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TARGETING NOMINAL INCOME: A NOTE

Kenneth D. West

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ABSTRACT

This paper compares nominal income and monetary targets in a standard aggregate demand - aggregate supply framework. If the desirability of policies is measured by their effect on the unconditional variance of output, nominal income targeting is preferable if and only if the aggregate elasticity of demand for real balances is greater than one. This is precisely the opposite of the condition that in Bean (1984) is sufficient to make nominal income targeting preferable. This points out the importance of specification of supply and of objective function in work on nominal income targeting.

Kenneth D. West
Woodrow Wilson School
Princeton University
Princeton, NJ 08544

A policy of targeting nominal income has been advocated in recent years by many economists, for example, Tobin (1983) and Vines et al. (1983). The arguments are for the most part informal, with no explicit model. Bean's (1984) able analysis is a notable exception. Bean uses a standard, simple aggregate demand curve and an aggregate supply curve similar to those found in the Fischer (1977) and Taylor (1980) contracting models. He measures the desirability of policies in terms of their ability to reduce the variance of output around a certain "full information" level. He reaches the conclusions (among others) that in the face of demand shocks nominal income targeting is always preferable to money supply targeting. In the face of supply shocks, a sufficient (but not necessary) condition for nominal income targeting to be preferable is that the elasticity of aggregate demand for real balances be less than one (Bean 1984, pp. 808-813).

The purpose of this note is to consider whether these conclusions still hold if Bean's supply curve is replaced with a standard expectations augmented supply curve (equation (1b) below). It turns out that radically different conclusions can result. The discussion in section I below focuses on a simple formulation where the contrast is dramatic, namely, when expectations are adaptive, shocks are serially uncorrelated and the desirability of policies is measured by their ability to reduce the unconditional variance of output. In such a case, nominal income targeting is preferable to money supply targeting if and only if the elasticity of demand for real balances is greater than one. This is true for both supply and demand shocks. Note that this necessary and sufficient condition is precisely the opposite of Bean's sufficient condition in the face of supply shocks.

The contrast between these conclusions and those of Bean result from the different supply curves and the different criteria for measuring the desirability of policies. As explained in section II, results contradictory to those of Bean are still obtained if the section I framework is amended to assume, as did Bean, rational expectations and serially correlated shocks. But results somewhat consistent with those of Bean do result when an analogue of Bean's measure of desirability is mechanically adapted. This measure does not, however, seem particularly sensible in an aggregate demand - aggregate supply framework.

To prevent misunderstanding, let me emphasize that my aim is not to argue for the use of variants of the present paper's model instead of Bean's in future theoretical and empirical analyses of nominal income targeting. On the contrary, I find Bean's carefully developed aggregate supply curve more attractive in many respects than the standard, somewhat ad hoc, aggregate supply curve used here. The point of this note, rather, is that the two models, each of which probably would be considered acceptable by many economists, lead not only to different but even contradictory conclusions concerning the conditions under which nominal income targeting is desirable. It is therefore extremely important in future work on nominal income targeting to be precise about what environment is assumed.

I. Nominal income versus money supply targets

Notation throughout is as close to Bean's as possible. Aggregate demand and supply are given by

$$y_t = \gamma_0 + \gamma(m_t - p_t) + v_t \quad (1a)$$

$$y_t = \gamma_0 + \beta(p_t - p_t^e) + u_t \quad (1b)$$

$$p_t^e = (1-\theta)p_{t-1} + \theta p_{t-1}^e$$

$$0 \leq \theta < 1$$

$$0 < \gamma, \beta$$

y_t is log output, m_t log money stock, p_t log price level, p_t^e price expected by the public at period $t-1$, γ_0 the natural rate of output, v_t and u_t serially uncorrelated disturbances. Aggregate demand (1a) is as in Bean a simple function of real balances. γ is the elasticity of the aggregate demand for real balances and will play a key role in the analysis. Aggregate supply, unlike Bean's, is an expectations augmented Phillips curve. Expectations are assumed to be formed adaptively, so

$$p_t^e = (1-\theta)(1-\theta L)^{-1} p_{t-1}$$

For algebraic simplicity, γ_0 and y_0 will be assumed to be zero in the algebra to follow. This is a harmless assumption since output variability does not depend on the constant terms. With the constants set to zero, the reduced form of the model is

$$y_t = (\beta + \gamma)^{-1} (\beta \gamma m_t - \beta \gamma p_t^e + \beta v_t + \gamma u_t) \quad (2a)$$

$$p_t = (\beta + \gamma)^{-1} (\gamma m_t + \beta p_t^e + v_t - u_t) \quad (2b)$$

As in Bean (1984), the monetary authority must choose the period t money supply m_t before the shocks u_t and v_t are known. Unlike Bean, policies will be compared in terms of their ability to stabilize output, i.e., to minimize Ey_t^2 . This is of course the criterion assumed in many textbook discussions of optimal monetary policy (e.g. Sargent (1979, ch. XV)).

Consider first Ey_t^2 under a constant money supply rule, say, $m_t = 0$ for all t . From the reduced form price equation (2b), under such a rule

$$p_t = (\beta + \gamma)^{-1} [\beta(1-\theta)(1-\theta L)^{-1} p_{t-1} + v_t - u_t] \quad (3)$$

Multiplying through by $(1-\theta L)$ and recollecting terms yields the final form equation for p_t and therefore for p_t^e :

$$p_t = (\beta + \gamma)^{-1} (1-\theta L)(1-\rho L)^{-1} (v_t - u_t) \quad (4a)$$

$$\rho \equiv (\beta + \gamma)^{-1} (\beta + \theta\gamma), \quad 0 < \rho < 1$$

$$p_t^e = (\beta + \gamma)^{-1} (1-\theta)(1-\rho L)^{-1} (v_{t-1} - u_{t-1}) \quad (4b)$$

To solve for the stochastic process for output under a constant money supply rule, subtract (4b) from (4a), and put the result into the supply equation (1b) (again, with y_0 set to zero). After a little rearrangement, this becomes

$$y_t = \beta(\beta + \gamma)^{-1} (1-\rho L)^{-1} (1-L)(v_t - u_t) + u_t \quad (5)$$

The first term is that of an ARMA(1,1) process. Use of the standard formula for the variance of such a process (Box and Jenkins (1976,p. 76)) yields the variance of output under a constant money supply rule:

$$E y_t^2 = \beta^2 (\beta + \gamma)^{-2} [2(1-\rho)(1-\rho^2)^{-1} E(v_t - u_t)^2] + 2\beta(\beta + \gamma)^{-1} E u_t (v_t - u_t) + E u_t^2 \quad (6)$$

Now consider the policy of targeting nominal income. The authorities attempt to set (log of) nominal income, $y_t + p_t$, to an arbitrary level, say, zero. Since they must choose m_t before the serially uncorrelated shocks u_t and v_t are known, it follows from the reduced form equations (2a) and (2b) that m_t is chosen so that

$$(\beta + \gamma)^{-1} (\beta \gamma m_t - \beta \gamma p_t^e) + (\beta + \gamma)^{-1} (\gamma m_t + \beta p_t^e) = 0 \quad (7)$$

Equation (7) may be solved to get a rule for setting money as a function of the expected price level p_t^e . The resulting rule may be plugged into the reduced form price equation (2b) to obtain the final form equations for p_t and p_t^e :

$$p_t - p_t^e = (\beta + \gamma)^{-1} (1 - vL)^{-1} (1 - L)(v_t - u_t) \quad (8)$$

$$v \equiv (\beta + \theta)(1 + \beta)^{-1} ; 0 < v < 1$$

A tedious detailed derivation of (8) is omitted to save space.

Equation (8) may now be plugged into the aggregate supply equation (1b) (again, with $y_0 = 0$), to obtain

$$y_t = \beta(\beta + \gamma)^{-1} (1 - vL)^{-1} (1 - L)(v_t - u_t) + u_t \quad (9)$$

This is precisely the same as the equation (5) stochastic process for output under the money supply rule, except that v replaces ρ . The variance of output under the nominal income rule is therefore

$$E y_t^2 = \beta^2 (\beta + \gamma)^{-2} [2(1-v)(1-v^2)^{-1} E(v_t - u_t)^2] \quad (10)$$

$$+ 2\beta(\beta + \gamma)^{-1} E u_t (v_t - u_t) + E u_t^2$$

Compare (10) and (6). The nominal income rule leads to a lower variance of output only if $(1-v)(1-v^2)^{-1} < (1-\rho)(1-\rho^2)^{-1}$. This in turn is true if and only if $\rho < v$, i.e., if and only if $(\beta + \gamma\theta)(\beta + \gamma)^{-1} < (\beta + \theta)(1 + \beta)^{-1}$. This latter inequality holds if and only if $\gamma > 1$. That is, a policy of targeting nominal income leads to a lower output variance than does a policy of targeting the money supply if and only if the elasticity of demand for real balances is greater than one. This condition is necessary and sufficient in the face of demand shocks, supply shocks or any combination of the two.

It is instructive to illustrate why the model (1) leads to this condition. In Figure (1), DD and SS are the supply and demand curves in and initial equilibrium with $y = y_0$. (The constant terms y_0 and γ_0 have been restored in the picture.) XX is a line with slope minus one along which nominal income is constant. Suppose that in period 1 a demand shock pushes demand to $D_1 D_1$. (The illustration in the case of a supply shock is similar.)

The period 1 supply shock is assumed to be zero, as are both demand and supply shocks in all future periods. Since price falls in period 1, supply shifts outwards in period 2, say, to $S_2 S_2$. Supply then slowly shifts back up towards SS.

The path followed by output depends on the monetary policy followed. Suppose first a constant money supply rule is followed. Then demand shifts back to DD in period 2, and period 2 equilibrium is at E_2 . In future periods, output shifts from y_2 toward y_0 .

Suppose instead a constant nominal income rule is followed. Then the monetary authority adjusts the money supply so that nominal income from period 2 onwards falls on the XX line. Since period 2 supply is S_2S_2 , period 2 equilibrium is a E'_2 . In future periods output shifts from y'_2 to y_0 .

Nominal income targeting clearly leads to greater variability of income. Just as clearly, this results because DD is steeper than XX, i.e., because $\gamma < 1$. Were $\gamma > 1$, nominal income targeting would lead to less variability of income.

II. Discussion

Six comments on the previous section's results are of interest. First, a comparison of Figure 1 here with Bean's Figure 1 (p. 812) will help illustrate the role played by the different specifications of supply. In both models, once a demand shock causes output to deviate from y_0 , supply shifts. But in the present paper's model, the shift is such that nominal income targeting does not return output to y_0 until long run equilibrium is achieved. In Bean's model, on the other hand, the shift is such that nominal income targeting does return output to its optimal level in the period following the shock. Hence in the face of demand shocks, nominal income targeting may or may not be optimal in the present paper's model, but it assuredly is optimal in Bean's model.

The second comment is that nominal income targeting will isolate the economy from the demand shock v_t even in the present paper's model if one drops Bean's assumption that the monetary authority does not see v_t when m_t is set. For if the authority sees the shock, it will prevent the shock from causing nominal income fluctuations by appropriately adjusting the money supply; this will prevent output (and price) fluctuations as well. How realistic it is to assume that the authority sees the shock perhaps depends on the unit of time. If t indexes, say, months, it would seem implausible to assume that v_t is seen when m_t is set: the relevant data on output, which are needed to deduce v_t (and u_t) are only available with a considerable time lag. If t indexes, say, years, the assumption may be more palatable. The Taylor (1985, p.65) statement that in an aggregate demand - aggregate supply framework nominal income targeting isolates that economy from demand shocks is therefore quite reasonable, given that he uses annual data.

The third comment concerns the implications of assuming rational expectations. With the supply curve (1b), monetary policy will not effect the probability distribution of output unless the monetary authority has an information advantage over the public (Sargent and Wallace (1975)). Perhaps

the simplest possible advantage is that the authority sees the shocks when setting m_t , but the public does not see them when forming p_t^e . The nominal income policy will of course be preferable in the face of demand shocks, as explained in the preceding comment. But it may be shown that in the face of supply shocks, nominal income targeting again leads to a lower output variance if and only if $\gamma > 1$.

The fourth comment is that there is an inverse relationship between output and price variability. With $\gamma > 1$, nominal income targeting leads to less output variability but more price variability, than does money supply targeting. In Figure 1, the variation in equilibrium price from E_2 to E_0 is greater than from E_2' to E_0 . If one believes that the sole function of monetary policy is to stabilize prices, then nominal income targeting is to be preferred to money supply targeting if and only if $\gamma < 1$. If the authority is to stabilize a weighted sum of output and price variances, then there appears to be no simple condition under which one policy is preferable.

The fifth comment is that the conflict between output and price variability is part of the explanation of the difference between the present paper's results and those of Bean, when there are supply shocks. Bean ranked policies by $E(y_t - y_t^*)^2$, where y_t^* is in his model a certain "full information" level of output. In the present paper's model, the natural analogue to Bean's criterion is probably $E(y_t - u_t)^2$: $y_t - u_t$ is the output that would result if $p_t = p_t^e$, i.e., if the public is fully informed and not surprised. In a private communication, Bean has pointed out to me that a possible justification for use of $E(y_t - u_t)^2$ is to penalize a policy for allowing the sustained inflation or deflation that can result from permanent shocks. A model with permanent shocks is discussed in the sixth comment below. It is useful as a preliminary to consider the implications of using $E(y_t - u_t)^2$ in the section I model. Use of $E(y_t - u_t)^2$ instead of $E y_t^2$ will not change the results of section I, as is evident from equations (5) and (9). Nor will it if rational instead of adaptive

expectations is assumed. But a result similar to Bean's is delivered when, as in the third comment, rational expectations is combined with the assumption that the shocks are seen by the monetary authority when m_t is determined. For then $y_t - u_t = p_t - p_t^e$, and under rational expectations, with serially uncorrelated shocks, $E(p_t - p_t^e)^2 = E p_t^2 = \text{price variance}$. When the policies are ranked purely in terms of their effect on the variance of price, the condition that in Bean's model suffices to make nominal income targets preferable, $\gamma < 1$, is necessary and sufficient here as well.

The sixth and final comment is that the results appear to carry over directly to more complicated and dynamic versions of the supply and demand curves. I considered two dynamic versions under the ground rules of the third comment, i.e., rational expectations, with the shocks seen by the authorities when m_t is set. (Under adaptive expectations, each of the dynamic versions leads to messy expressions that are difficult to evaluate.) One version allowed stationary serial correlation of the shocks u_t and v_t ; the other added a lagged output term to the right hand side of (1b), as did, e.g., Lucas (1973). Space limitations preclude presenting anything but the results, which were the same for both versions. Nominal income targeting always leads to less output (and price) variability in the face of demand shocks, for reasons explained in the third comment. It leads to less output variability in the case of supply shocks if and only if $\gamma > 1$. If the policies are compared by the $E(y_t - u_t)^2$ criterion, then, as in the preceding comment, the nominal income policy is preferable in the face of supply shocks if and only if $\gamma < 1$. This last comment holds even when u_t and v_t are nonstationary, with unit roots, as assumed by Bean.

It is worth noting in closing that the last two comments have established conditions under which the present paper's aggregate demand - aggregate supply model will yield Bean's result that nominal income targeting is always preferable in the face of demand shocks, and preferable in the face of supply

shock if $\gamma < 1$. These conditions are that: expectations are rational, the monetary authority has an information advantage over the public, and the desirability of policies is measured by the variance of output around a certain full information level. The first assumption is made by Bean. The second is not, and may or may not be plausible (see the first comment). The third is formally equivalent to one made by Bean. The assumption has an explicit microeconomic justification in Bean, where it is linked to the functioning of the labor market. This is not the case here, however, where the assumption simply ranks policies by their effect of price volatility. I doubt that most economists would consider this a reasonable criterion for monetary policy (see, e.g. Hall (1984)).

III. Conclusions

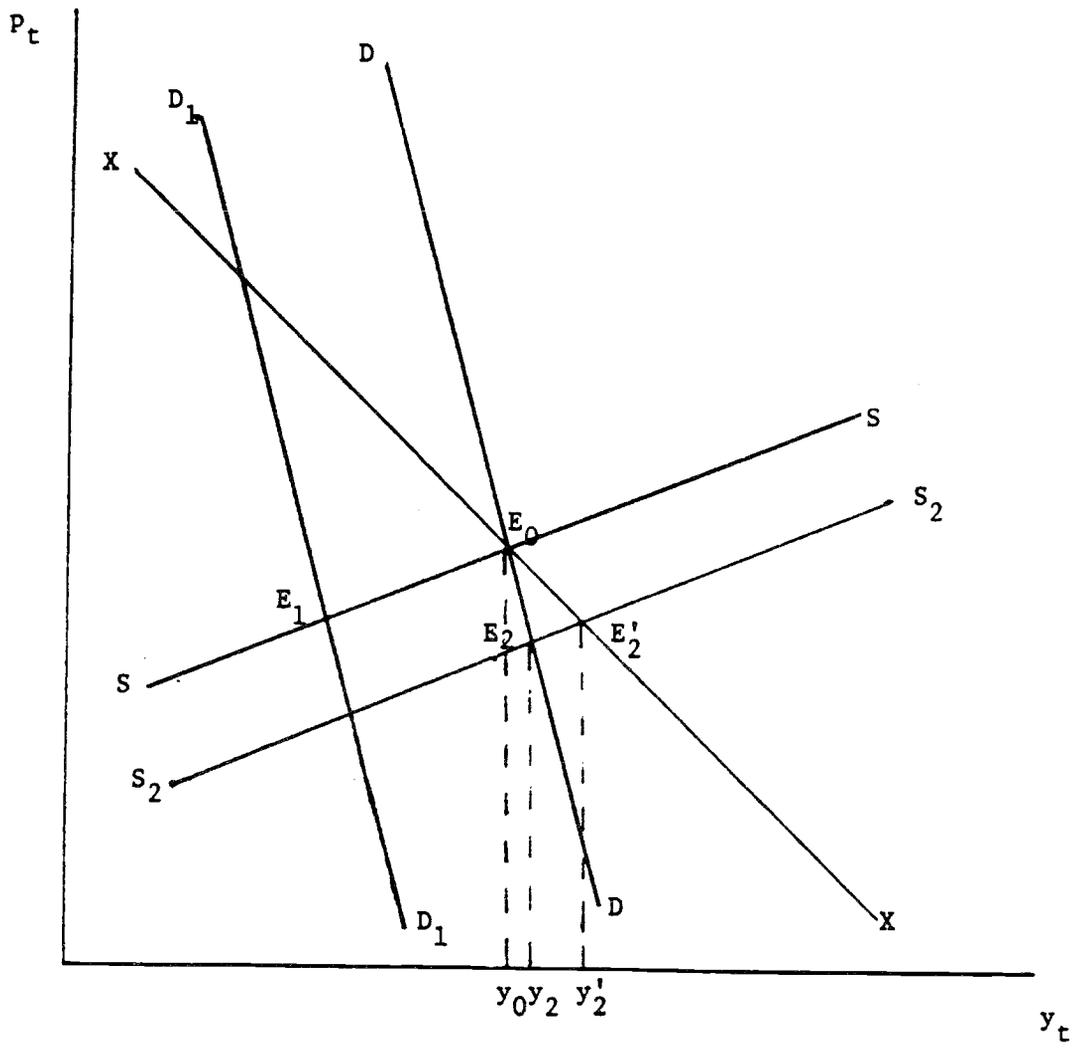
This paper compared nominal income targeting to money supply targeting in an aggregate demand - aggregate supply framework, assuming for the most part that the desirability of policies is measured by their effect on the unconditional variance of output. The results were quite different from those of Bean (1984), who used a contracting model and measured the desirability of policies by their effect on the variance of output around a certain "full information" level. A condition that is sufficient to make nominal income targeting more desirable in Bean's model is necessary and sufficient to insure precisely the opposite in the present paper's model. This suggests that future work on nominal income targeting be precise about what supply curve and what objective function is assumed, since the conclusions obtained depend quite sensitively on these.

FOOTNOTES

1. The supply curve assumes adaptive expectations on the price level rather than on the inflation rate for algebraic simplicity. It is intuitively clear that the necessary and sufficient condition to be established here applies as well when the public adapts on the inflation rate. See the discussion of Figure 1 below. I have not, however, verified this algebraically: the ARMA (1,1) processes for output about to be derived here are instead ARMA (2,2) when the public adapts on the inflation rate and the variance formulas are too complicated to make it easy to prove the necessary and sufficient condition.

If expectations are rational (as in some of the comments in section II), one could of course just as well put inflation instead of price level in the supply curve, since with rational expectations the solution is the same in the two cases.

FIGURE 1



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