the estimation of the NKPC.

References

ANDRES, J., J. D. LOPEZ-SALIDO, and E. NELSON (2005): "Sticky-Price Models and the Natural Rate Hypothesis," *Journal of Monetary Economics*, 52, 1025-1053.

BATINI, N., B. JACKSON, and S. NICKELL (2005): "An Open-Economy New Keynesian Phillips Curve for the U.K," *Journal of Monetary Economics*, 52, 1061-1071.

BENATI, L. (2008): "Investigating Inflation Persistence across Monetary Regimes," European Central Bank, Working Paper Series: 851, 55 pages.

BENIGNO, P., and J. D. LOPEZ-SALIDO (2006): "Inflation Persistence and Optimal Monetary Policy in the Euro Area," *Journal of Money, Credit, and Banking*, 38 3, 587-614.

BERNDT, E. R., and L. R. CHRISTENSEN (1973): "The Translog Function and the Substitution of Equipment, Structures, and Labor in U.S. Manufacturing 1929-68," *Journal of Econometrics*, 1, 81-113.

BLINDER, A. S., and ET AL. (1998): *Asking About Prices: A New Approach to Understanding Price Stickiness*. New York: Russell Sage Foundation.

BRISSIMIS, S. N., and N. S. MAGGINAS (2008): "Inflation Forecasts and the New Keynesian Phillips Curve," *International Journal of Central Banking*, 4, 1-22.

CALVO, G. A. (1983): "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12, 383-398.

CLARIDA, R., J. GALI, and M. GERTLER (1999): "The Science of Monetary Policy: A New Keynesian Perspective," *Journal of Economic Literature*, 37, 1661-1707.

COGLEY, T., and A. M. SBORDONE (2006): "Trend Inflation and Inflation Persistence in the New Keynesian Phillips Curve," Federal Reserve Bank of New York, Staff Reports: 270.

DUPUIS, D. (2004): "The New Keynesian Hybrid Phillips Curve: An Assessment of Competing Specifications for the United States," Bank of Canada, Working Papers, 36 pages.

FISCHER, S. (1977): "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule," *Journal of Political Economy*, 85 1, 191-205.

GALI, J. (2008): *Monetary Policy, Inflation, and the Business Cycle*. Princeton: Princeton University Press.

GALI, J., and M. GERTLER (1999): "Inflation Dynamics: A Structural Econometric Analysis," *Journal of Monetary Economics*, 44, 195-222.

GALI, J., M. GERTLER, and J. D. LOPEZ-SALIDO (2005): "Robustness of the Estimates of the Hybrid New Keynesian Phillips Curve," *Journal of Monetary Economics*, 52, 1107-1118.

HENZEL, S., and T. WOLLMERSHAUSER (2006): "The New Keynesian Phillips Curve and the Role of Expectations: Evidence from the Ifo World Economic Survey," CESifo GmbH, CESifo Working Paper Series: CESifo Working Paper No. 1694.

JONDEAU, E., and H. LE BIHAN (2005): "Testing for the New Keynesian Phillips Curve: Additional International Evidence," *Economic Modelling*, 22 3, 521-50.

KLENOW, P. J., and J. L. WILLIS (2007): "Sticky Information and Sticky Prices," *Journal of Monetary Economics*, 54, S79-99.

LINDE, J. (2005): "Estimating New-Keynesian Phillips Curves: A Full Information Maximum Likelihood Approach," *Journal of Monetary Economics*, 52, 1135-1149.

MANKIW, N. G., and R. REIS (2002): "Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve," *Quarterly Journal of Economics*, 117, 1295-1328.

MASH, R. (2002): "New Keynesian Microfundations Revisited: A Generalised Calvo-Taylor Model and the Desirability of Inflation Vs. Price Level Targeting," University of Oxford, Department of Economics, Economics Series Working Papers: 109.

MCADAM, P., and A. WILLMAN (2007): "State-Dependency and Firm-Level Optimization - a Contribution to Calvo Price Staggering," European Central Bank, Working Paper Series: 806, 32.

MCCALLUM, B. T. (1998): "Stickiness: A Comment," *Carnegie-Rochester Conference Series on Public Policy*, 49, 357-63.

MEHRA, Y. P. (2004): "The Output Gap, Expected Future Inflation and Inflation Dynamics: Another Look," Federal Reserve Bank of Richmond, Working Paper: 04-06.

NASON, J. M., and G. W. SMITH (2005): "Identifying the New Keynesian Phillips Curve," Queen's University, Department of Economics, Working Papers: 1026, 46 pages.
O'REILLY, G., and K. WHELAN (2005): "Has Euro-Area Inflation Persistence Changed over Time?," *Review of Economics and Statistics*, 87 4, 709-20.
PALOVIITA, M. (2006): "Inflation Dynamics in the Euro Area and the Role of Expectations," *Empirical Economics*, 31 4, 847-60.
RUDD, J., and K. WHELAN (2005): "New Tests of the New-Keynesian Phillips Curve," *Journal of Monetary Economics*, 52, 1167-1181.
RUMLER, F. (2007): "Estimates of the Open Economy New Keynesian Phillips Curve for Euro Area Countries," *Open Economies Review*, 18 4, 427-51.
SBORDONE, A. M. (2005): "Do Expected Future Marginal Costs Drive Inflation Dynamics?," *Journal of Monetary Economics*, 52 6, 1183-97.
YAZGAN, M. E., and H. YILMAZKUDAY (2005): "Inflation Dynamics of Turkey: A Structural Estimation," *Studies in Nonlinear Dynamics and Econometrics*, 9 1, 1-13.
ZHANG, C., D. R. OSBORN, and D. H. KIM (2008): "The New Keynesian Phillips Curve: From Sticky Inflation to Sticky Prices," *Journal of Money, Credit, and Banking*, 40, 667-699.