Comments on Benigno and Woodford's "Optimal Monetary and Fiscal Policy"*

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1 Introduction

Following the tradition of Ramsey (1928), Barro (1979), and Lucas and Stokey (1983), the neoclassical literature on optimal fiscal policy has emphasized that, when taxation is distortionary, welfare is maximized if the government smoothes taxes across different periods of time and different realizations of uncertainty. To what extent, however, such smoothing is possible depends on the ability of the government to transfer budget resources from one date and state to another. If the government can trade a complete set of Arrow securities (or state-contingent debt), perfect smoothing across all dates and states is possible, implying that the optimal tax rate is essentially invariant (Lucas and Stokey, 1983, Chari, Christiano and Kehoe, 1991). If instead insurance is unavailable, any innovation in fiscal conditions needs to be spread over time, implying that the optimal tax rate follows essentially a random walk (Barro, 1979, Aiyagari et al, 2002).

When the government can not trade state-contingent debt, there might be other ways to obtain insurance. Bohn (1990) and Chari, Christiano and Kehoe (1991) have argued that, when the government trades nominal bonds, unexpected variation in inflation may generate all the desirable variation in the real value of the outstanding public debt and may therefore replicate state-contingent debt. A serious caveat with this argument, however, is that it considers a world where prices are perfectly flexible and price volatility has no welfare consequences.

But when nominal prices are sticky, unexpected variation in the aggregate level of prices creates distortions in the allocation of resources and reduces welfare. The New Keynesian literature on optimal monetary policy has therefore stressed the importance of minimizing price volatility in order

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to minimize inefficiencies in the cross-sectoral allocation of resources.[1] Recent work by Schmitt-Grohe and Uribe (2001) and Siu (2001) shows that the conflict between insurance and price stability is likely to be resolved overwhelmingly in favor of the latter.[2] At the same time, the New Keynesian literature has noted that fiscal policy could in principle help stabilize output by offsetting cyclical variation in monopolistic distortions (price or wage markups), but has bypassed this possibility and instead focused on monetary policy.

The paper by Pierpaolo Benigno and Michael Woodford merges the New Keynesian paradigm of optimal monetary policy with the Neoclassical paradigm of optimal fiscal policy. It examines the joint determination of optimal fiscal and monetary policy in the presence of incomplete insurance and sticky prices. Furthermore, it shows how one can start from a full-fledged micro-founded model and, through a long series of clever approximations, end up to a simple linear-quadratic framework similar to the ad-hoc specifications used in the early contributions to both fiscal and monetary policy.

I believe that the welfare costs of business cycles in economies with sticky prices and incomplete markets and the consequent stabilization role of fiscal and monetary policy are important questions. The paper by Pierpaolo Benigno and Michael Woodford makes an important contribution in this direction. I have a serious concern, however, regarding the strategy of the paper. It is important to know that ad-hoc representations of the policy problem can be backed up by proper micro-foundations, but in their paper this comes at the cost of an astonishing number of linear-quadratic approximations, which I find impossible to follow. Moreover, the reduced-form analytic representation is hard to interpret. For example, all impulse responses are found to depend critically on a composite exogenous variable that the authors call "fiscal stress", but it remains a mystery what exactly this variable is.

In the present discussion, I will attempt an alternative, simpler route. I will set up an ad-hoc framework from the very beginning. This will permit me to derive the essential results with less effort and more clarity. We will see that, when the government has access to either lump-sum taxation or complete insurance, the inflation rate is always zero, the output gap is always constant, and output stabilization is obtained only via fiscal policy. When instead there is incomplete insurance, the output gap has a unit root, like the tax rate and the level of government debt, and monetary policy complements fiscal policy in stabilizing the economy. Moreover, innovations in the inflation rate, the output gap, or the tax rate are driven by innovations in an exogenous "fiscal stress" variable, which simply measures the annuity value of government spending plus the subsidy that would have been necessary to implement the first best.

[1] See, for example, Clarida et al (1999), the excellent textbood by Woodford (2003), and the referencees therein.
[2] This result is verified by the findings of Benigno and Woodford as well.

2 Optimal Fiscal and Monetary Policy: A Simple Model

2.1 Social Welfare

We can approximate social welfare around the first-best outcome as

$$\mathcal{U} = -\sum_{t=0}^{\infty} \beta^t \mathbb{E}_t \left[(y_t - y_t^*)^2 + \omega \cdot \pi_t^2 \right] \tag{1}$$

where y_t^* is an exogenous random variable representing the efficient (or first-best) level of output, whereas y_t and π_t are the endogenous actual levels of output and inflation. The last term in (1) reflects the welfare loss associated with the distortion in the cross-sectoral allocation of resources cause by a higher dispersion of prices.[3] The scalar $\omega \geq 0$ depends on how flexible prices are. If $1-\alpha$ is the probability that a firm can adjust prices in any given period, so that α measures the degree of price stickiness, then $\omega = \omega(\alpha)$ is increasing in α; flexible prices correspond to $\alpha = 0$ and $\omega = 0$.

2.2 Market Equilibrium

We can similarly summarize the market equilibrium with the following condition characterizing the equilibrium level of output:

$$y_t = -\psi\tau_t + \chi\left(\pi_t - \beta\mathbb{E}_t\pi_{t+1}\right) + \varepsilon_t, \tag{2}$$

where $\psi > 0$ and $\chi \geq 0$. The first term in (2) reflects the distortion of the tax on final output or the sale of intermediate goods. More generally, the first term can be interpreted as aggregate demand management via fiscal policy. The second term reflects the output effect of monetary policy when prices are sticky. The slope $\chi = \chi(\alpha)$ is increasing in α, the degree of price stickinees.[4] Provided $\chi > 0$, (2) gives the New Keynesian Phillips curve:

$$\pi_t = \beta\mathbb{E}_t\pi_{t+1} + \tfrac{1}{\chi}\left(y_t - y_t^n\right),$$

where $y_t^n \equiv -\psi\tau_t + \varepsilon_t$ represents the "natural" level of output. Finally, the exogenous random variable ε_t captures what the litterature has called a "cost-push shock" (e.g., Clarida et al, 1999). As it will become clear, variation in ε_t is isomorphic to variation in y_t^*; either one reflects variation in mark-ups and other shorts of distortions, namely shocks that affect the natural level of output differently from the efficient level.

[3] The implicit assumption is that the first-best level of inflation is zero.

[4] Provided $\chi > 0$, (2) gives the New Keynesian Phillips curve: $\pi_t = \beta\mathbb{E}_t\pi_{t+1} + \frac{1}{\chi}\left(y_t - y_t^n\right)$, where $y_t^n \equiv -\psi\tau_t + \varepsilon_t$ represents the "natural" level of output.

2.3 The Government Budget

Suppose the government trades only one-period discount bonds, both real and nominal. For simplicity, I will ignore seigniorage and the fiscal effect of variations in either the growth rate of output or the real interest rate. I will also assume that the government freely adjusts the level of real bond issues, but keeps the level of nominal bond issues constant at some level $\overline{d}$ (as fraction of GDP), and treat $\overline{d}$ as a parameter. The government budget then reduces to[5]

$$b_{t-1} = \left[\tau_t + z_t + \overline{d}\,(\pi_t - \beta \mathbb{E}_t \pi_{t+1}) - g_t\right] + \beta b_t. \tag{3}$$

b_t denotes the total level of public debt (as fraction of GDP) and τ_t denotes the tax rate on aggregate income. The initial value of debt is $b_{-1} = \overline{b}$. g_t denotes the level of government spending (also as a fraction of GDP) and follows a stationary markov process with mean $\mathbb{E} g_t = \overline{g}$. The term $\overline{d}\,(\pi_t - \beta \mathbb{E}_t \pi_{t+1})$ captures the gains from unexpected deflation of nominal debt. Finally, z_t captures any state-contingent lump-sum transfers the government potentially receives from the private sector. These may reflect either direct lump-sum taxation or various explicit and implicit kinds of insurance (other than the inflation of nominal debt). I will later distinguish three cases: (**i**) Unrestricted lump-sum taxation; z_t is a free control variable. (**ii**) No lump-sum taxation but complete insurance; z_t has to satisfy only the constraint $\mathbb{E}_{t-1} z_t = 0$. (**iii**) No lump-sum taxation and no insurance; $z_t = 0$ in all periods and events.

2.4 The Ramsey Problem

The government seeks to maximized social welfare subject to its budget constraint and the equilibrium condition for aggregate economic activity. Hence, the Ramsey problem is given by

$$\min \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[(y_t - y_t^*)^2 + \omega \pi_t^2 \right] \tag{4}$$

$$\text{s.t.} \qquad y_t = -\psi \tau_t + \chi\,(\pi_t - \beta \mathbb{E}_t \pi_{t+1}) + \varepsilon_t,$$

$$b_{t-1} - \beta b_t = \tau_t + z_t - g_t + \overline{d}\,(\pi_t - \beta \mathbb{E}_t \pi_{t+1})$$

[5] To see this, let v_t and D_t denote the quantity of real and nominal bonds issued in the end of period t (as fraction of GDP) and write the government budget as $\left(v_{t-1} + \frac{D_{t-1}}{P_t}\right) + g_t = \tau_t + z_t + \left(\frac{1}{1+r_t} v_t + \frac{1}{1+R_t}\frac{D_t}{P_t}\right)$. The first term represents the total real liabilities of the government in the beginning of period t, while the last term represents the revenue from the issue of new bonds. P_t is the price level, r_t is the real interest rate, and R_t is the nominal interest rate. Next, let $1/P_t \approx (1-\pi_t)/P_{t-1}$, $(1+r_t)^{-1} \approx \beta$, $(1+R_t)^{-1} \approx \beta(1 - \mathbb{E}_t \pi_{t+1})$, and $D_{t-1}/P_{t-1} = D_t/P_t = \overline{d}$; and define $b_t \equiv v_t + D_t/P_t$. The budget constraint then reduces to (3).

The Lagrangian of this problem can be written as $\mathcal{L} = \sum_{t=0}^{\infty} \beta^t \mathbb{E}_t [L_t]$, where

$$\begin{aligned} L_t \equiv & \frac{1}{2}\left[(y_t - y_t^*)^2 + \omega\pi_t^2\right] - \mu_t \left[\chi(\pi_t - \beta\pi_{t+1}) - (y_t + \psi\tau_t + \varepsilon_t)\right] + \\ & + \lambda_t \left[(b_{t-1} - \beta b_t) - (\tau_t - g_t + z_t) - \overline{d}(\pi_t - \beta\pi_{t+1})\right]. \end{aligned} \tag{5}$$

$\mu_t \geq 0$ represents the shadow value of real resources and $\lambda_t \geq 0$ represents the shadow cost of the government budget.[6] Taking the FOCs with respect to y_t, π_t, b_t, and τ_t, and using the last one to substitute away μ_t, we conclude to the following optimality conditions:[7]

$$y_t - y_t^* = -\tfrac{1}{\psi}\lambda_t \tag{6}$$

$$\pi_t = \tfrac{1}{\omega}\left(\tfrac{\chi}{\psi} + \overline{d}\right)(\lambda_t - \lambda_{t-1}) \tag{7}$$

$$\lambda_t = \mathbb{E}_t \lambda_{t+1} \tag{8}$$

These conditions together with the equilibrium output condition (2), the budget constraint (3), and the initial condition $b_{-1} = \overline{b}$, pin down the optimal policy plan.

Note that (7) and (8) imply $\mathbb{E}_t \pi_{t+1} = 0$. Note also that both the optimal output gap and the optimal inflation rate are determined merely by the shadow cost of government budget resources (the multiplier λ_t). Finally, (8) states that the shadow cost of government budget resources follows a random walk. This property reflect intertemporal smoothing, which is possible as long as the government can freely borrow and lend in riskless bonds. How large is the variance of the innovation in λ_t depends critically on how much insurance the government may obtain against the fiscal consequences of business cycles.

2.5 The First Best

Suppose for a moment that the government had unlimited access to lump-sum taxation. This means that the government can freely choose z_t. The FOC with respect to z_t implies $\lambda_t = 0$, for all periods and events. That is, the shadow cost of the government budget is always zero, reflecting simply the fact that there is unrestricted lump-sum taxation. It follows that

$$y_t - y_t^* = 0 \quad \text{and} \quad \pi_t = 0, \tag{9}$$

meaning that there is complete output and price stabilization exactly at the first-best levels.

[6] Note that the exogenous disturbances of the economy are given by $s_t = (y_t^*, \varepsilon_t, g_t)$ and the endogenous variables $(\pi_t, \tau_t, y_t, b_t)$ are contingent on $s^t = (s_0, ..., s_t)$. Along the optimal plan, however, the history in the beggining of period t can be summarized by $(\mu_{t-1}, \lambda_{t-1})$. See Marcet and Marimon (2001).

[7] To be precise, (7) holds for $t \geq 1$. Period $t = 0$ is special for the usual reason, namely that expectations formed in the past are now sunk.

The first-best outcome is implemented by setting the tax rate so that the aggregate supply condition is satisfied at the efficient level of output with zero inflation. This gives

$$\tau_t = \tau_t^* \equiv -\tfrac{1}{\psi}(y_t^* + \varepsilon_t). \tag{10}$$

The sum $y_t^* + \varepsilon_t$ measures the overall distortion in the economy due to monopolistic competition or other market imperfections, and τ_t^* represents the Pigou tax (or subsidy) that corrects any such distortion and implements the first-best outcome. (In the case of monopolistic distortions, output is inefficiently low, and therefore $\tau_t^* < 0$, meaning that the government uses a subsidy to offset the monopolistic distortions.) Finally, to balance the government budget, we can pick the level of lump-sum taxes so that they are enough to finance the level of government spending, plus the interest payments on the initial public debt, plus the subsidy that implements the first-best level of output. That is, we let $z_t = (g_t - \tau_t^*) + (1-\beta)\overline{b}$.

2.6 Optimal Policy with Complete Markets

Suppose now that lump-sum taxation is not available, but the government can issue state-contingent debt (or otherwise replicate full insurance). The government chooses z_t subject to the constraint $\mathbb{E}_{t-1}z_t = 0$. The FOCs with respect to z_t together with (8) now imply $\lambda_t = \overline{\lambda} > 0$ for all periods and events. That is, the shadow value of tax revenues is positive (since taxation is distortionary) but constant across all periods and events (since markets are complete). It follows that

$$y_t - y_t^* = -\tfrac{1}{\psi}\overline{\lambda} < 0 \qquad \text{and} \qquad \pi_t = 0. \tag{11}$$

This outcome is now obtained by setting

$$\tau_t = \tfrac{1}{\psi^2}\overline{\lambda} + \tau_t^*, \tag{12}$$

where $\tau_t^* \equiv -\frac{1}{\psi}(y_t^* + \varepsilon_t)$ is again the Pigou tax that would implement the first best, and letting

$$z_t = (g_t - \tau_t) - (\overline{g} - \overline{\tau}), \tag{13}$$

where $\overline{g} \equiv \mathbb{E}g_t$ and $\overline{\tau} \equiv \mathbb{E}\tau_t$. That is, variation in z_t absorbs any business-cycle variation in either the level of government spending or the subsidy that implements the first-best level of output. Finally, to compute $\overline{\lambda}$, note that the government budget clears if and only if $\overline{\tau} = \overline{g} + (1-\beta)\overline{b}$, which together with (12) implies

$$\overline{\lambda} = \psi^2\left[(1-\beta)\overline{b} + (\overline{g} - \overline{\tau}^*)\right] \tag{14}$$

That is, the (constant) shadow cost of budget resources is proportional to the interest cost of public debt, plus the annuity value of government spending, plus the annuity value of the subsidy that would be necessary to implement the first best. It follows that the (constant) output gap is higher the higher the initial level of public debt, the higher the average level of government spending, or the higher the monopolistic distortion in the economy. Finally, substituting (14) in (12), we infer

$$\tau_t = \overline{\tau} + (\tau_t^* - \overline{\tau}^*), \tag{15}$$

where $\overline{\tau} = \overline{g} + (1-\beta)\overline{b}$. Note that $\overline{\tau}$ corresponds to the optimal tax rate in a Neoclassical economy, such as in Barro (1979) or Lucas and Stokey (1983). In the presence of a Keynesian business cycle, the optimal tax rate inherits in addition a cyclical component, the latter being the cyclical variation in the Pigou subsidy that would have implemented the first-best level of output. Fiscal policy can thus eliminate the inefficient business cycle by simply offseting the cyclical variation in the monopolistic (or other) distortion.

To see how fiscal policy works under complete markets, consider a negative shock in the output gap (a shock that reduces the natural rate of output more than the first-best level). The government can offset this shock and fully stabilize the output gap by simply lowering the rate of taxation, while keeping the price level constant. This policy leads to a primary deficit, but the latter is totally covered by an increase in state-contingent transfers. Hence, the government does not need to issue any new public debt and the stabilization policy has no fiscal consequences for the future.

2.7 Optimal Policy with Incomplete Markets

Finally, consider the case that the government can not obtain any insurace. It is useful to define the variable

$$f_t \equiv (1-\beta)\sum_{j=0}^{\infty}\beta^j \mathbb{E}_t\left(g_{t+j} - \tau_{t+j}^*\right), \tag{16}$$

which measures the annuity value of government spending plus the annuity value of the subsidy that is necessary to implement the first best, and let $\xi_t \equiv f_t - \mathbb{E}_{t-1}f_t$ denote the innovation in this variable. (f_t corresponds to the mysterious object that Benigno and Woodford call the "fiscal stress" variable.) After some tedious algebra, we can show that the shadow value of budget resources satisfies

$$\lambda_{t-1} = \psi^2\left[(1-\beta)b_{t-1} + \mathbb{E}_{t-1}f_t\right] \qquad \text{and} \qquad \lambda_t - \lambda_{t-1} = \eta\xi_t, \tag{17}$$

for some constant $\eta > 0$. That is, the shadow cost of budget resources is proportional to the interest cost of public debt, plus the annuity value of government spending, plus the annuity value of the subsidy that would be necessary to implement the first best; and the innovation in the shadow cost of budget resources is proportional to the innovation in the fiscal stress variable f_t. It follows that any transitory change in f_t results to a permanent change in λ_t, which manifests the effect of intertemporal tax smoothing. Finally, using (17) together with the FOCs (6)-(8), we conclude to the following impulse-response functions:

$$\pi_t = \varphi_\pi \xi_t, \tag{18}$$

$$y_t - y_{t-1} = \left(y_t^* - y_{t-1}^*\right) - \varphi_y \xi_t, \tag{19}$$

$$\tau_t - \tau_{t-1} = \left(\tau_t^* - \tau_{t-1}^*\right) + \varphi_\tau \xi_t, \tag{20}$$

for some constants $\varphi_\pi, \varphi_y, \varphi_\tau > 0$. It follows that inflation is white noise,[8] whereas the output gap and the tax rate follow a martingale plus a stationary component, which is proportional to the change in the output gap (that is, the distance from the first best). This cyclical component of optimal fiscal and monetary policy is absent in the Neoclassical paradigm (Barro, 1979, Lucas and Stokey, 1983) and arises here because there exists cyclical variation in the extent of distortions in the economy. Finally, the coefficients φ_π, φ_y, and φ_τ are decreasing in $\overline{d}$, reflecting the fact that a higher level of nominal debt permits the government to obtain more insurance with less inflation volatility.

To see how fiscal policy works under incomplete markets, consider a negative shock in the output gap (a shock that reduces the natural rate of output more than the first-best rate). Contrary to what was the case with complete markets, the government can not fully stabilize the output gap and keep the price level constant at the same time. Since complete insurance is no more available, lowering the contemporaneous rate of taxation necessarily results in a primary deficit that has to be financed by an increase in public debt and thus an increase in future taxes. The government thus finds it optimal to lower the tax rate by less than what it would have done under complete markets, that is, by less than what is necessary to offset the negative cyclical shock. And since fiscal policy can no more do it all, it becomes optimal to use also monetary policy for the purpose of output stabilization output. Actually, an unexpected increase in inflation, not only stimulates aggregate demand, but also lowers the real value of nominal public debt and thus eases fiscal conditions. Nonetheless, monetary policy can not do it all either. Since inflation surprises distort the cross-sectoral allocation of resources, the government finds it optimal to raise inflation by an amount less than what it would be necessary to fully stabilize output and cover the primary deficit. Overall, both fiscal and monetary policy are now used to stabilize output, but the negative cyclical shock is only partly offset and results to a permanent increase in the level of public debt and thereby to a permanent increase in taxes and a permanent reduction in output.

[8]Note that the white-noise result for inflation is not robust to the introduction of lags in fiscal policy. The martingale property for fiscal policy and the output gap, however, is likely to be robust to more general frameworks.

3 Concluding Remarks

I conclude with some important (at least in my view) open questions about fiscal policy over the business cycle.

First, the theory suggests that there are important welfare gains to be made if the government traded state-contingent debt (or, at least gains of the same order of magnitude as the gains from eliminating business cycles). And if state-contingent debt is not available, our models predict the government could obtain insurance by appropriately designing the maturity structure of public debt (Angeletos, 2002) or the cyclical properties of consumption taxes (Correia et al, 2002). Similarly, the government could replicate more insurance with less cyclical variation in inflation by issuing a lot of nominal debt and at the same time investing in real assets so as to keep the overall level of public debt at the desired level. Yet, none of these forms of insurance appear to play an important role in practice. Why not?[9]

Second, the implications of incomplete insurance become even more interesting once we abandon the simple linear-quadratic framework. If the lack of insurance is due to exogenous reasons, then a precautionary motive dictates that the government should accumulate a large amount of assets to use it as a buffer stock against cyclical shocks (Aiyagari et al, 2002). If instead the lack of insurance is due to the government's own moral hazard, then a desire to minimize the costs of providing future governments with optimal incentives dictates that the government should accumulate a large amount of debt (Sleet, 2002). But which of the two opposite predictions should we follow?

Third, consider the comparison of fiscal and monetary policy as instruments for managing the business cycle. The simple model presented here, the more elaborate models of Correia et al (2002) or Benigno and Woodford, and probably any model we teach our graduate students, share the prediction that fiscal policy can not do all (if markets are complete) or most (if markets are incomplete) of the job of stabilizing the economy. One could even argue that fiscal policy is superior to monetary policy in stabilizing the economy, for its effectiveness does not depend on the extent of nominal rigidities. In practice, however, fiscal policy is quickly dismissed on the basis that it takes time to implement changes in fiscal policy and even more time for these changes to have an effect on economic activity. But, where is the hard proof for this? And even if there are important lags involved in discretionary cyclical fiscal policy, why don't we undertake the necessary reforms to reduce them, or why don't we redesign the existing automatic stabilizers so as to implement the optimal cyclical variation in fiscal policy? Or, why should a systematic fiscal

[9] Moral hazard in government behavior can be only part of the answer: If it were severe enough to explain complete lack of insurance, one would also expect the government to customarily default on (domestic) public debt, which is not the case in reality.

policy rule have a weaker and slower impact on market incentives than a systematic monetary policy rule? Similarly, cyclical fiscal policy may have a differential impact on different sectors of the economy, but this is equally true for monetary policy. I personally doubt that monetary policy is intrinsically more effective as an instrument for managing the business cycle, I believe that we should carefully investigate the alleged asymmetries between fiscal and monetary policies, and I wonder if it is mostly a historical coincidence that economists and policy makers alike have been "obsessed" with monetary policy.[10]

Finally, consider the nature of the shocks that justify policy intervention. The conventional wisdom is that we should try to stabilize the actual level of output, or the gap between the actual level and some smoother level (the empirically measured natural rate). The theory instead dictates that we should stabilize the gap between the actual and the first-best level of output, because it is this that minimizes welfare losses. What is more, the cannonical model predicts that productivity and taste shocks move the actual and the first-best level of output proportionally, in which case there is no inefficient business cycle and thus no reason for counter-cyclical policy.[11] The "resolution" to this "unappealing" theoretical prediction has been to introduce ad hoc shocks that perturb directly the gap between the actual and the first-best level of output.[12] It remains an open question what exactly these shocks are, and why they may be highly correlated with the actual level of output, in which case only the conventional wisdom and the common policy practice would be justifiable.

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[10] For a posibility that sunspots (or self-fulfilling expectations) determine which policy instruments are effective and actively used in equilibrium, see Angeletos, Hellwig, and Pavan (2003).

[11] See Woodford (2003) for an extensive analysis of this issue.

[12] These shocks are commonly called "cost-push shocks", although they may have little to do with real-life cost-push socks, such as an increase in oil prices, which are bound to affect both the actual and the first-best level of output and may have an ambiguous effect on the level of the distortion in the economy. See Blanchard (2003) for a critical assessment.

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