ANO 2002/14

Working Paper

Research Department

A Note on Inflation Persistence

by

Steinar Holden and John C. Driscoll

A Note on Inflation Persistence

by

Steinar Holden
University of Oslo and Norges Bank
Department of Economics, University of Oslo
Box 1095 Blindern, 0317 Oslo, Norway
email: steinar.holden@econ.uio.no
homepage: http://folk.uio.no/~sholden/

and

John C. Driscoll
Brown University and NBER
Department of Economics, Brown University
Box B, Providence RI 02912
Email: John_Driscoll@alum.mit.edu

Abstract

Macroeconomists have for some time been aware that the New Keynesian Phillips curve, though highly popular in the literature, cannot explain the persistence observed in actual inflation. We argue that one of the more prominent alternative formulations, the Fuhrer and Moore (1995) relative contracting model, is highly problematic. Fuhrer and Moore (1995)'s formulation generates inflation persistence, but this is a consequence of their assuming that workers care about the past real wages of other workers. Making the more reasonable assumption that workers care about the current real wages of other workers, one obtains the standard formulation with no inflation persistence.

JEL Classification: E31, E3, E5.
Keywords: Inflation persistence

In an important paper, Fuhrer and Moore (1995) showed that the standard formulation of staggered wage setting due to Taylor (1980) implied price stickiness, but not inflation stickiness. Fuhrer and Moore proposed a new formulation, which they referred to as the relative contracting model, which exhibits persistence in inflation. Fuhrer and Moore then showed that the relative contracting model is consistent with US macroeconomic data for inflation and output, while the standard contracting model of Taylor is resoundingly rejected.

Fuhrer and Moore made an important contribution to the literature by showing the empirical weakness of the Taylor model, and by proposing a simple resolution to the problem with a seemingly reasonable justification. The model they proposed has clear advantages, being a convenient analytical formulation that fits the data. Consequently, it has been widely used in the literature and in popular graduate text books (e.g. Walsh (1998), pp. 224-225, 460-467, 472-474, and Romer (2001) pp. 295-296). Furthermore, the model of the US economy used by Federal Reserve Bank (see Brayton and Tinsley (1996), and Brayton et. al. (1997) for discussions of the model) also has close similarities to the Fuhrer and Moore formulation. However, finding a formulation that is both empirically and theoretically satisfying is harder than what one may infer from Fuhrer and Moore. As a justification for their new model, Fuhrer and Moore argue that agents care about relative real wages, and not about nominal wages. In this note, we will argue that this motivation is misleading. Fuhrer and Moore's model is based on agents caring about the real wages that other workers obtained in the past. If Fuhrer and Moore's model were modified so that workers cared about the contemporaneous real wages of other workers, which is arguably the more reasonable assumption, then the model coincides with the standard formulation of Taylor (1980).[1]

---

[1] This paper is not the first that questions the microfoundations of Fuhrer and Moore (1995); c.f. Roberts (1998) and Taylor (1999). However, their arguments are different from ours. Roberts' criticism is that the model implies agents "are concerned about having a large change in their nominal wage relative to inflation when employment is high. Hence, the Fuhrer and Moore model "slips a derivative" relative to the conventional microeconomics". Taylor argues that the wage should be related to the price level over the full contract period, a point already acknowledged by Fuhrer and Moore in their appendix B.

The Fuhrer and Moore model

Consider the two-period framework used by Taylor (1980) and Fuhrer and Moore (1995). Wages are set in contracts lasting for two periods. Contracts are staggered, so that half of the contracts are set in each period. Let xt denote the log of the contract wage set in period t. Prices are a constant unit markup over wages so that the log of the price index in period t, pt, is the average of the contract wages negotiated in period t and period t-1.

(1) pt = ½ (xt + xt-1).

Taylor (1980) assumed that contract wages are set as an average of the lagged and the expected future wage contracts, adjusted for excess demand yt.

(2) xt = ½ (xt-1 + Etxt+1) + kyt   k > 0.

(2) can be rearranged to

(3) Δxt = EtΔxt+1 + 2kyt,

where $\Delta x_t \equiv x_t - x_{t-1}$. First difference (1) to obtain the rate of inflation as:

$$\pi_t \equiv \Delta p_t = \frac{1}{2}\left(\Delta x_t + \Delta x_{t-1}\right)$$

(4)

Substituting out for Δx_t and Δx_{t-1} using (3) in (4), we obtain

(5) πt = Etπt+1 + k(yt + yt-1)

Thus, as emphasized by Fuhrer and Moore (1995), in the Taylor model any persistence in πt must derive from persistence in yt. In contrast, Fuhrer and Moore propose an alternative contracting equation, where agents care about relative real wages:

(6) xt - pt = ½ (xt-1 - pt-1 + Et(xt+1 - pt+1)) + kyt.

Substituting the definition of x_t in equation (6) into the price index equation (1), yields

(7) $\pi t = \frac{1}{2} (\pi t\text{-}1 + Et\pi t+1) + (k/2) (yt + yt\text{-}1)$.

Thus, there is persistence in inflation, as lagged inflation enters with a positive coefficient.

To justify their model, Fuhrer and Moore (page 131) argue: "In the relative wage specification, however, agents compare the real value of their wage contracts with the real value of wage contracts previously negotiated and still in effect, and with contracts expected to be negotiated over the duration of the contract..." However, this justification is misleading. Presumably, the most natural interpretation of "the real value of wage contracts previously negotiated that are still in effect" is xt-1 – pt, i.e. the nominal wages set in the previous period evaluated at current prices. In contrast, according to (6), agents care about xt-1 – pt-1, that is, the real wages that the other group of workers had in the previous period.

Much more importantly, however, the assumption implicit in (6) is difficult to defend theoretically. It is not difficult to explain why agents may compare their own real wage with the real wage that other groups obtain at the same time, and many other studies make this assumption (eg V. Bhaskar, 1990). However, it is harder to understand why workers should compare their own real wage with the real wage other groups had last period, in particular without taking into consideration the real wage they had themselves at that point in time.

To explore the consequences of the more reasonable assumption, that workers care about the real wage other groups obtain at the same time, we substitute xt-1 - pt for xt-1 - pt-1 in (6). Furthermore, we also make the theoretically preferable assumption that the real wage to be determined is the expected real wage over the contract period, and not the real wage in the first period of the contract period (as also argued by Fuhrer and Moore, 1995, in their appendix B). Thus, we substitute xt – ½(pt + Etpt+1) for xt - pt on the LHS of (6)[2], to obtain

(8) $xt – \frac{1}{2}(pt + Etpt+1) = \frac{1}{2} (xt\text{-}1 - pt + Et(xt+1 - pt+1)) + kyt$.

---

[2] Retaining x_t - p_t would not change the conclusion qualitatively.

However, it is immediate that the price levels cancel out so that (8) can be simplified to (2), that is, the standard framework of Taylor (1980). Thus, the crucial feature of the model of Fuhrer and Moore is not that agents care about relative real wages; indeed, the standard formulation of Taylor is consistent with that. The crucial feature of the model of Fuhrer and Moore is that agents are assumed to care about the real wages that other groups had in the previous period, which is an assumption that is harder to justify.

The empirical specification of the Fuhrer and Moore model, based on four-quarter contracts and given in their equation (16), does also reduce down to the Taylor formulation, if one makes the same modifications as above: (i) replace the past real wages of other workers with their contemporaneous and (ii) deflate the contract to be set with the expected price level over the entire contract period, rather than only with the price level in the first period.[3] However, this specification is explained accurately by Fuhrer and Moore on page 141 "Note that we have implicitly defined the real contract price as the difference between the current nominal contract price and the current price index, xt – pt." (in the latter part of the paper, Fuhrer and Moore refer to "contract price" rather than "contract wage").

The empirical specification is referred to as "a convenient simplification from the theoretically preferable specification that defines the real contract price as the difference between the nominal contract price and the weighted average of price indexes that are expected to prevail over the life of the contract" (p 141). This more elaborate specification is laid out in Appendix B, where it is accurately explained. However, again

---

[3] We then obtain (for notational simplicity, and in line Taylor, 1980, we set the weights for all groups of workers, f_i in Fuhrer and Moore's notation, to be identical. We also omit the output and error terms)

$$x_t - \frac{1}{4}\left(p_t + E_t \sum_{i=1}^{3} p_{t+i}\right) =$$

$$\frac{1}{4}\left[\left(\frac{1}{3}\sum_i^3 x_{t-i} - p_t\right) + E_t\left(\frac{1}{3}(\sum_i^2 x_{t-i} + x_{t+1}) - p_{t+1}\right) + E_t\left(\frac{1}{3}(x_{t-1} + \sum_i^2 x_{t+i}) - p_{t+2}\right) + E_t\left(\frac{1}{3}\sum_i^3 x_{t+i} - p_{t+3}\right)\right]$$

As is readily observable, the price levels cancel out, so this reduces down to the Taylor

(1980), equation (1): $x_t = \frac{1}{12}x_{t-3} + \frac{1}{6}x_{t-2} + \frac{1}{4}x_{t-1} + \frac{1}{4}E_t x_{t+1} + \frac{1}{6}E_t x_{t+2} + \frac{1}{12}E_t x_{t+2}$

the key source for persistence of the specification is that workers compare their wages to the real contract wages other workers had in previous periods.

Conclusions

Macroeconomists are faced with a puzzle: As pointed out by Fuhrer and Moore (1995) and Taylor (1999), the standard theoretical formulation of the short run aggregate supply curve seems to be an empirical failure. The standard formulation exhibits stickiness in prices but not in inflation, in contrast with the persistence in actual inflation. A number of alternative formulations have been proposed. We argue that one of the more prominent ones, the Fuhrer and Moore (1995) relative contracting model, is highly problematic. Fuhrer and Moore (1995)'s formulation generates inflation persistence, but this is a consequence of their assuming that workers care about the past real wages of other workers. Once one replaces their formulation with the more reasonable assumption that workers care about the current real wages of other workers, the resulting formulation immediately reduces to the standard formulation with no inflation persistence.

This leaves open the question of how to generate inflation persistence in contracting models. Recently, several different alternative types of explanations have been proposed. Roberts (1998) and Ball (2000) have suggested models that relax the assumption that expectations are rational. Gali and Gertler (1999) make progress by relating inflation to a measure of marginal costs rather than output. Mankiw and Ricardo Reis (2001) argue that information about macroeconomic conditions diffuses slowly through the economy. In a companion paper (Driscoll and Holden, 2002), we show that inflation persistence may be caused by coordination problems associated with workers being concerned about fair treatment, in the sense that they care disproportionately more about being paid less than other workers than they do about being paid more.

References

Ball, Laurence S. (2000). "Near-Rationality and Inflation in Two Monetary Regimes." NBER Working Paper No. 7988.

Bhaskar, V. (1990). "Wage Relatives and the Natural Range of Unemployment." *Economic Journal* 100, 60-66.

Brayton, Flint and P. Tinsley (eds.) (1996). "A guide to FRB/US. A Macroeconomic Model of the United States". Federal Reserve Board Finance and Economic Discussion Series No. 1996-42.

Brayton, Flint, Andrew Levin, Ralph Tryon and John C. Williams (1997). "The Evolution of Macro Models at the Federal Reserve Board." *Carnegie-Rochester Conference Series on Public Policy* 47(1), pp. 43-81.

Calvo, Guillermo A. (1983). "Staggered Prices in a Utility Maximizing Framework". *Journal of Monetary Economics 12*, pp. 383-398.

Clarida, Richard, Jordi Gali and Mark Gertler (1999). "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature*, XXXVII(4), pp. 1161-1707.

Driscoll, John and Steinar Holden (2002). "Coordination, Fair Treatment and Inflation Persistence." Mimeo, Brown University and University of Oslo.

Fuhrer, Jeffrey and Gerald Moore (1995). "Inflation Persistence." *Quarterly Journal of Economics*, CX, pp.127-160.

Gali, Jordi and Mark Gertler (1999). "Inflation Dynamics: A Structural Econometric Analysis." *Journal of Monetary Economics 44*, 195-222.

Mankiw, N. Gregory and Ricardo Reis (2001). "Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve." Mimeo, Harvard University.

Romer, David (2001). *Advanced Macroeconomics.* McGraw-Hill.

Roberts, John (1998). "Inflation Expectations and the Transmission of Monetary Policy." Board of Governors of the Federal Reserve System.

Taylor, John. (1980). "Aggregate Dynamics and Staggered Contracts." *Journal of Political Economy* LXXXVIII, pp. 1-24.

--------------- (1999). "Staggered Wage and Price Setting in Macroeconomics." Chapter 15 in J. B. Taylor and M. Woodford (eds). *Handbook of Macroeconomics.* North-Holland.

Walsh, Carl (1998) *Monetary Theory and Policy*, Cambridge, MA: The MIT Press.

WORKING PAPERS (ANO) FROM NORGES BANK 2001- 2002

Working Papers were previously issued as Arbeidsnotater from Norges Bank, see Norges Bank's website http://www.norges-bank.no

2001/1   Qvigstad, Jan Fredrik
                Monetary policy in real time
                Monetary Policy Wing 2001, 22p

2001/2   Claussen, Carl Andreas and Karsten Staehr
                Explaining the low US inflation – concidence or "new economy"
                Evidence based on a wage-price spiral
                International Department 2001, 26p

2001/3   Ball, Laurence
                Policy Rules and External Shocks
                Monetary Policy Department 2000, 21p

2001/4   Batini, Nicoletta, Richard Harrison and Stephen P. Millard
                Monetary Policy Rules for an Open Economy
                Monetary Policy Department 2000

2001/5   Guðmundsson Már, Thórarinn G. Pétursson and Arnór Sighvatsson
                Optimal Exchange Rate Policy: The Case of Iceland
                Monetary Policy Department 2001, 60p

2001/6   Leitemo Kai and Ulf Söderström
                Simple monetary policy rules and exchange rate uncertainty
                Research Department 2001, 41p

2001/7   Akram, Qaisar Farooq and Ragnar Nymoen
                Employment behaviour in slack and tight labour markets
                Research Department 2001, 34p

2001/8   Kim, Moshe, Eirik Gaard Kristiansen and Bent Vale
                Endogenous product differentiation in credit markets: what do
            borrowers   pay for?
                Research Department 2001, 24p

2001/9   Kolsrud, Dag
                Simulating forward-looking models
                Research Department 2001, 20p

2001/10   Bernhardsen, Eivind
                A Model of Bankruptcy Prediction
                Financial Analysis and Structure Department
                Research Department 2001, 47p

2002/1   Bache, Ida Wolden
            Empirical Modelling of Norwegian Import Prices
            Research Department 2002, 44p

2002/2   Bårdsen, Gunnar og Ragnar Nymoen
            Rente og inflasjon
            Forskningsavdelingen 2002, 24s

2002/3   Rakkestad, Ketil Johan
            Estimering av indikatorer for volatilitet
            Avdeling for Verdipapirer og internasjonal finans Norges Bank 33s

2002/4   Akram, Qaisar Farooq
            PPP in the medium run despite oil shocks: The case of Norway
            Research Department 2002, 34p

2002/5   Bårdsen, Gunnar, Eilev S. Jansen og Ragnar Nymoen
            Testing the New Keynesian Phillips curve
            Research Department 2002, 38p

2002/6   Lindquist, Kjersti-Gro
            The Effect of New Technology in Payment Services
            on Banks'Intermediation
            Research Department 2002, 28p

2002/7   Sparrman, Victoria
            Kan pengepolitikken påvirke koordineringsgraden i lønnsdannelsen?
            En empirisk analyse.
            Forskningsavdelingen 2002, 44s

2002/8   Holden, Steinar
            The costs of price stability - downward nominal wage rigidity
            in Europe
            Research Department 2002, 43p

2002/9   Leitemo, Kai and Ingunn Lønning
            Simple Monetary Policymaking without the Output Gap
            Research Department 2002, 29p

2002/10   Leitemo, Kai
            Inflation Targeting Rules:
            History-Dependent or Forward-Looking?
            Research Department 2002, 12p

2002/11   Claussen, Carl Andreas
            Persistent inefficient redistribution
            International Department 2002, 19p

2002/12   Næs, Randi and Johannes A. Skjeltorp
             Equity Trading by Institutional Investors: Evidence on
             Order Submission Strategies
             Research Department 2002, 51p

2002/13   Syrdal, Stig Arild
             A Study of Implied Risk-Neutral Density Functions
             in the Norwegian Option Market
             Securities Market and International Finance Department 2002, 104p

2002/14   Steinar Holden and John C. Driscoll
             A Note on Inflation Persistence
             Research Department 2002, 10p