Fiscal Policy in a Model With Financial Frictions

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What are the effects of fiscal policy in the presence of financial frictions? This question is particularly relevant given the great recession of 2008-2009, how forcefully some governments have resorted to fiscal stimulus over the last two years to fight it, and the widespread view that financial markets have played a decisive role in our current economic problems. To analyze this topic, I build a dynamic stochastic general equilibrium (DSGE) model with financial frictions and fiscal policy, calibrate it to observations of the U.S. economy, and compute the response of output to several fiscal shocks.

I. A DSGE Model with Financial Frictions and Fiscal Policy

Due to space constraints, I will only briefly describe the main elements of the model that I employ for my investigation. The interested reader can find a more detailed exposition in Fernández-Villaverde (2010). Suffice it to say in terms of motivation that the model is based on the work of Ben S. Bernanke, Mark Gertler, and Simon Gilchrist (1999) and Lawrence J. Christiano, Roberto Motto, and Massimo Rostagno (2009) that has successfully been applied to study business cycle dynamics. The model has a representative household, final and intermediate good producers, producers of capital, entrepreneurs, financial intermediaries, and a government that conducts monetary and fiscal policy. The financial frictions appear as a consequence of information asymmetries between lenders and borrowers.

The representative household maximizes:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t e^{\phi_t} \left\{ \begin{array}{c} \log\left(c_t - hc_{t-1}\right) - \psi \frac{l_t^{1+\vartheta}}{1+\vartheta} \\ +\upsilon \log\left(\frac{m_{t-1}}{p_t}\right) \end{array} \right\}$$

where c_t is consumption, l_t hours worked, p_t the price level, m_{t-1}/p_t real money balances carried into the period, β the discount factor, h habit persistence, and ϕ_t an intertemporal preference shock with law of motion:

$$\phi_t = \rho_d \phi_{t-1} + \varepsilon_{\phi,t},\ \varepsilon_{\phi,t} \sim \mathcal{N}(0, \sigma_\phi).$$

The intertemporal shock allows me to account for shifts in aggregate demand in a simple way.

The household can save on:

1) Money balances to carry into the next period, m_t.
2) Nominal deposits at the financial intermediary, a_t, which pay an uncontingent nominal gross interest rate R_t.
3) Nominal public debt, d_t, which yields an uncontingent nominal gross return Rd_t.
4) Arrow securities over all possible events (which, however, I do not include explicitly in the notation since they are in zero net supply).

Given the portfolio possibilities, the household's budget constraint is:

$$\left(1+\tau_{c,t}\right) c_t + \frac{a_t}{p_t} + \frac{d_t}{p_t} + \frac{m_t}{p_t} =$$
$$\left(1-\tau_{l,t}\right) w_t l_t + \left(1 + \left(1-\tau_{R,t}\right)\left(R_{t-1}-1\right)\right) \frac{a_{t-1}}{p_t}$$
$$+Rd_{t-1}\frac{d_{t-1}}{p_t} + \frac{m_{t-1}}{p_t} + T_t + \digamma_t + tre_t$$

where consumption is taxed at rate $\tau_{c,t}$, the real wage w_t is is taxed at a rate $\tau_{l,t}$, the net returns on deposits are taxed at rate $\tau_{R,t}$, T_t is a lump-sum transfer from the result of open market operations of the monetary authority, $\digamma_t$ are the profits of the firms in the economy (financial and non-financial) plus the intermediation costs of the financial firm, and tre_t is the net real transfer to new and from old entrepreneurs that I will describe momentarily.

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There is one final good producer that aggregates intermediate goods according to:

$$y_t = \left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where ε is the elasticity of substitution across goods. Therefore, the price level is given by:

$$p_t = \left(\int_0^1 p_{it}^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}}.$$

There is a continuum of intermediate goods producers that enjoy market power on their own good. Each intermediate good producer i has access to a production function $y_{it} = e^{z_t} k_{it-1}^{\alpha} l_{it}^{1-\alpha}$ where k_{it-1} is the capital and l_{it} the amount of labor rented by the firm, and where the productivity z_t follows:

$$z_t = \rho_z z_{t-1} + \varepsilon_{z,t}, \ \varepsilon_{z,t} \sim \mathcal{N}(0, \sigma_z).$$

The intermediate goods producers are subject to a Calvo pricing mechanism. In each period, a fraction $1-\theta$ of them can reoptimize their prices while all other firms can only index their prices by a fraction χ of past inflation.

Capital is manufactured by a perfectly competitive capital good producer that buys installed capital, x_t, and adds investment, i_t, using the final good, to generate new installed capital for the next period:

$$x_{t+1} = x_t + \left(1 - S\left[\frac{i_t}{i_{t-1}} \right] \right) i_t$$

where $S[1] = 0$, $S'[1] = 0$, and $S''[\cdot] > 0$. The investment adjustment cost $S[\cdot]$ induces a relative price of capital of q_t. By market clearing, the law of motion for aggregate capital is:

$$k_t = (1-\delta) k_{t-1} + \left(1 - S\left[\frac{i_t}{i_{t-1}} \right] \right) i_t$$

Entrepreneurs use their (end of period) real wealth, n_t, and a nominal loan b_t, to purchase installed capital k_t:

$$q_t k_t = n_t + \frac{b_t}{p_t}.$$

When mapping into the data, we can think about wealth as equity and the loan as the sum of all liabilities of the firm. The presence of nominal debt opens the door for a "Fisher effect" where inflation increases (or deflation erodes) the net wealth of entrepreneurs. This point will play a key role in the results.

The purchased capital is shifted by a productivity shock ω_{t+1} that is lognormally distributed with CDF $F(\omega)$ and parameters $\mu_{\omega,t}$ and $\sigma_{\omega,t}$ that evolve over time with the restriction that $\mathbb{E}_t \omega_{t+1} = 1$ for all t. The law of motion for $\sigma_{\omega,t}$ is:

$$\log \sigma_{\omega,t-1} = (1-\rho_\sigma) \log \sigma_\omega + \rho_\sigma \log \sigma_{\omega,t} + \varepsilon_{\sigma,t+1},$$

where $\varepsilon_{\sigma,t+1} \sim \mathcal{N}(0, \eta_\sigma)$ is revealed at the end of period t, right before investment decisions for period $t+1$ are made. This shock reflects the idea of changing riskiness of projects. Quantitatively, it noticeably enhances the role of financial frictions.

The entrepreneur rents the capital to intermediate good producers, who pay r_{t+1}. Then, at the end of the period, the entrepreneur sells the undepreciated capital to the capital good producer at price q_{t+1}. Hence, the average return of the entrepreneur per nominal unit invested in period t is:

$$R_{t+1}^k = \frac{p_{t+1}}{p_t} \frac{r_{t+1} + q_{t+1}(1-\delta)}{q_t}.$$

The debt contract is structured as follows. For every state with associated return on capital R_{t+1}^k, entrepreneurs have to either service a state-contingent gross nominal interest rate R_{t+1}^l on the loan or default. If the entrepreneur defaults, it gets nothing: the financial intermediary seizes its revenue, although a proportion μ of that revenue is lost in bankruptcy procedures. Hence, the entrepreneur will always meet its obligations if it has generated enough revenue to do so. This is the case if productivity is at least as high as a level $\overline{\omega}_{t+1}$ at which the entrepreneurs can just reimburse its debt:

$$R_{t+1}^l b_t = \overline{\omega}_{t+1} R_{t+1}^k p_t q_t k_t.$$

If $\omega_{t+1} < \overline{\omega}_{t+1}$, the entrepreneur defaults, the financial intermediary monitors it and recovers $(1-\mu)$ of the revenue. This mechanism captures the asymmetries of information between lenders and borrowers that can only be circumvented with a costly state verification.

The debt contract determines R_{t+1}^l to be the return such that financial intermediaries satisfy its zero profit condition in all states of the world:

$$s_t R_t b_t = \left[1 - F\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)\right] R^l_{t+1} b_t +$$
$$(1-\mu) \int_0^{\overline{\omega}_{t+1}} \omega dF\left(\omega, \sigma_{\omega,t+1}\right) R^k_{t+1} p_t q_t k_t$$

where R_t is the (non-contingent) return of households that have saved in the financial intermediary and s_t is a spread caused by the costs of intermediation (for example, the outlays for underwriting the loan contract). The spread $s_t = 1 + e^{\overline{s}+\widetilde{s}_t}$ evolves stochastically over time as:

$$\widetilde{s}_t = \rho_s \widetilde{s}_{t-1} + \varepsilon_{s,t}, \varepsilon_{s,t} \sim \mathcal{N}(0, \sigma_s).$$

For simplicity, I assume that the intermediation cost is rebated to the households in a lump-sum fashion. The zero profit condition loads all the risk of delivering the right return to the financial intermediary through changes in $\overline{\omega}_{t+1}$ and R^l_{t+1}. The (endogenous) difference between R^l_{t+1} and R_t is known as the finance premium.

The state-contingent interest rate R^l_{t+1} and the cutoff $\overline{\omega}_{t+1}$ are chosen, in equilibrium, to maximize the expected net worth of the entrepreneur given the zero profit condition of the financial intermediary. The solution of this optimization implies that all the entrepreneurs, regardless of their wealth, will have the same leverage, a most convenient feature for aggregation.

At the end of each period, a fraction γ^e_t of entrepreneurs survives, while the rest die and their wealth is taxed at a 100 percent rate. The dead entrepreneurs are replaced by a new cohort that enters with initial real net wealth w^e (a transfer that, to ease the algebra, the surviving entrepreneurs also receive). The share γ^e_t is equal to:

$$\gamma^e_t = \frac{1}{1 + e^{-\overline{\gamma}^e - \widetilde{\gamma}^e_t}}$$

where $\widetilde{\gamma}^e_t$ follows:

$$\widetilde{\gamma}^e_t = \rho_\gamma \widetilde{\gamma}^e_{t-1} + \varepsilon_{\gamma,t}, \varepsilon_{\gamma,t} \sim \mathcal{N}(0, \sigma_\gamma).$$

There is a representative, competitive financial firm that intermediates between the household and entrepreneurs. In the data, that firm corresponds not only to banks but also to other financial institutions such as venture capital firms or investment funds commonly engaged in the matching of savers and investors. The financial intermediary lends a nominal amount b_t to entrepreneurs at rate R^l_{t+1}, but recovers only a rate R_t because of default and intermediation costs. Therefore, the financial intermediary pays interest R_t to the household. Furthermore, by market clearing, loans must be equal to deposits, $a_t = b_t$ (since all the debts are short-term, I can forget about reserve requirements for the financial intermediary).

The last agent in the economy is the government, which determines monetary and fiscal policy. To keep the analysis focused, in a first pass, I abstract from the interactions between the two policies (for instance, I assume that the results of open market operations are distributed in a lump-sum fashion to households and not transferred to the general flow of government income). The current balance sheet of the Federal Reserve System and the dangers it entails to the U.S. Treasury suggest, though, that such an abstraction is only a provisional simplification that should be removed in the near future.

The government sets the nominal interest rates with a Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left(\frac{\Pi_t}{\Pi}\right)^{\gamma_\Pi (1-\gamma_R)} e^{m_t}$$

through open market operations that are financed with lump-sum transfers T_t. The variable Π is the steady state target level of inflation and $R = \frac{\Pi}{\beta}$ is the steady state nominal gross return of public debt. The term $\varepsilon_{mt} \sim \mathcal{N}(0, \sigma_m)$ is a random shock to monetary policy.

The government intertemporal budget constraint is given by:

$$\frac{d_t}{p_t} = g_t + R d_{t-1} \frac{d_{t-1}}{p_t} - tax_t$$

where g_t is government expenditure in terms of the final good and tax revenues are:

$$tax_t = \tau_{c,t} c_t + \tau_{l,t} w_t l_t + \tau_{R,t} \left(R_{t-1} - 1\right) \frac{a_{t-1}}{p_t}.$$

The budget constraint can be rewritten as:

$$\frac{d_t}{p_t} = g_t + \frac{R d_{t-1}}{\Pi_{t-1}} \frac{d_{t-1}}{p_{t-1}} - tax_t$$

to make explicit the reduction in real public debt caused by inflation.

Government expenditure fluctuates as:

$$\widehat{g}_t = \gamma_g \widehat{g}_{t-1} + d_g \frac{d_{t-1}}{p_t y_t} + \sigma_g \varepsilon_{g,t}$$

where $\widehat{g}_t = \log g_t / \overline{g}$ is the log deviation with respect to $\overline{g}$, the mean of the process, and d_g pins down the sensitivity of expenditures to the ratio of public debt brought into the period over nominal output. A negative value of d_g ensures that the model has a stable equilibrium.

The laws of motion for taxes are:

$$\widehat{\tau}_{c,t} = \gamma_c \widehat{\tau}_{c,t-1} + \varepsilon_{\tau c,t}, \varepsilon_{\tau c,t} \sim \mathcal{N}(0, \sigma_{\tau c})$$
$$\widehat{\tau}_{l,t} = \gamma_l \widehat{\tau}_{l,t-1} + \varepsilon_{\tau l,t}, \varepsilon_{\tau l,t} \sim \mathcal{N}(0, \sigma_{\tau l})$$
$$\widehat{\tau}_{R,t} = \gamma_R \widehat{\tau}_{R,t-1} + \varepsilon_{\tau k,t}, \varepsilon_{\tau k,t} \sim \mathcal{N}(0, \sigma_{\tau k})$$

where I have defined $\widehat{\tau}_{c,t} = \log\left(1 + \tau_{c,t}\right) / (1 + \overline{\tau}_c)$, $\widehat{\tau}_{l,t} = \log\left(1 - \tau_{l,t}\right) / (1 - \overline{\tau}_l)$, and $\widehat{\tau}_{R,t} = \log\left(1 - \tau_{R,t}\right) / (1 - \overline{\tau}_R)$.

To close the model, some algebra steps give us an expression for aggregate demand:

$$y_t = c_t + i_t + g_t + \mu G\left(\overline{\omega}_t, \sigma_{\omega,t}\right)\left(r_t + q_t\left(1-\delta\right)\right) k_{t-1}$$

and another for aggregate supply:

$$y_t = \frac{1}{\upsilon_t} e^{z_t} k_{t-1}^{\alpha} l_t^{1-\alpha}$$

where $\upsilon_t = \int_0^1 \left(\frac{p_{it}}{p_t}\right)^{-\varepsilon} di$ is the inefficiency created by price dispersion. By the properties of the index under Calvo's pricing, υ_t moves as:

$$\upsilon_t = \theta \left(\frac{\Pi_{t-1}^{\chi}}{\Pi_t}\right)^{-\varepsilon} \upsilon_{t-1} + (1-\theta)\, \Pi_t^{*-\varepsilon}.$$

The equilibrium definition of the model is standard and piles up the optimality conditions for all the agents, market clearing conditions, and the laws of motion for exogenous processes.

II. Calibration and Computation

I solve the model by loglinearizing the equilibrium conditions around the deterministic steady state (which must be found numerically). I calibrate the model to match certain characteristics of the U.S. economy at a quarterly frequency. When feasible, I take standard values in the literature as reported in table 1. The only parameter that deserves more attention is $d_g = -0.001$. I select a small value such that the variations in government expenditure triggered by raising public debt are negligible in the very short run. For all the autoregressive processes, I pick a persistence value of 0.95, a conventional choice for the frequency of the model. Finally, for the exercises reported in this paper, and since I am loglinearizing, I do not need to specify the standard deviations of shocks.

TABLE 1—CALIBRATED VALUES.

Preferences	$\beta = 1, h = 0.9, \psi = 3.83, \vartheta = 0.5$
Technology	$\alpha = 0.22, \delta = 0.01, S''[1] = 4.75$
Rigidities	$\varepsilon = 10, \theta = 0.8, \chi = 0.6$
Entrepreneur	$\sigma_\omega = 0.5, b/p = 0.33, \overline{\gamma}^e = 3.67$
Intermediation	$\mu = 0.1, \overline{s} = 5.99$
Taylor rule	$\Pi = 1.005, \gamma_R = 0.95, \gamma_\Pi = 0.95$
Debt	$d = 0, d_g = -0.001$
Taxes	$\overline{\tau}_c = 0.05, \overline{\tau}_l = 0.24, \overline{\tau}_R = 0.32$

III. Numerical Results

I simulate the behavior of the economy after different fiscal shocks. The challenge is how to set up experiments that are both meaningfully comparable and informative. A natural option is to look at shocks that impose an equal drag on the budget, that is, a reduction in taxes that lowers revenue in the same amount as the increase in expenditure we are comparing it to. However, even this simple logic faces a number of difficulties: when do we measure this budgetary cost? At impact? Discounted over time? A possibility that is close to much of the political debate (but certainly not the only reasonable one) is to postulate a static scoring rule. I will look at reductions of taxes that generate a fall in revenue at impact, starting at the steady state, equal to (minus) the rise in government expenditure that I will be considering.

In the interest of brevity, I concentrate on the effects of my experiments on output. The main result appears in figure 1, which plots the impulse response functions (IRFs) of output to a 1 percent jump in government expenditure and to the equivalent reduction in each of the three taxes in the economy. In all four cases, the fiscal shocks are debt-financed (and, thus, paid in the medium run by reductions in government expenditure). The most expansionary shock in the

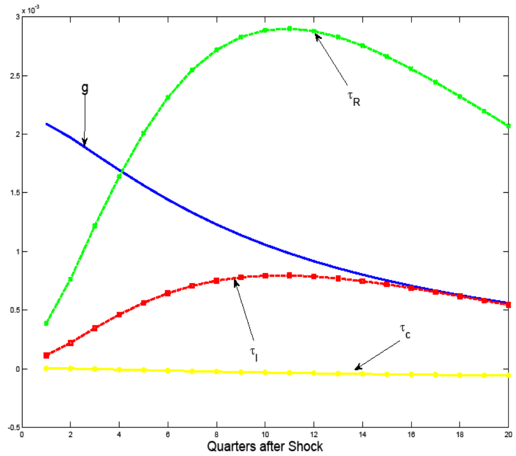

FIGURE 1. IRFS OF OUTPUT TO DIFFERENT FISCAL POLICY SHOCKS

first several quarters comes from government expenditure. The multiplier at impact is nearly 1, a relatively large value for New Keynesian models. The three taxes, by contrast, raise output much less at impact, although lowering the tax on returns of deposits ends up, after a few quarters, having a larger effect (this is just a manifestation of the Chamley-Judd result on taxation of capital).

The reason behind the results is straightforward. A shock to government expenditure increases aggregate demand. Since in the model output is partially demand-determined, this causes an expansion. More interestingly, a shock to government expenditure also raises inflation. Through the "Fisher effect," inflation boosts the wealth of entrepreneurs, reduces the finance premium on their loans, and hence minimizes the crowding out of private investment by government expenditure.

In comparison, reductions in tax rates on labor and returns on deposits lower inflation and, consequently, work in the exact opposite direction to increments in government expenditure: they bring a higher finance premium and a smaller expansion of output (plus the considerable burden of habit persistence, which lowers the consequences of any reduction of taxes on current consumption and hence on aggregate demand). Reductions on the tax on consumption have little bite because, by twisting relative prices, they incentivize consumption and reduce investment, wages, and hours worked.

IV. Conclusion

In an environment with financial frictions, increases in government expenditure can be a more powerful tool than reductions in taxes to stimulate output in the very short run. A central mechanism for this finding is the movements on real wealth created by the "Fisher effect" and the endogenous evolution of the finance premium induced by each fiscal shock.

The implications for welfare are, however, ambiguous. Since I calculate that the multiplier at impact is smaller than 1 (and then it falls quickly), government expenditure crowds out, at least partially, private consumption. The question is, therefore, whether this increase in government expenditure raises the utility of the representative household. The answer depends, though, on what we assume regarding the valuation by the household of that flow of government expenditures. Since the empirical studies have not reached a consensus about this valuation, I omit further discussion.

Another point I have glossed over is the ramifications of the zero bound on nominal interest rates. Christiano, Martin Eichenbaum, and Sergio Rebelo (2009) have recently presented a study of such a situation that suggests that known results on fiscal policy are severely transformed when the bound is binding. Given the computational complexities of having a satisfactory treatment of the issue, I leave this dimension for future work.

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