

Macroeconomic Implications for Tax Indexing
in the McCallum-Whitaker Framework

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Macroeconomic Implications for Tax Indexing
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High rates of inflation during the past few years have generated a vigorous public debate on the question of indexing the federal income tax system. A recent paper by McCallum and Whitaker (MW 1979) shows that automatic stabilizers are effective in both indexed and nonindexed tax structures. But, since that is not the purpose of their paper, they do not directly address the question of whether or not to index. The purpose of this note is to extend the MW framework so that the indexing questions can be addressed directly. This analysis leads to explicit propositions about the macroeconomic consequences of the indexing decision.

MW use a macroeconomic model that incorporates rational expectations and the natural-rate hypothesis to show that systematic fiscal and monetary stabilization policies in the form of feedback rules will be ineffective in determining the level of output. In addition to this standard result, MW show that fiscal policy in the form of so-called built-in stabilizers can affect the variability of real output. But unless a certain condition is satisfied, MW show that built-in stabilizers may be destabilizing in the face of supply shocks. They conclude that "an increase in the value of [the] progressivity parameter will reduce the variability of output if the tax system is indexed to make real taxes independent of the price level. But without indexation an increase in progressivity may conceivably make variations in output (relative to capacity) more severe." While they never directly pose the question of whether or not to

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index the tax structure, their discussion leaves the reader with the impression that the resolution of this issue in the context of their model can depend on the stability condition.

In this note I show that the MW stability condition is irrelevant to the indexing issue. Even if supply shocks are not destabilizing, an indexed tax structure can dominate a nominal tax structure in terms of output variance. Similarly, in terms of price variance, a nominal tax structure can dominate an indexed tax structure regardless of the stability condition. In order to focus directly on the tax indexing question, in the context of their macro setup, I compare two models that differ only in the tax revenue function, whereas MW compare models that differ in both the government revenue and spending functions. Their conclusions regarding the effectiveness of built-in stabilizers and the ineffectiveness of systematic feedback policies are robust to this alternative specification. I also show that the MW stability condition is equivalent to the condition that the aggregate demand curve has elasticity greater than unity.

I first set out the MW model along with an indexed version of the model, and then present and discuss the geometric solutions to these models.

The MW model for what I call the nominal tax case is:

$$y_t = a_0 + a_1(p_t - E_{t-1}p_t) + a_2y_{t-1} + u_t \quad (1)$$

where $a_1 > 0 < a_2 < 1$.

$$y_t = b_0 + b_1[r_t - E_{t-1}(p_{t+1} - p_t)] + b_2g_t + b_3z_t + v_t \quad (2)$$

$$m_t = p_t + c_0 + c_1y_t + c_2r_t + e_t \quad (3)$$

where $b_1, b_3, c_2 < 0 < b_2, c_1$.

$$z_t + p_t = \tau_0 + \tau_1(y_t + p_t) + \xi_t \quad (4)$$

$$g_t + p_t - E_{t-1}p_t = \gamma_0 + \gamma_1 g_{t-1} + \gamma_2 y_{t-1} + \eta_t \quad (5)$$

$$m_t = \mu_0 + \mu_1 m_{t-1} + \mu_2 y_{t-1} + \zeta_t \quad (6)$$

All variables, except the nominal interest rate (r_t), are logarithms where y_t is output, p_t is the price level, g_t is real government spending on goods and services, z_t is real tax liabilities (net of transfers), m_t is the nominal money stock, and E_{t-1} denotes the expectation conditional on information at the end of period $t-1$. Equation (1) is the aggregate supply function, (2) is the IS function, and (3) is the LM function. The last three equations represent policy rules, with (5) reflecting the idea that the fiscal authorities control nominal spending so that expected real spending is set at some desired level. Since the variables are in logarithms, the tax progressivity parameter (τ_1) is the ratio of the marginal to the average tax rate. All disturbances are assumed to be temporally independent white noise processes which may be contemporaneously correlated, but the policy rule disturbances cannot be contemporaneously correlated with the first three disturbances.

The alternative model that I call the indexed tax case is exactly the same as the nominal tax case, except that the tax rule is

$$z_t = \tau_0 + \tau_1 y_t + \xi_t \quad (7)$$

The output/price solutions to these models are of the form

$$y_t = \pi_{10} + \pi_{11}y_{t-1} + \pi_{12}m_{t-1} + \pi_{13}g_{t-1} + \pi_{14}u_t \quad (8)$$

$$+ \pi_{15}v_t + \pi_{16}e_t + \pi_{17}\xi_t + \pi_{18}\eta_t + \pi_{19}\zeta_t$$

Table 1

	Nominal Tax Structure Coefficients	Indexed Tax Structure Coefficients
π_{14}	θ/ϕ	x_0/x_1
π_{15}	a_1c_2/ϕ	a_1c_2/x_1
π_{16}	$-a_1b_1/\phi$	$-a_1b_1/x_1$
π_{17}	$b_3a_1c_2/\phi$	$a_1c_2b_3/x_1$
π_{18}	$b_2a_1c_2/\phi$	$a_1b_2c_2/x_1$
π_{19}	a_1b_1/ϕ	a_1b_1/x_1
π_{24}	$-(b_1c_1+c_2(1-b_3\tau_1))/\phi$	$-(b_1c_1+c_2(1-b_3\tau_1))/x_1$
π_{25}	c_2/ϕ	c_2/x_1
π_{26}	$-b_1/\phi$	$-b_1/x_1$
π_{27}	b_3c_2/ϕ	c_2b_3/x_1
π_{28}	b_2c_2/ϕ	b_2c_2/x_1
π_{29}	b_1/ϕ	b_1/x_1

where

$$\theta = b_1 + b_2c_2 - b_3c_2(\tau_1-1)$$

$$\phi = a_1b_1c_1 + a_1c_2(1-b_3\tau_1) + \theta$$

$$x_0 = b_1 + b_2c_2$$

$$x_1 = a_1b_1c_1 + a_1c_2(1-b_3\tau_1) + x_0$$

and

$$\theta, \phi, x_0, x_1 < 0 \text{ for } \tau_1 > 1.$$

$$\begin{aligned}
 p_t = & \pi_{20} + \pi_{21}y_{t-1} + \pi_{22}m_{t-1} + \pi_{23}s_{t-1} + \pi_{24}u_t \\
 & + \pi_{25}v_t + \pi_{26}e_t + \pi_{27}\xi_t + \pi_{28}\eta_t + \pi_{29}\zeta_t.
 \end{aligned}
 \tag{9}$$

Since we are only interested in discussing variances here, the coefficients of the disturbance terms are shown in Table 1.^{1/} Both ϕ and x_1 are decreasing functions of τ_1 so that all coefficients, except possibly π_{14} and π_{24} , unambiguously decline in absolute value as τ_1 increases. Since it is only absolute values that are relevant to the discussion of variance, I will discuss $-\pi_{24}$ rather than π_{24} , and since the qualitative response to a change in τ_1 is the same for all of the nonsupply shock coefficients, I will simplify the discussion by talking only about π_{15} and π_{25} rather than all of the nonsupply shock coefficients.

In the nominal tax case, the model assumptions are insufficient to permit an a priori determination of how π_{14} will respond to a change in τ_1 . But MW show that the output variance due to supply shocks (i.e., $\pi_{14}^2\sigma_u^2$) will decrease (is stabilizing) with an increase in τ_1 if and only if^{2/}

$$c_1 < 1 - \frac{c_2}{b_1}(1-b_2-b_3).
 \tag{10}$$

^{1/}For the indexed model, $\pi_{10} = a_0$, $\pi_{11} = a_2$, $\pi_{12} = \pi_{13} = 0$, so the MW conclusions regarding the ineffectiveness of systematic feedback policies also hold for this model.

^{2/}In order to discuss separate supply and demand shocks, I assume from this point on that the shocks are independent so that covariance terms are ignored. However, all of the results in the two-variable case hold as long as the shocks are not negatively correlated. In the case that u and v are negatively correlated, the observations on dominance below must be modified. For output variation, there always exists a τ_1 in the indexed system (τ_1^i) which is greater than the τ_1 of the nominal system (τ_1^n) and which produces a lower variance of y , but a $\tau_1^i < \tau_1^n$ could also produce a lower variance of output. For the variance of the expectational error of the price level, there always exists a τ_1^n , larger or smaller than τ_1^i , which produces a smaller variance than the indexed tax structure.

This condition is equivalent to the aggregate demand curve being in the elastic range and is independent of the level of τ_1 . The slope of the aggregate demand curve in the nominal tax case is

$$\frac{dy}{dp} = - \frac{b_1 + b_2 c_2 + b_3 c_2 - b_3 c_2 \tau_1}{c_2 + b_1 c_1 - b_3 c_2 \tau_1}. \quad (11)$$

It is easy to show that $\frac{dy}{dp} < -1$ (elastic demand) if and only if condition (10) holds. And as a function of τ_1 , the elasticity of the aggregate demand schedule varies as shown in Figure 1.

[Insert Figure 1 Here]

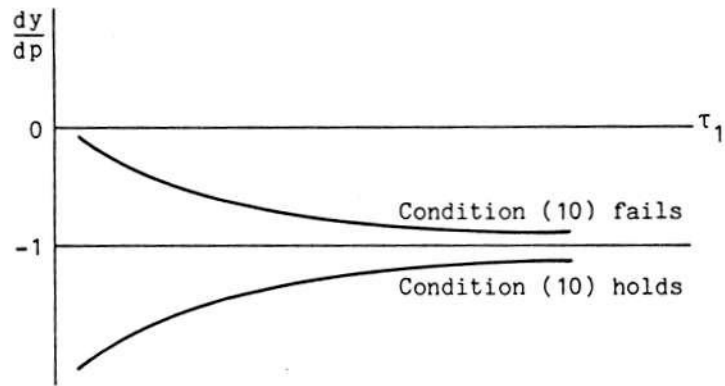
Although [as seen in Figures (2a) and (2b)] the variance of output due to a supply shock is smaller in the inelastic aggregate demand case, the variance of output increases as tax progressivity is increased when aggregate demand is inelastic.

In the indexed tax case it may be shown that an increase in τ_1 always reduces output variance regardless of the elasticity of aggregate demand. As tax progressivity increases, the aggregate demand curve always becomes more inelastic.

The various trade-offs between the nominal and indexed tax systems and between output and price variance are summarized in Figure 2.^{3/} This figure shows how the coefficients (π_{14} , π_{15} , and $-\pi_{24}$, π_{25}) of the supply and demand shocks shown in Table 1 vary with τ_1 . In the coefficient plane of Figure 2, isovariance curves would generally be in the form of an ellipse centered at the origin whose precise shape depends on the variances and covariances of u and v .

^{3/} Comparing the parameter levels across models as is done in Figure 2 involves the questionable assumption that behavioral parameters are independent of the form of the tax function: see, for example, Sargent (1980). It is not clear that this assumption is any more heroic than the assumption that the behavioral parameters are independent of the level of the tax progressivity parameter.

Figure 1



When u and v are uncorrelated, a movement along a negatively sloped line, therefore, produces an ambiguous effect on total variance, but a movement in the southwest direction unambiguously reduces total variance. All of the intersections in Figure 2 occur when $\tau_1 = 1$, so as long as we restrict our attention to progressive tax structures, we are concerned only with the points to the left of the intersections. Movement to the left means τ_1 is increasing.

[Insert Figure 2 Here]

Figures (2a) and (2b) show that, at the same setting of $\tau_1 = \tau_1^0$, an indexed tax structure has a lower output variance with respect to supply shocks but a higher variance with respect to demand shocks than a nominal tax system regardless of the elasticity of aggregate demand. However, it is clear that there exists a higher tax progressivity setting at which an indexed tax structure dominates the nominal tax structure. At the same variance with respect to demand shocks, there is a smaller variance with respect to supply shocks.^{4/}

As MW observe, a strong case can be made that a more relevant criterion for stabilization policy is the minimization of the mean square expectational error $E(p_t - E_{t-1} p_t)^2$, i.e., variance of the expectational error of the (log of the) price level, rather than minimization of output variance. The expectational error is determined in our setup by equation (9) and is dependent on coefficients π_{24} and π_{25} as shown in Figures (2c) and (2d). Under this criterion, the nominal tax structure dominates the indexed tax system, even at the same tax progressivity setting.

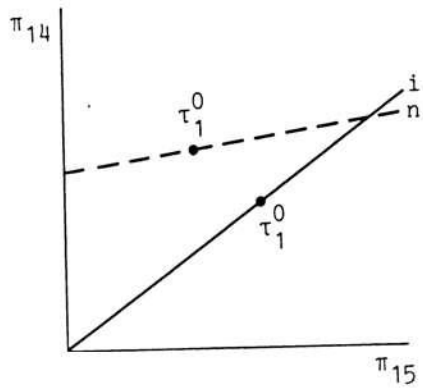
^{4/}Following this definition of dominance, and from the coefficients of Table 1, the nonsupply shock coefficients (in particular π_{15}) will be the same across tax structures if $x_1 = \phi$. This occurs when τ_1 in the indexed system (τ_1^i) is larger than τ_1 in the nominal system (τ_1^n) by the amount $\tau_1^i - \tau_1^n = (1/a_1)(\tau_1^n - 1)$. It may then be shown that at these settings of τ_1 , π_{14} in the indexed system is smaller than π_{14} in the nominal system.

Figure 2

(n = nominal tax structure; i = indexed tax structure)

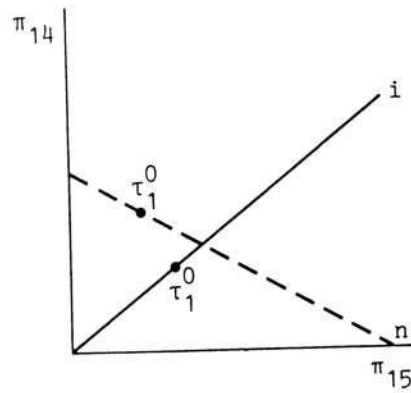
Condition (10) holds
(elastic demand)

(2a)

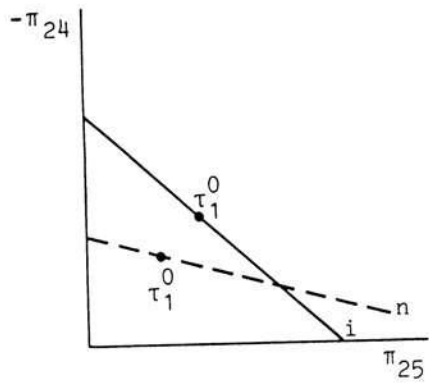


Condition (10) fails
(inelastic demand)

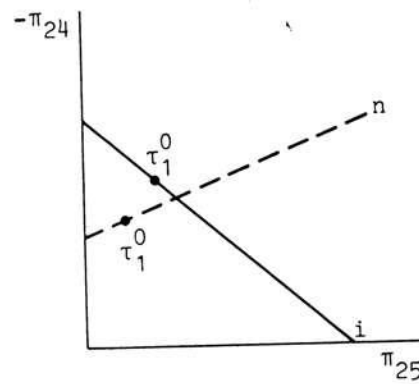
(2b)



(2c)



(2d)



Thus, in the macroeconomic context of the MW model, one's position on the tax indexing question depends critically on the policy criterion. If expectational price variance is the relevant criterion, the nominal tax structure clearly dominates the indexed tax structure. But under the output variance criterion, the indexed tax structure can dominate unambiguously only with a higher tax progressivity setting. At the same tax rates, whether or not the indexed system has a lower total variance of output is a quantitative question. Increasing marginal tax rates to achieve the output dominance described above raises questions of incentives which are properly recognized by MW to be outside the scope of the model.

Finally, incentive questions aside, whichever tax structure prevails, there is no optimal setting of the progressivity parameter that can minimize both price and output variance. Consider, for example, the nominal tax structure described in Figures (2a) and (2c) where the aggregate demand curve is elastic. Because the $-1/\eta$ is negatively sloped, there could possibly exist a price isovariance curve that is tangent to the line. But at that optimal setting for T , under the price variance criterion, output variance is not minimized.

References

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