How Effective is Fiscal Policy in Bad Times?

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Abstract

I develop a model with job rationing *à la* Michaillat (2012a), in which the government buy goods produced by the firms. I examine the magnitude of government spending multipliers in and out of the ZLB. For the ZLB case, I take explicitely into account the fact that the ZLB usually binds when the economy is in a slump, modeled here as a large negative productivity shock. I compare this case to the standard one where the ZLB is the result only of a taste shock. I show that the multiplier is larger in a ZLB environment with low productivity than one without , with both being higher than the multiplier in a boom. The mechanisms behind the high multiplier in the low productivity ZLB are different from the virtuous cycle on real interest rates and private consumption that has been emphasized previously. It relies on the fact that the elasticity of marginal cost to aggregate demand is lower in a recession—consistent with empirical evidence—with the binding constraint on the nominal rate playing only a minor role. When the economy recovers, however, the elasticity of marginal cost to aggregate demand rises and the Taylor principle becomes operative again. In this environment, I show that an austerity policy of lower government spending can send the economy back at the Zero Lower Bound.

1 Introduction

Three years after the American Recovery and Reinvestment Act has been passed, the debate about government spending multipliers is still lively among academics. There is mounting empirical evidence pointing towards bigger government spending multipliers in periods of recession. Using non-linear Vector Auto-Regression methods, Bachmann & Sims (2012) and Auerbach & Gorodnichenko (2012) show that the government spending multiplier is higher when some measure of the output gap is higher than usual.[1] On the theoretical side, attempts to explain this are still going on. Canzoneri et al. (2012), building on a model à la Curdia & Woodford (2010), show that countercyclical financial frictions can make government spending quite effective during recessions, all the more so when it is financed by debt. Focusing on the labor market, Michaillat (2012b) shows that increasing public employment has a larger effect on total private employment in a recession than in an expansion. The reason is that since there is job rationing in a recession and the labor market tightness is low, public employment has a low crowding out effect on private employment in a recession. Aside from those two papers (to the best of my knowledge), most of the papers have been focused on episodes where the Zero Lower Bound (ZLB henceforth) is a binding constraint (see Eggertsson & Woodford (2003), Woodford (2011) or Christiano et al. (2011)). This encompasses very few of the episodes covered by the sample of Auerbach & Gorodnichenko (2012). The mechanism that is typically put forward in those papers is the following : by increasing inflation through higher government spending, the government can reduce real interest rates since the nominal rate is pinned at zero. This will induce people to consume more today, generating more inflation and thus more consumption. At the end of this virtuous cycle stands an output multiplier of about 2. All of these papers use a New-Keynesian model in which prices are set as a markup over future expected marginal costs[2].

Now while the ZLB doesn't always bind in a recession, the ZLB itself is always the *consequence* of a recession. In fact, it has been a binding constraint only three times in recent history : in most of developed countries during the Great Depression, in the United States and EuroZone in the

[1] Owyang et al. (2013), however, using US and Canadian data along with a narrative approach find little evidence for state-dependant multipliers of government spending.

[2] One notable exception is Rendahl (2012), who uses a neoclassical model with a frictional labor market. By lowering unemployment today and tomorrow, government spending increases current output further. This generates a virtuous cycle, which again yields a multiplier of about 2.

Great Recession and in Japan during the "Lost Decade(s)". Three periods which are associated with severe recessions. I do not need to provide a figure showing that unemployment usually rises in a recession. Moreover, Michaillat (2012a) shows that job rationing, *i.e* unemployment that is not due to search and matching frictions, is more prevalent in times of recession. Surprisingly, there is no reference to the dismal state of the labor market in the mainstream literature about the impact of government spending at the ZLB. One might then wonder : is it really this important? Rendahl (2012) shows that it matters a lot. In this paper, I also argue that the answer is yes. One feature of the model developed by Michaillat (2012b) is that hiring is essentially costless in a recession. In fact, empirical evidence tends to show that labor market adjustment occurs largely through the extensive margin in a recession. Since hiring is cheap, one might then conjecture that the elasticity of marginal cost with respect to government spending will be low in a recession, and *a fortriori* when the ZLB binds. Since there is a high degree of slack in the labor market, a recession might precisely be one in which the marginal cost of putting additional resources to use is lower.

This insight is reversed when the economy is on the recovery path. Since there are less idle resources, the cost of producing a marginal unit of output increases. Furthermore, usually the recession leaves the economy with a high burden of public debt. The temptation is thus high to start cleaning up the mess and push trough austerity measures. One example of such austerity measures would be lower government spending (*c.f* the so-called "sequester" in the U.S). In this environment, a sharp decrease in government spending might drive the economy back at the Zero Lower Bound by generating deflation.

I first develop a search and matching frictions with job rationing *à la* Michaillat (2012b), in which I add government spending on goods and a preference shock. I show the intuition of the results by considering the standard New-Keynesian model, which is nested in the previous one. I then perform simulations using the non-linear solution of the full-fledged model. I conclude in the last section.

2 The Model

In this section, I detail a variation of the model proposed by Michaillat (2012b). This model features job rationing, that is, unemployment that is not due to search and matching frictions. It will allow me to analyze the dependence of the output multiplier on how "slack" is the economy.

2.1 The Labor Market

Workers and firms matches are given by the following matching function:

$$m_t = m u_t^{\eta} v_t^{1-\eta},$$

where u_t is the pool of unemployed workers and v_t is the number of vacancies posted. Let $\theta_t \equiv \frac{v_t}{u_t}$ denote the labor market tightness. Firm-worker matches are destroyed at an exogenously given rate s, therefore the pool of unemployed at t is given by $u_t = 1 - (1-s)N_{t-1}$ (the size of the labor force is normalized to 1). Unemployed people find work with probability $f(\theta_t) \equiv \frac{m_t}{u_t} = m\theta_t^{1-\eta}$ and firms fill a vacancy with probability $q(\theta_t) \equiv \frac{m_t}{v_t}$. To recruit, the firm pays a cost of $r \cdot A_t$. Therefore, the recruiting expenses are given by:

$$\frac{rA_t}{q(\theta_t)}[N_t(i) - (1-s)N_{t-1}(i)].$$

The household's employment rate is given by the following law of motion:

$$N_t = (1-s)N_{t-1} + \Big[1 - (1-s)N_{t-1}\Big] f(\theta_t). \tag{1}$$

2.2 The Representative Household

The household is assumed to be large and solve the following maximization program:

$$\max_{C_t, B_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \xi_t \left\{ log(C_t) - \chi \frac{h_t^{1+\varphi}}{1+\varphi} N_t \right\},$$

where ξ_t is a preference shock, h_t is the number of hours worked and φ is the inverse of the Frisch labor supply elasticity. As in **?**, workers pool their income before choosing consumption and so the budget constraint reads:

$$P_t C_t + B_t = P_t h_t N_t W_t + R_{t-1} B_{t-1} + \mathcal{P}_t,$$

where P_t is the price level, C_t is real consumption, B_t are nominal one-period riskless bonds, R_t is the gross nominal interest rate, W_t is the real wage and $\mathcal{P}$ are nominal profits distributed by firms. The first order conditions with respect to C_t and N_t[3] yield:

$$\frac{1}{C_t} = \beta R_t \mathbb{E}_t \left\{ \frac{\xi_{t+1}}{\xi_t} \frac{1}{C_{t+1}} \frac{1}{\Pi_{t+1}} \right\} \tag{2}$$

$$\chi h_t^{\varphi} = \frac{W_t}{P_t C_t} \tag{3}$$

[3] I do not do efficient bargaining on hours as is typically done. This does not matter for the results that I report in the model with job rationing since I only consider the extensive margin. I am currently working on the inclusion of an extensive margin in the model with job rationing.

where $\Pi_t = \frac{P_t}{P_{t-1}} - 1$.

2.3 The Representative Firm

The monopolistically competitive firm—indexed by i—post vacancies to recruit workers, who, once employed produce according to the following production function:

$$Y_t(i) = A_t L_t(i)^{\zeta}, \tag{4}$$

where $L_t(i) = h_t(i)N_t(i)$. The firm is assumed to face costs when changing its price as in **?** and knows the demand facing its product, with elasticity ϵ. The Lagrangian of the firm then writes:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \frac{\beta^t}{C_t}\xi_t \Bigg\{ \left(\frac{Pt(i)}{P_t}\right)^{1-\epsilon} Y_t - W_t L_t(i) - \frac{\phi}{2}\left(\frac{Pt(i)}{P_t} - 1\right)^2 \\ - \frac{rA_t}{q(\theta_t)}[N_t(i) - (1-s)N_{t-1}(i)] + \Lambda(i)\left[L_t(i)^{\zeta} - \left(\frac{Pt(i)}{P_t}\right)^{-\epsilon} Y_t\right] \Bigg\}$$

where $\Lambda(i)$ is the Lagrange multiplier on the firm's production function and will be equal to real marginal cost. Since every firm is identical, the equilibrium will be symmetric as far as firms are concerned and therefore I can drop the index i. The first order condition with respect to P_t then gives the standard New Keynesian Phillips Curve:

$$\epsilon\Lambda_t = \epsilon - 1 + \phi\Pi_t(1+\Pi_t) - \beta\phi\mathbb{E}_t\left\{\frac{\xi_{t+1}}{\xi_t}\frac{C_t}{Y_t}\frac{C_{t+1}}{Y_{t+1}}\Pi_{t+1}(1+\Pi_{t+1})\right\}. \tag{5}$$

Likewise, the first order condition with respect to N_t gives:

$$\zeta A_t \Lambda_t h_t^{\zeta} N_t^{\zeta-1} = h_t W_t + \frac{rA_t}{q(\theta_t)} - \beta(1-s)\mathbb{E}_t\left\{\frac{rA_{t+1}}{q(\theta_{t+1})}\frac{C_t}{C_{t+1}}\right\}. \tag{6}$$

Assumption 1. *As in Blanchard & Gali (2010), the real wage is rigid. That is, for* $0 \leq \gamma \leq 1$,

$$W_t = \omega A_t^{\gamma}$$

where ω is the steady state level of W_t and $\gamma < 1$ is the index of real wage rigidity. The lower γ, the more rigid are real wages, since they react less to variation in technology. As in Michaillat (2012b), this assumption, coupled with decreasing returns with respect to labor implies that there will be job rationing for low enough realizations of the technology process. For low enough A, the real wage will be higher than the marginal product of the worker, who will therefore not be hired. In other words, there will be classical unemployment.

2.4 Fiscal and Monetary Policy

The government finances an exogenous stream of expenses G_t, which it finances levying non-distortionary lump-sum taxes. In contrast to Michaillat (2012b), government spending does not take the form of public employees. While public employees do represent a large share of government spending in the data, I am interested here—as is most of the literature on the effects of government spending —in the effects on aggregate output of the purchase of goods by the government. In fact, public employment did not represent a large share of the American Recovery and Reinvestment Act of 2009, if anything at all.[4] The budget constraint of the government then reads:

$$T_t + \frac{B_t}{P_t} = G_t + \frac{R_t - 1}{P_t} B_{t-1}$$

The Monetary Authority sets the gross nominal interest rate according to:

$$R_t = \max\left\{1, \frac{1}{\beta}(1+\Pi_t)^{\mu_\pi}\right\} \tag{7}$$

2.5 Equilibrium

Substituting the definition of real profits in the household's budget constraint and combining the result with the government budget constraint, one gets the resource constraint of this economy:

$$Y_t\left[1 - \frac{\phi}{2}\Pi_t^2\right] = C_t + G_t + \frac{rA_t}{q(\theta_t)}[N_t - (1-s)N_{t-1}]. \tag{8}$$

3 Labor Market Dynamics at ZLB In a Particular Case : The Baseline New Keynesian Model

In this section, I study the baseline New Keynesian model, which is nested in the more general model I have just described. In fact, taking $s = \eta = m = 1$, equation (1) becomes:

$$N_t = f(\theta_t) = 1.$$

In other words, there is full employment. The only margin by which work effort is adjusted is through hours worked : the intensive margin. I assume

[4] With spending reversals on the state level, one can even argue that the net effect of ARRA on public jobs might be negative.

further that recruiting is costless, *i.e* $r = 0$. Together with $s = 1$ and abstracting from technology shocks this implies that equation (6) becomes:

$$\Lambda_t = \frac{W_t}{\zeta h_t^{\zeta-1}}, \tag{9}$$

real marginal cost is equal to the real wage over the marginal productivity of labor. Finally, with fiscal and monetary policy unchanged, the resource constraint now reads:

$$Y_t \left[1 - \frac{\phi}{2}\Pi_t^2\right] = C_t + G_t.$$

As is well known, the log-linear approximation of this model boils down to the following three equation system:

$$c_t = \mathbb{E}_t c_{t+1} - \left[i_t - \mathbb{E}_t \pi_{t+1} + \log\beta\right] \tag{10}$$

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa\left[(1 + (1-g)\psi)c_t + \psi g_t\right] \tag{11}$$

$$i_t = -\log\beta + \phi_\pi \mathbb{E}_t \pi_{t+1} \tag{12}$$

where $\psi = \frac{\varphi+1-\zeta}{\zeta}$, g is the steady state share of output purchased by the government and $\phi_\pi > 1$.

3.1 The Multiplier at ZLB with Perfectly Flexible Wages

I consider first the standard framework that has been used in most of the literature, which abstracts from real wage rigidity. Again in line with the literature, the economy goes to the Zero Lower Bound as a result of a negative shock to the discount factor. This can be seen as a sudden desire to save more today and therefore consume less. Since aggregate savings are zero in the model (everyone is identical), another force has to bring savings down : output must decrease. This in turn implies a fall in inflation, which triggers a deflationary spiral. The dynamics of the model at the ZLB are given by the following system of two equations:

$$c^L = pc^L + p\pi^L + \delta^L \tag{13}$$

$$\pi^L = \beta p \pi^L + \kappa(1 + \psi(1-g))c^L + \kappa\psi g^L, \tag{14}$$

where the superscript L stands for "low". One can view equation (13) as an Aggregate Demand (AD henceforth) relationship, while (14) stands for an

Aggregate Supply (AS henceforth) relationship. Rewriting these equations with π^L as a function of c^L, it is clear that both AS and AD are increasing functions of c^L. Now taking $c^L = 0$, we see that the intercept of AD is positive while the one for AS is negative. Therefore, for an equilibrium to exist the two lines should cross, which requires that the slope of AD is steeper than for AS. Formally, this condition translates into:

$$(1-p)(1-\beta p) - p\kappa(1+\psi(1-g)) > 0$$

In the remainder, I will refer to the left hand side of this equation as z. Looking at the equilibrium without automatic government spending stimulus ($i.e$ $g^L = 0$), this is the condition that guarantees that there is deflation and a fall in consumption when there is a discount rate shock that takes the economy to the ZLB. In fact, under $g^L = 0$, c^L and π^L are given by:

$$c^L = \frac{1-\beta p}{z}\delta^L \tag{15}$$

$$\pi^L = \kappa\frac{1+\psi(1-g)}{z}\delta^L \tag{16}$$

Since individuals want to save more, real rates should be increasing to be consistent with these expectations : there is deflation. But since there is no capital in this economy, net savings are zero in equilibrium, so a decrease in income is needed to pull savings down. This is why the AS and AD curves will be situated in the southwest part of the (c^L, π^L) space. Before investigating the effects of government spending in a liquidity trap, I make the following standard assumption (see Eggertsson (2011)):

Assumption 2. *The increase in government spending following the discount rate shock is not enough to get out of ZLB. Formally,* $g < -\Gamma_g \times \delta^L$*, where* $\Gamma_g > 0$ *is a function of structural parameters of the model.*

Under Assumption 2 solving equations (13) and (14) system for c^L and π^L gives the following output multiplier:

$$\frac{\partial y^L}{\partial g^L} = 1 + (1-g)\frac{p}{z}\kappa\psi > 1. \tag{17}$$

Once again, the mechanisms behind this result are by now well known (see Eggertsson (2011), Woodford (2011) and Christiano et al. (2011)). Higher government spending generates higher current and future expected marginal costs (because the shock is persistent). This spurs inflation which, combined with the fact that the ZLB is still a binding constraint, reduces the real interest rate. This induces the representative consumer to consume more today with respect to tomorrow. As a result, private consumption is crowded in after a rise in government spending and output reacts more than one for one. As far as the magnitude of the multiplier is concerned, Christiano et al. (2011) show that the multiplier is higher in an economy in which the cost of being in a liquidity trap is more severe. In the current framework, the severeness of the liquidity trap is summarized by the parameter z. The lower z, the more negative consumption and inflation as deviations from the steady state when the economy is in a liquidity trap. For example, the higher p, the longer the expected duration of the liquidity trap episode (which is given by $\frac{1}{1-p}$).[5]. A longer duration for the liquidity trap episode postpones the time of recovery farther away, thus raising the cost of being in the liquidity trap. Here, I choose the baseline value of p so that $z > 0$. The effects of higher government spending in an AS-AD diagram (Figure 8) as well as the dependence of the multiplier on the value of p (Figure 9) can be found in the appendix.Quantitatively, the results are not exactly comparable with the ones of Eggertsson (2011), since the production he uses exhibits constant returns to scale in his framework, whereas it has decreasing ones in my framework. The fact that $\zeta < 1$ influences the parameter mc_t (in Eggertsson (2011), $mc_t = w_t$ and n_t does not appear) as well as the value taken by the elasticity of inflation with respect to marginal cost, κ. In fact, κ will be lower in my framework. In light of these remarks, I take a baseline value for p of 0.78, which gives an output multiplier roughly higher than 2, in line with values reported in Eggertsson (2011), Woodford (2011) and Christiano et al. (2011).

I will now describe what happens in the labor market following the discount rate shock, and then the government spending shock. Why is this important? As the description of the mechanisms has made clear, the elasticity of marginal cost plays a key role. In turn, marginal cost depends on hours worked and the real wage, both of which are determined in the labor market. Understanding what happens in the labor market is then key to understand why government spending is so effective at the ZLB. The labor market equilibrium is depicted in Figure 1

[5]As in most of the literature, I consider an excess-savings liquidity trap. In this framework, the liquidity trap is triggered by a fundamental shock : the increase in the representative consumer's desire to save. If p is higher than a certain threshold however, z becomes negative. In this case, the economy is still in a liquidity trap, but the interpretation is not the same, and so are the mechanisms involved. In fact, they are just the opposite. When $z < 0$, the economy can be said to be in an expectation driven liquidity trap (Mertens & Ravn (2010), building on Schmitt-Grohe et al. (2001))What drives the economy to a liquidity trap in this case in a shock to agent's beliefs. I confine the analysis here to an excess-savings liquidity trap since it is the case that has received the most attention in the literature.

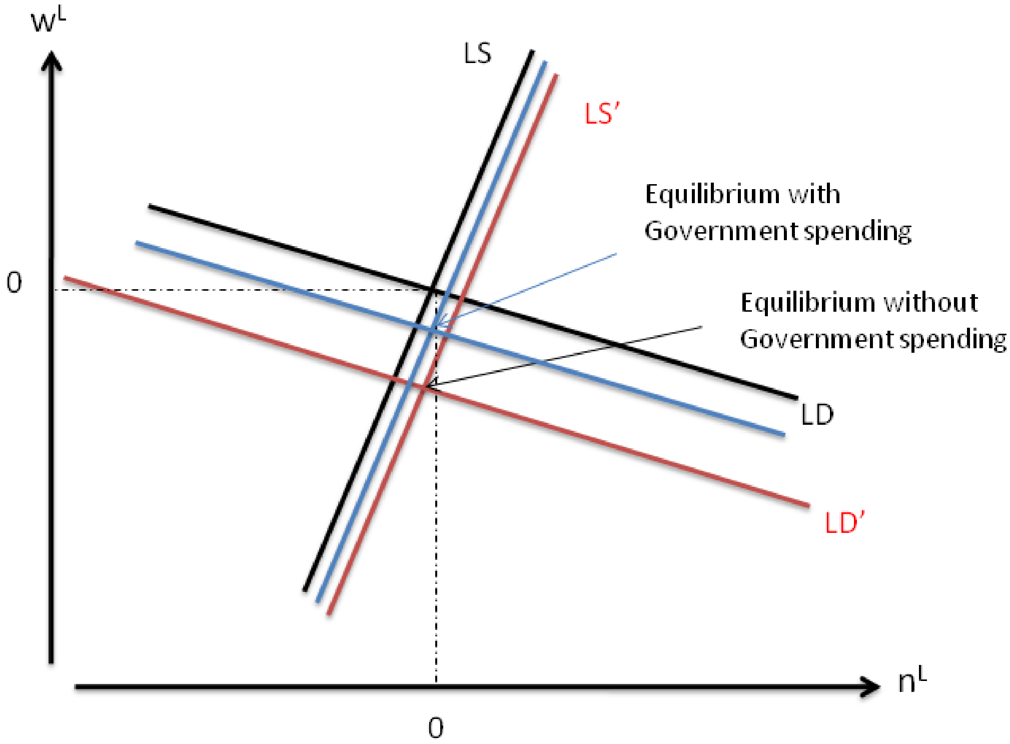

Figure 1: Labor market equilibrium in a liquidity trap, flexible wages.

Since people want to consume less today, output is lower and labor demand falls. Meanwhile, since the marginal utility of consumption is lower, the representative household is willing to work more hours for a given real wage : labor supply shifts right. The net effect is a decrease in marginal cost, so prices decline. This triggers a rise in the real interest rate which induces people to consume less today through the Euler equation : labor demand falls further. The equilibrium is characterized by lower hours worked and real wage —both axis are in deviation from steady state so that a negative value for w^L means a real wage lower than in steady state. One can see that the adjustment occurs mainly through variation in real wages. In fact, without government spending n^L and w^L are given by the following expressions:

$$h^L = \frac{c^L}{\zeta} \quad \text{and} \quad w^L = (\sigma + \varphi)c^L.$$

In most of the literature, reasonable values for σ and φ are typically greater or equal than 1. In particular, Eggertsson (2011) takes $\sigma = 1.16$ and $\varphi = 1.57$.

Therefore, the real wage reacts much more than hours worked do. The same is true after a government spending shock, as can be seen in the graph. When moving from the point where the red lines cross towards the one when the blue cross, the adjustment occurs mainly through real wages. In fact, letting Ω_{cg} and Ω_{ng} denote, (respectively) the impact effect of government spending on consumption (hours worked), the following holds:

$$\frac{\partial w^L/\partial g^L}{\partial h^L/\partial g^L} = \varphi + \sigma\frac{\Omega_{cg}}{\Omega_{ng}}$$

with $\Omega_{cg}/\Omega_{ng} > 0$. What happens after a government spending shock mirrors what happens without. Higher government spending increases labor demand, putting pressure on marginal costs and thus prices. This effect is somewhat dampened by the rise in labor supply due to the negative wealth effect of higher government spending. The net effect of this first round is a rise in inflation, which translates into a decrease in the real interest rate. This in turns begets more spending today, putting again negative pressure on the real interest rate. This continues until the real interest rate has adjusted sufficiently to equal supply and demand of goods.

As we have just seen, this virtuous circle depends largely on flexible real wages. It is because real wages—and thus, real marginal costs—react strongly after a government spending shock that inflation plays a key role. Using the baseline specification, I get a multiplier of 2.3, in line with the literature. I also get the following values for the elasticities of real wages, hours worked and marginal cost with respect to the government spending shock:

$$\frac{\partial w^L}{\partial g^L} = 8.45, \quad \frac{\partial mc^L}{\partial g^L} = 9.46$$

which seem to be rather high.

Suppose now that the initial rise in real wages is dampened. Then the whole virtuous cycle is dampened and the output multiplier is likely to be lower. I investigate this possibility now.

3.2 Labor Dynamics with Real Wage Rigidity

What motivates this subsection is the fact that an economy stuck at the ZLB is an economy in a recession. While we do not have, to the best of my knowledge, evidence on the reaction of real wages to a government spending shock at the ZLB, we do have evidence on the reaction of real wages in a typical recession. Auerbach & Gorodnichenko (2012), in particular, study the effects of government spending shocks in and out of recessions. They

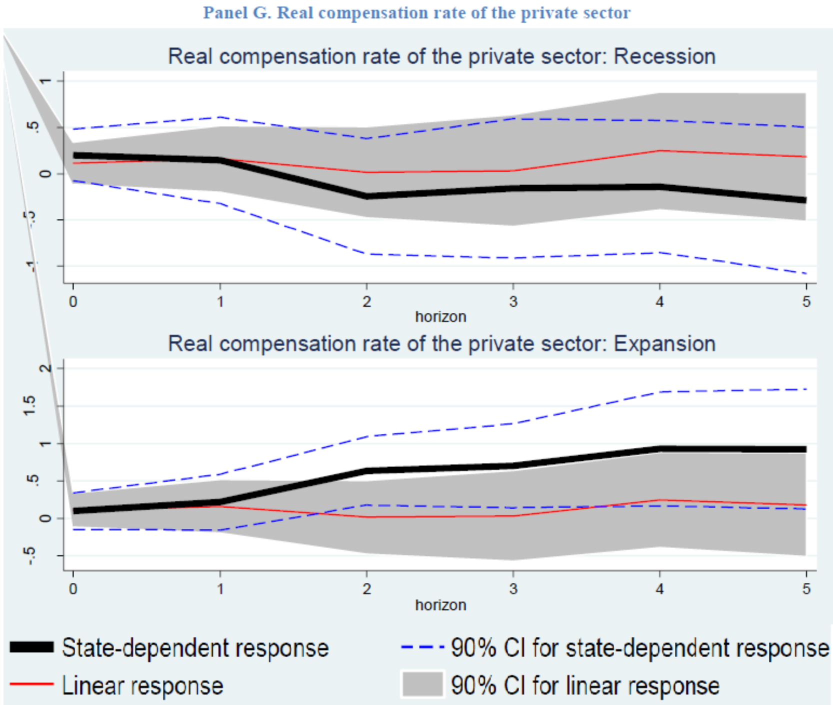

Figure 2: Effects of a government spending shock on real wages. Source : Auerbach & Gorodnichenko (2012).

report results for a comprehensive set of macro variables. I reproduce the ones for real wages in Figure 2. One can see from those impulse responses that real wages do not essentially react to a government spending shock in a recession. As we have seen in the preceding subsection, this can have important implications for the magnitude of the multiplier.

To capture this, I make use of Assumption ??.[6] When the real wage is rigid, actual employment and desired supply of labor will not be equal[7] : there will be unvoluntary unemployment. Accordingly, as in Blanchard & Galí

[6]In an earlier version of the paper, I assumed that real wages could not go below its steady state level, *i.e* $w \geq 0$. With this assumption, the fact that $w = 0$ binds is a consequence of the preference shock. The expression I derive are then the same under both assumptions at the ZLB. In normal times however, $w = 0$ will bind if real wages are downwardly rigid only if there is a negative government spending shock, but not a positive one. When I consider a negative government spending shock in the next subsection, I state the results in a more general form that encompasses rigid and flexible real wages.

[7]Labor supply will be given by the level of hours that equates the real wage to the marginal rate of substitution between consumption and leisure, equation (3). Labor demand, on the other hand, will be given by the level of hours that equates the marginal product of labor to the real wage, equation (9)

(2007), I define the rate of unemployment, $\tilde{u}$, as the percentage deviation from steady state between the desired supply of labor and actual unemployment:

$$\tilde{u} = h^s - h^d$$

Using the labor demand and supply equations, I get the following expression for the rate of unemployment in a liquidity trap:

$$\tilde{u} = n^s - n^d = -\frac{\zeta + \varphi}{\zeta\varphi} c > 0.$$

Then, if government spending is enough to fill the output gap (so that $c = 0$), unemployment will go to zero as well. The labor market equilibrium after a discount rate shock is depicted in Figure 3.

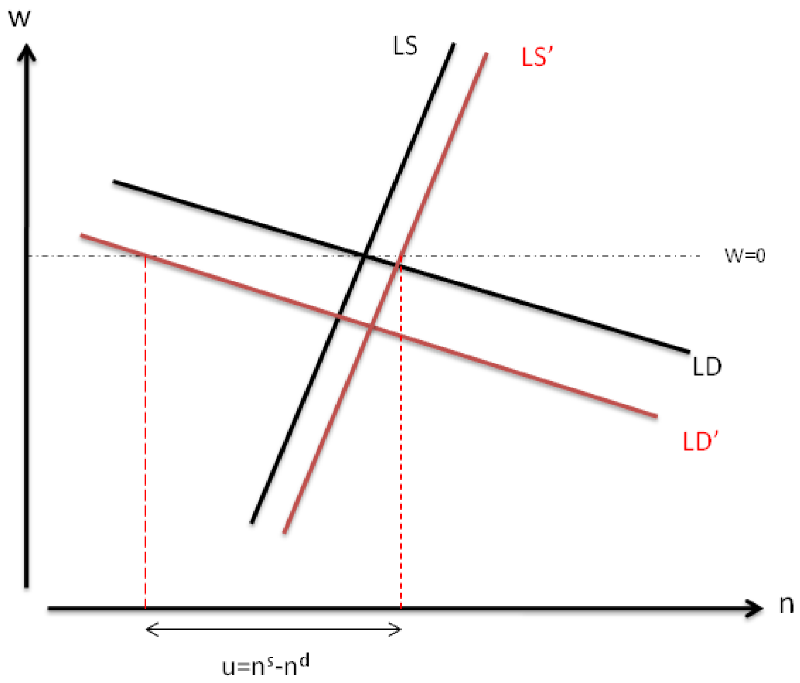

Figure 3: Labor market equilibrium in a liquidity trap with rigid real wages, $g^L = 0$.

Now that the wage is not responsive anymore, what are the effects of government spending in a liquidity trap? Under Assumption 2, and since the real wage does not react after a government spending shock, the multiplier is given by the following expression:

$$\frac{\partial c}{\partial g} = \frac{p\kappa(1-\zeta)}{(1-p)(1-\beta p) - p\kappa(1-\zeta)} < \frac{\partial c^L}{\partial g^L} \tag{18}$$

Why is the consumption (and also the output) multiplier lower than in the setting with perfectly flexible real wages? Assume that there is constant returns with respect to hours. Log-linearization of equation (9) gives $mc_t = w_t + (1-\zeta)h_t$. Since the real wage does not deviate from its steady-state value, the only feature that can put upward pressure on real marginal costs is decreasing returns to scale. Assuming constant returns ($\zeta = 1$) then implies that real marginal costs do not react at all after a government spending shock. In turn, inflation does not react so the real interest rate does not move. Individuals are not pushed to consume more today, so there is no second round effect on private consumption. The only effect on output will then come from government spending. In fact, one can see from (18) that, for constant returns to scale, $\partial c/\partial g = 0$. Since, from the resource constraint $y = (1-g)c + g$, we get that $\partial y/\partial g = 1$. This is the multiplier for constant real interest rate derived in Woodford (2011).

3.3 The Austerity Driven ZLB and the Mistake of 1937

When the economy recovers, unemployment decreases gradually. According to the argument I have put forward, real marginal costs should be more elastic to aggregate demand in the recovery period. As the economy gets closer to full capacity, it becomes more costly to produce a marginal unit of output. Additionaly, countries typically enter the recovery phase with a lot of public debt. The temptation to enact sharp austerity measures is then high. In fact, this is what is being done right now in the U.S and in Europe. Both of these economic units are still constrained by an effective Zero Lower Bound. We know the effects of a negative shock to government spending when the nominal interest rate is pinned at zero (see Eggertsson (2011)): it is (very) contractionary. The multiplier of a negative shock to government spending is just minus the one for positive government spending. Whatever the elasticity of real marginal cost to aggregate demand is, the multiplier of negative government spending will be lower or equal to -1. In this framework then, austerity in a liquidity trap is very damaging.

What I want to investigate is the effect of a negative shock to government spending when the recovery phase is well under way, *i.e* when the Taylor Rule starts to be operative again. In the U.S for example, this has been subjected to unemployment going back to 6.5%. But if we look at what happened during the Great Depression, taking the 3 Month Treasury Bill as the effective nominal interest rate, the Taylor principle was re-activated before unemployment went back to its 1929 level. In fact, unemployment was still close to 15%.

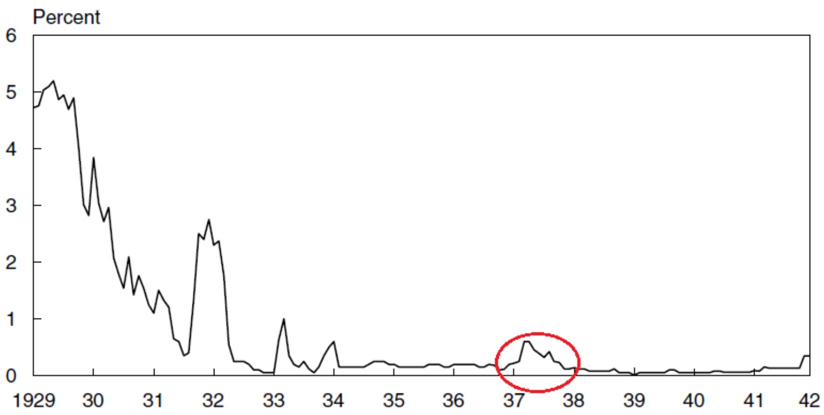

Figure 4: 3 Month Treasury Bill, source : Eggertsson(2006), *My Emphasis*

Shortly after, by fear of excessive inflation, the Roosevelt administration engaged in an austerity program while nominal rates were just beginning to rise. A large increase in payroll taxes was enacted along with a decrease in government spending. Eggertsson & Pugsley (2006) argues that those actions, coupled with higher reserve requirement from the Fed, sent signals of lower inflation which triggered a depression : the Mistake of 1937. While this may be true, I want to emphasize another mechanim, which is the aggregate demand effect of government spending.[8] Solving the system of three equations (10), (11) and (12) by the method of undetermined coefficients, I get the policy rule for inflation in terms of government spending, $\pi_t = \Omega_\pi g_t$, with $\Omega_\pi > 0$. From the Taylor rule, the Zero Lower Bound constraint reads then:

$$g_t \leq \frac{\log \beta}{\rho \Omega_\pi \Phi_\pi} < 0 \tag{19}$$

The higher the elasticity of marginal cost to both private and government consumption, the easier it is to satisfy this condition. In fact, Ω_π is given by

[8] I concentrate only on government spending and not on taxes here. Introducing distortionary taxes in this model can yield misleading results since such taxes are not desired in a representative agent framework (see Werning (2007)). To really investigate the impact of higher payroll taxes, one would need to consider an heterogenous agent model in which distortionary taxes would actually play a role. I leave this for future research.

the following expression:

$$\Omega_\pi = \frac{(1-\rho)\frac{\partial mc_t}{\partial g_t}}{\beta(1-\rho)(1-\beta\rho) + \rho\frac{\phi_\pi - 1}{\beta}\frac{\partial mc_t}{\partial c_t}}$$

The assumption of rigid wages has the effect as removing the φ term from ψ in equation (11). This reduces the elasticity of real marginal cost to aggregate demand (private and government consumption). In turn, since in the expression for Ω_π the elasticity with respect to government consumption dominates, rigid wages reduces Ω_π and thus a larger government spending shock is necessary for equation (19) to be satisfied. In the polar case of rigid wages and constant returns, $\frac{\partial mc_t}{\partial c_t} = \frac{\partial mc_t}{\partial g_t} = 0$, and thus $\Omega_\pi = 0:$ the required negative government spending shock to bring the economy at the ZLB again is infinite. Since inflation does not react to aggregate demand in this case, the ZLB will never bind as a result of a negative government spending shock. If wages are flexible however, this condition will be easier met. Since wages—and more generally, marginal costs—will be more elastic with respect to aggregate demand in the recover phase, this condition is likely to be more constraining. However, this conclusion rests on an log-linear approximation that is only valid close to the steady state. If the required government spending shock is too large, this conclusion might not hold any more. I investigate the robustness of this mechanims in the full model, which is solved non-linearly.

4 Government Spending and the ZLB in a Model with Job Rationing

It is not a new idea that the government spending multiplier depends on the shock that sends the economy at the Zero Lower Bound. For example, Christiano et al. (2011) show that the more persistent the taste shock, the more efficient government spending will be to boost consumption and output. But this relies on the fact that the persistence is not too high, otherwise, the algebra behind the multiplier is consistent with a liquidity trap arising from self-fulfilling expectations (see Mertens & Ravn (2010)). In this case, the multiplier on consumption is negative : an increase in government spending deepens the liquidity trap. As is said in the introduction, those papers do not consider that the labor market can be severely disrupted when the ZLB is a binding constraint. In a recent paper, **?** consider the effects of being at the ZLB on the dynamics of unemployment, and how the presence of search and matching frictions influences the size of the government spending multiplier. However, both unemployment and the ZLB are the consequence of the negative discount factor shock in this framework. I take a slightly different route here : along with the standard taste shock, the economy is hit with a negative productivity shock. The slump is an economy that is hit with both shocks.

Since the shock is large, one needs to consider non-linear methods to solve the model as it departs substantially from the steady state. I follow Michaillat (2012b) and simulate the model using a shooting algorithm, implemented in DYNARE.

4.1 Calibration

For the moment, I take the model without an intensive margin, *i.e* $\chi = 0$. The share of government spending with respect to output is set to 20%. The rest of the calibration is similar to the one in Michaillat (2012b), which is set at a weekly frequency.

4.2 The Multiplier in Good/Bad times

I consider here the response of output other macroeconomic variables to a government spending shock of 1%, conditional on the occurrence of a large positive/negative technology shock. The size of the negative productivity shock is large enough to push the economy into a liquidity trap for 9 periods.

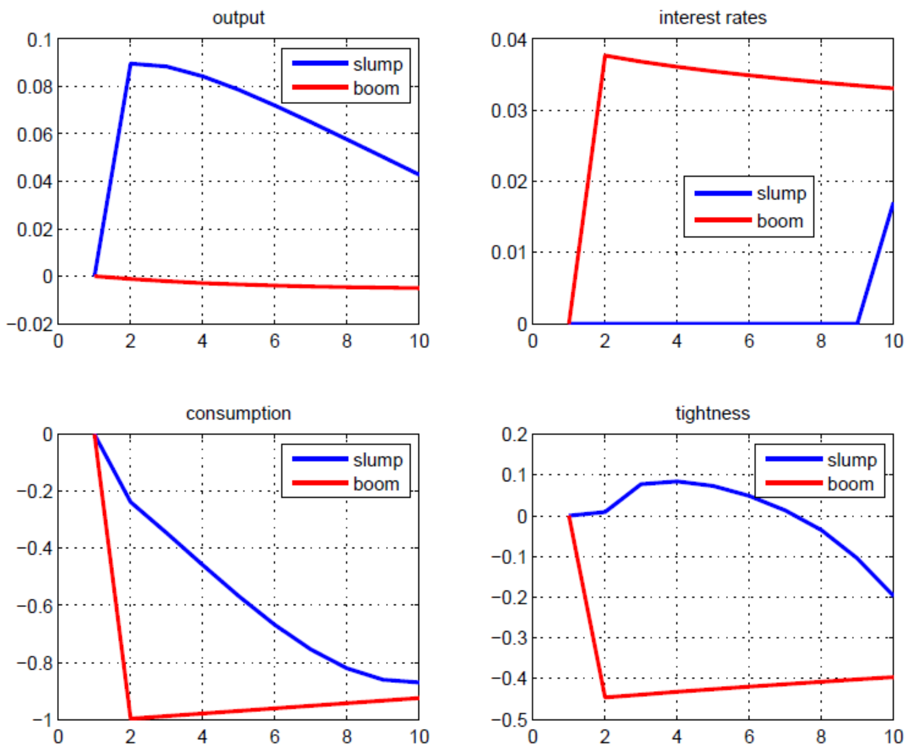

Figure 5: ***Government spending multipliers in a boom and in a slump***

The first feature to stand out of this picture is the size of the government spending multiplier on output : it is very small in magnitude in both cases. To understand why, recall than when faced with a (positive) government spending shock, the household in a standard New Keynesian model has two choices : work more or consume less. Here there is no trade-off for the household since there is no labor supply decision from the household. The only margin he has is to dampen the negative wealth shock induced by higher government spending is to consume less. In fact, he does precisely this, almost one for one in the "boom" case. Furthermore, because of logarithmic utility, the household is not very risk averse and doesn't mind moving its consumption with a large elasticity on impact. More technically, in the resource constraint equation, replacing the production function with its expression, we are left with two state variables, N_t and A_t and to jump variables : C_t and θ_t. The later ones react quickly to the government spending shock, but since output ultimately depends on labor, it is slow to react. This is why the output multiplier is so small.

Now, why is the output multiplier higher in a boom? First, since the slump induces a binding constraint on the nominal rate, the rise in government spending is not compensated almost one for one by a decrease in private consumption. So necessarily, the reaction of output will be higher. But what can also be observed is that the ratio of the increase/decrease in output over the increase/decrease in labor market tightness is much higher in a slump. In a boom, there is a large decrease in labor market tightness associated with a mild decrease in output : in a boom, we are on the steep locus of the quasi-labor demand, in which the adjustment goes mainly through labor market tightness. On the contrary, in a slump, the adjustment goes mainly through actual employment because, after a large negative productivity shock we are on the "nearly flat" locus of the labor supply curve. This is consistent with empirical evidence (see van Rens (2012)).

4.3 The Multiplier at ZLB

I will now take a look at the government spending multiplier(s) at the ZLB. I consider two cases. First, the one that has been considered by most of the literature so far in which the ZLB arises as a consequence of a negative taste shock only, without any productivity shock. Then, I will compare it with the case—studied is the last subsection—where the ZLB arises as a consequence of a large negative productivity shock coupled with a standard taste shock. In both setups, the economy is stuck at the Zero lower bound for 9 periods. The results are in Figure 7.

I focus on the period at which the economy is stuck at the ZLB, that is 9 periods. What can be observed is that for the model featuring only a shock on preferences of the household, the virtuous cycle is at play. A rise in government spending raises marginal cost and thus inflation, whith the nominal interest rate pinned at zero, *consumption is crowded in*. This puts further upwards pressure on labor demand, so output and inflation increase in turn, which decreases further the real interest rate, prompting the household to consume more today.

For the model featuring negative taste and productivity shocks however, there is job rationing. Therefore marginal cost, and thus inflation rises less after a government spending shock. In fact, the rise in inflation is not large enough to prompt households to consume more today : private consumption is mildly crowded out after a rise in government spending at the ZLB. As a consequence, there is less pressure on labor demand and labor market tightness increases significantly less. But, as I have pointed before, the relatively low rise in tightness (with respect to the case with a preference shock) is associated to a comparatively higher increase in total employment. In other words, for a given increase in tightness, the increase in employment —and thus, output—is higher in the model with job rationing than in the model without.

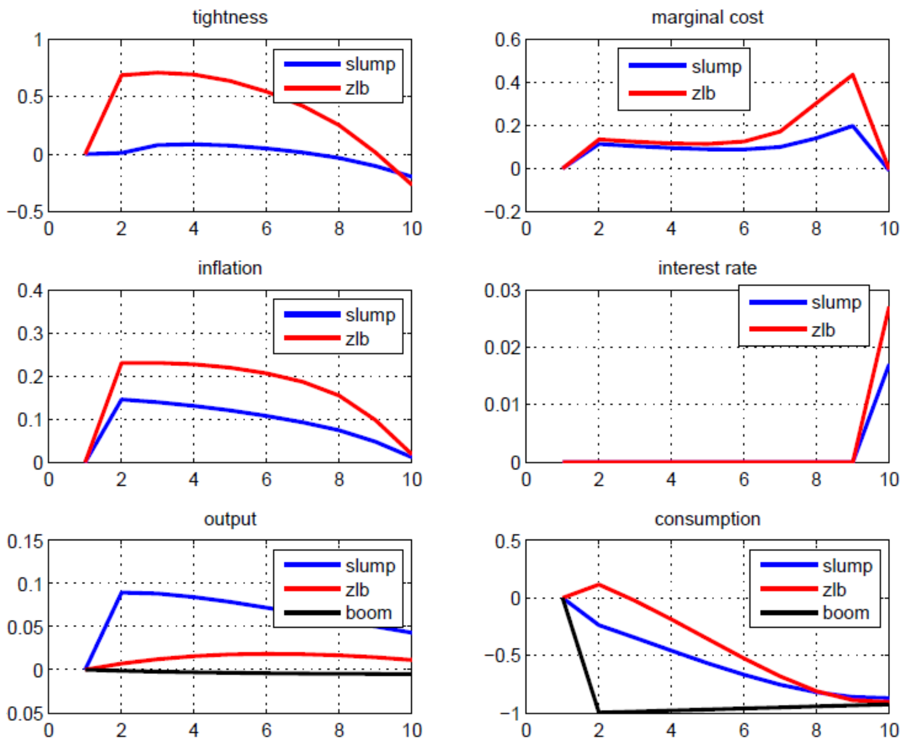

Figure 6: ***Government spending multipliers at ZLB, with and without productivity shocks***

As in the "toy model" without a rigid real wage presented in the last section, the elasticity of inflation with respect to the government spending shock is higher in the model with a preference shock. Auerbach & Gorodnichenko (2012) show that the response of inflation to a government spending shock is slightly negative in a typical recession. The model with job rationing is therefore closer to the actual behavior of an economy in recession. A good test to further discriminate the two approaches would be to study the response of labor market tightness after a government spending shock in a recession. One counterfactual result of the model with a negative productivity shock is that consumption is crowded out in this case. My conjecture is that by adding consumption habits into the utility function, this feature will vanish, for the reasons I have alluded to earlier to explain the small magnitude of the output multiplier. The inclusion of such habits will also probably give output multipliers more in line with empirical evidence.

At the end of the day, the more salient feature to explain higher government spending multipliers at the ZLB is the fact that hiring people to meet the extra demand generated by higher government spending is essentially costless in a slump, and not the fact that higher inflation will prompt households to consume more today.

4.4 Aggregate Demand Effects of Austerity in the Full Model

In this subsection, I simply model the effects of a negative government spending shock when the economy is at steady state. Using data from **?**, I simulate the decrease in total government spending (Federal plus State and Local) from 1936 to 1937. This amounts to $\frac{G}{Y} = 0.14$ and $\frac{G_t - G}{G} = -0.03$. The results are reported in Figure 7. One can see that the intuition of the log-linear model carries forward to the non-linear one with job rationing. A negative government spending shock has the potency to bring back the economy at the Zero Lower Bound. To stabilize debt then, for a given amount to save with respect to output, one would rather prefer a negative shock that is less pronounced but more persistent.

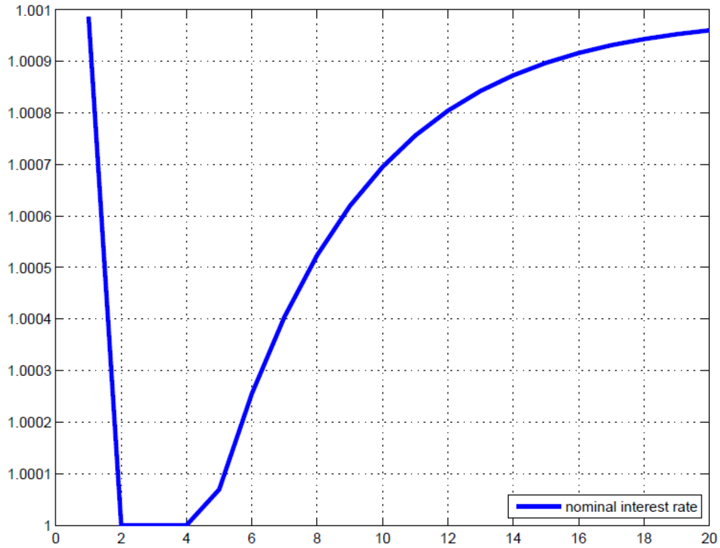

Figure 7: ***Impact of a negative 3% negative spending shock on nominal rates***

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A Figures

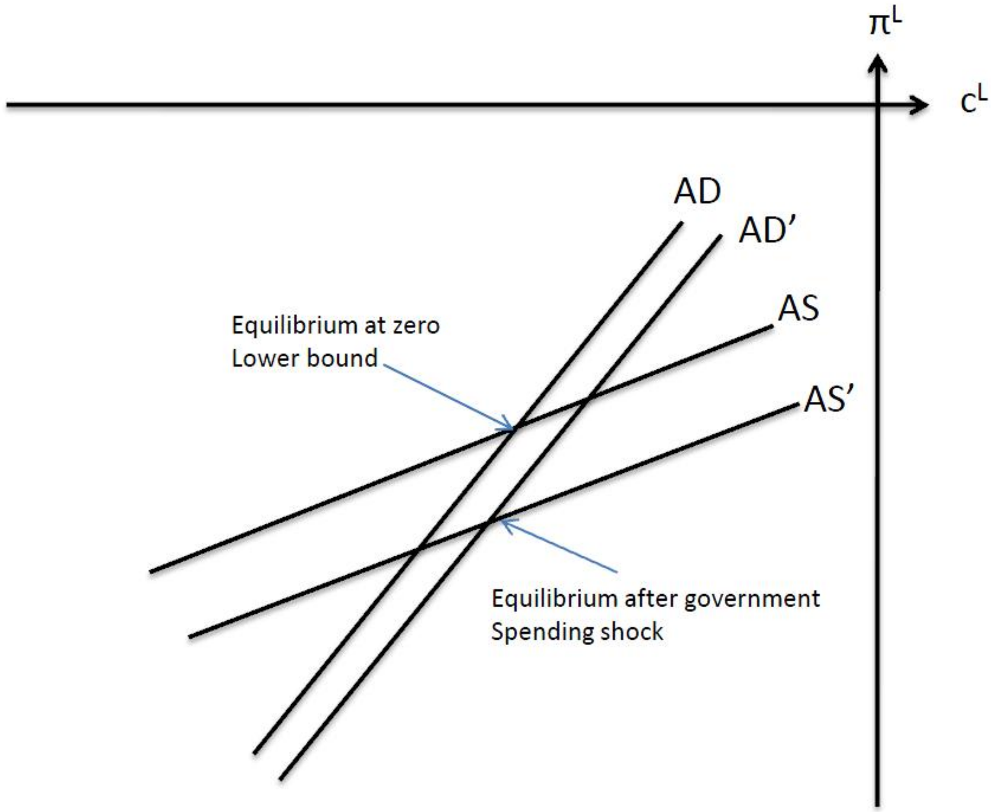

Figure 8: Effects of a government spending shock in an excess-savings liquidity trap.

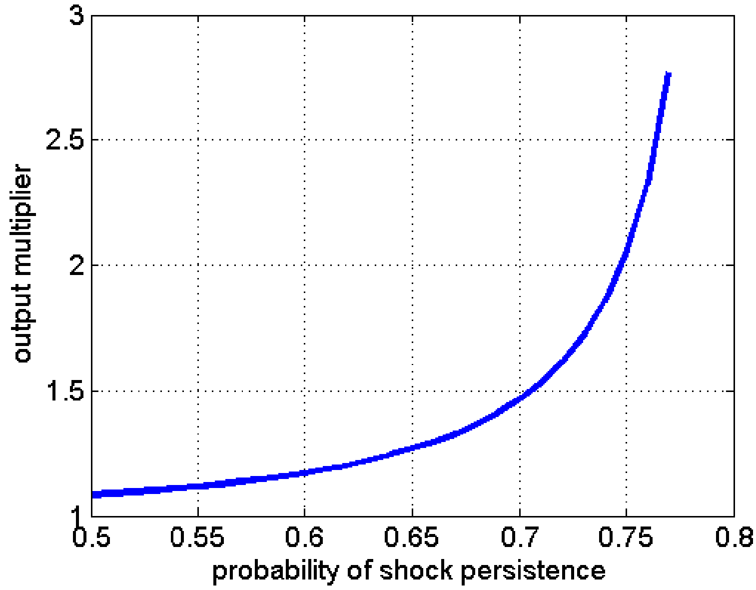

Figure 9: Effects of a government spending shock as a function of p.