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IS BUDGETARY POLICY MORE EFFICIENT THAN MONETARY POLICY TO STABILIZE THE COVID SHOCK?

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Abstract

With a simple macro-economic modelling, wehighlight the respective potential advantages of monetary and budgetary policies in the framework of a both negative demand and supply shock like the COVID crisis. We show the ambiguous consequences of an expansionary monetary policy: inflationary tensions and the increase of the real wage candepress labor demand and supply. Furthermore, if monetary policy is constrainedor if wages are rigid, monetary policy cannot avoid a global recession proportional to the negative demand shock. Therefore, budgetary policies would be more appropriate to fight the recessionary consequences of a complex shock likethe COVID. More precisely, the best fiscal policy appears to decrease the consumption taxation rate morethan the negative demand shock. Besides, whatever the degree of wages rigidity, increasing the relative share of public investment in comparison with public consumption expenditure would be very efficient to stabilize a negative supply shock.

Keywords: Supply shocks, demand shocks, COVID-19, monetary policy, budgetary policies

JEL Classification Codes: E24, E30, J20

INTRODUCTION

In response to the COVID-19 crisis, governments and public health authorities around the world implemented confinement measures (lockdown and quarantines). These measures led to the shutdown of entire sectors of the economy, especially those that supply economic activities and services involving high physical contact with other people, such as restaurants, hairdressers, airlines, tourist places and entertainments, etc. Besides, workers who stay at home were prevented from producing goods and services. Therefore, the COVID-19 implied a negative supply shock in some production sectors, the most affected being restauration, tourism (hospitality), or leisure in particular. On the contrary, sectors where the job can be done at home were much less affected. As negative supply shock, this crisis reduced both the available labor force and the productivity of workers. Furthermore, as mentioned by Baldwin and Weder di Mauro (2020), the health crisis hit China first, which is today the leading country in production of industrial intermediate goods (particularly in electronics, automobiles, machinery and equipment), and for the world global economic production and demand. So, a 'supply chain contagion' has been quickly propagated to all industrialized nations' manufacturing sectors.

On the other hand, the confinement and the closure of many establishments required the obligation for many workers to stay home, and some of them even lose their job and their income. Therefore, at home and often with a weaker (or sometimes even with no) salary, consumers reduced their consumption of goods and services. This, combined with uncertainty about the evolution of the pandemic, led to a reduction in demand for nearly all goods and services, except obviously for food. Indeed, self-isolated customers had fewer opportunities to spend. Besides, faced with uncertainties about future economic prospects, they were tempted to cut down spending even further. Only some scarce sectors benefited from a positive demand shock; for example, retail trade, as people stopped going to restaurants and started buying more groceries and cooking at home. The information sector also benefitted, likely due to increased interest of firms by telework software and arrangements.

Therefore, the consequences of the COVID-19 combine aspects of both negative supply and demand shock, affecting asymmetrically the various sectors of the economy. A supply shock reduces the economy's ability to produce goods and services at given prices. A demand shock reduces consumers' ability or willingness to purchase goods and services at given prices. Which one is predominant in case of the current crisis? Brinca *et al.* (2020) estimate a Bayesian structural vector auto-regression on monthly statistics of hours worked and real wages for the US Economy. They find that two-thirds of the 16.24 percentage point drop in the growth rate of hours worked in April 2020 are attributable to supply.

In the same way, Bekaert *et al.* (2020) extract aggregate demand and supply shocks for the US economy during the COVID-19 crisis from real-time survey data on inflation and real GDP growth. They attribute two thirds of the decline in 2020:Q1 GDP to a negative shock to aggregate demand. In contrast, they estimate that two thirds of the decline in GDP in 2020:Q2 was due to a reduction in aggregate supply. Auray and Eyquem (2020) also show that Keynesian supply shocks can arise in one-sector models with sticky prices, incomplete markets and unemployment risk. They find that the effects of lockdown policies are huge on unemployment. Output falls dramatically and debt-output ratios increase by several tens of percentage points. In addition, the surge in unemployment risk triggers a rise in precautionary saving, implying Keynesian supply shocks: aggregate demand falls by more than aggregate supply, and lockdown policies are deflationary. Unfortunately, the authors also show that raising public spending and extending Unemployment Insurance benefits stimulate aggregate demand or improve risk-sharing, but have little effects on output and unemployment.

More precisely, Guerrieri *et al.* (2020) assume that the COVID can be qualified of 'Keynesian supply shock': in a multiple sectors economy, a negative supply shock which triggers a demand shortage that leads to an endogenous contraction in output and employment larger than the supply shock itself. In this case, standard fiscal stimulus can be less effective than usual because agents with the highest propensity to consume are the one with the strongest difficulties and constraints. Low substitutability across sectors and incomplete markets, with liquidity constrained consumers, all contribute towards the possibility of Keynesian supply shocks. Nevertheless, monetary policy can then prevent firm exits, if it is weakly constrained.

In this framework, the COVID crisis implied an unprecedented large fiscal response in all countries to support health systems and to provide support to vulnerable households, firms, and economic activity sectors: additional spending or temporary tax cuts to compensate for foregone revenues, loans, guarantees and equity injections by the public sector. In all countries, the public deficits and debts increased to unprecedented levels. These policies provided the necessary support in the short run; however, they could also have long term implications. Wage subsidies preserved jobs and worker-firm relations, but may slow the allocation of the labor force and the adjustment on the labor market, the fundamental sectoral reallocation. Besides, there is a risk that temporary tax deferrals and cuts become permanent, reduce public resources and aggravate the public indebtedness level and the problem of its sustainability.

However, in the current crisis, there is strong complementarity between monetary and fiscal policy. Central banks (US Federal Reserve, European Central Bank, Bank of England, Bank of Japan) have also implemented quantitative easing measures, in particular purchases of corporate bonds. In Europe, high borrowing needs of governments are accommodated by low interest rates and asset purchases of the ECB, ensuring favorable financing conditions. Fielder *et al.* (2020) mention that while these expansive monetary policies are appropriate given downward pressure on inflation at already subdued levels, these policies ultimately amount to monetary financing. First, bond purchases of the central bank are sufficiently large to fully cover government net lending. Second, when a sovereign debt crisis was looming in March 2020, the ECB was quick to ensure capital market access for all Member States by announcing the Pandemic Emergency Purchase Program (PEPP). Third, the central bank has become governments' single biggest creditor, which creates strong interdependencies: by holding that much public debt, the central bank plays a major role in the financing of governments. Indeed, ECB involvement in bond markets strongly affects financing conditions of governments; and interest payments on bonds held by the central bank eventually flow back to government budgets.Finally, in July 2020, the European governments adopted a program called 'Next Generation EU', and for the first time in history, the issuing of joint debt (quasi 'Eurobonds') was decided in Europe, reinforcing the fiscal integration.

Which economic policies are the most efficient, in the very difficult current economic framework? Monetary policy can lack efficiency when approaching the ZLB constraint. Indeed, Caballero and Simsek (2020) underline the key mechanism of heterogeneous risk tolerance: as a recessionary shock hits the economy and brings down asset prices, risk-tolerant (banks) agents' wealth share declines. This reduces the market's risk tolerance (households are mostly risk intolerant) and generates downward pressure on asset prices and aggregate demand, even exceeding the decrease in supply. Then, monetary policy could offset the decline in risk tolerance with an interest rate cut. However, if the interest rate policy is constrained, new contractionary feedbacks arise: recessionary shocks lead to further asset price and output drops. In this context, unconventional monetary policy and Large Scale Asset Purchases are necessary to improve asset prices and aggregate demand by transferring risk to the government's balance sheet. Indeed,Correia *et al.* (2013) underline that when the Zero Lower Bound on nominal interest rates binds, monetary policy cannot provide appropriate stimulus. However, they show that in the standard New Keynesian model, tax policy can deliver such stimulus at no cost and in a time-consistent manner. Whatever policy can do with the nominal interest rate can be done with a combination of labor income, consumption, and capital income taxes.

Furthermore, the IMF (2020) underlines the necessity of increasing public investment in the context of the current COVID crisis. Indeed, it underlines that investment multipliers are particularly high in a framework of strong and unusually large macroeconomic uncertainty. In this context, public investment can act as a catalyst for private investment to take off. The IMFestimates that a 1% of GDP increase in public investment, in advanced economies and emerging markets, has the potential to push GDP up by 2.7%, private investment by 10% and, most importantly, to create between 20 and 33 million jobs, directly and indirectly. Investment in health and education and in digital and green infrastructure can connect people, improve economy wide productivity, and improve resilience to climate change and future pandemics. Priorities include developing well-resourced and better-prepared healthcaresystems, expanding digital infrastructure, and addressingclimate change and environmental protection.According to the IMF (2020), scaling up of quality public investment can have a powerful impact on employment and activity, crowd in private investment, and absorb excess private savings without causing a rise in borrowing costs. In case of a strong negative supply shock, Fornaro and Wolf (2000) also underline that a supply-demand doom loop might take place, amplifying the supply disruption directly caused by the virus. Then, this epidemic might make the global economy vulnerable to stagnation traps, to episodes of low growth and high unemployment driven by pessimistic animal spirits. While monetary easing can help mitigate the drop in global demand, their analysis suggests that aggressive fiscal policy interventions to support investment will be needed to push the global economy out of stagnation.

In the economic literature, budgetary policies are often considered as efficient to sustain economic activity in the framework of the current negative shock due to the COVID. For example, Woodford (2011) shows that in New-Keynesian models, sticky prices or wages allow for larger multipliers than in neoclassical models. Amultiplier well in excess of one is even possible when monetary policy is constrained by the zero lower bound, and welfare increases if government purchases expand to partially fill the output gap that arises from the inability to lower interest rates. Nevertheless, Bilbiie *et al.* (2019) underline that government spending at the ZLB is not necessarily welfare enhancing, even when its output multiplier is large. With a New-Keynesian model, they show that when spending does not provide direct utility, it is generically welfare-detrimental. Even when government spending provides direct utility to the household, its optimal level is at most 0.5-1 percent of GDP for recessions of -4%.

Furthermore, in case of a severe negative shock like the COVID, renationalizing the productiondoes not seem to be the appropriate solution.

Indeed, Bonadio*et al.* (2020) study the role of global supply chains in the impact of the Covid-19 pandemic on GDP growth for 64 countries, and they show that the average real GDP downturn due to the Covid-19 shock is expected to be - 29.6%, with one quarter of the total due to transmission through global supply chains. However, 'renationalization' of global supply chains would not make countries more resilient to pandemic-induced contractions in labor supply, and would even be slightly harmful. Indeed, eliminating reliance on foreign inputs increases reliance on the domestic inputs, which are also disrupted due to nationwide lockdowns. According to the authors, even the renationalization of some specific sector would not be beneficial. Moreover, Schmidt (2013) studies the respective roles of monetary and budgetary policies as stabilization tools in an environment of low interest rates where the Zero Lower Bound can bind. According to the author, when the policymaker is able to credibly commit to state-contingent future policy actions, monetary policy alone is able to offset most of the adverse effects arising from the zero lower bound, and budgetary policy should be less active. However, under discretion, the welfare losses associated with the presence of the zero lower bound constraining monetary policy can largely be compensated by a more active budgetary policy.

Besides, Baqaee and Farhi (2020) show that downward nominal wage rigidities always weakly magnify the impact on output of negative supply shocks: in equilibrium, the shocks can endogenously reduce demand more than supply in some factor markets, push them against their downward nominal wage rigidity constraint, and lead to Keynesian unemployment.Furthermore, negative supply shocks are necessarily stagflationary. On the other hand, negative aggregate demand shocks are deflationary, and once they are large relative to the negative supply shocks, they amplify Keynesian unemployment and output effects. Besides, the authors analyze policy responses to the Covid-19 shock; they show that indiscriminate fiscal stimulus is wasteful and should instead be targeted towards the sectors that use more intensively, directly and indirectly through the network, the depressed factors.

In this framework, with a simple macro-economic modelling, the current paper studies analytically the respective potential advantages of monetary and budgetary policies to stabilize a both negative demand and supply shock like the COVID crisis. Then, we show the ambiguous consequences of an active and expansionary monetary policy. Indeed, inflationary tensions and the increase of the real wage can then depress labor demand and supply. Therefore, budgetary policy would be more appropriate to fight the recessionary consequences of a shock as complex as the COVID. More precisely, the best fiscal policy appears to allow a decrease of the consumption taxation rate in order to stabilize the negative demand shock, and to increasethe relative share of public investment in comparison with public consumption expenditure in order to stabilize the negative supply shock.

The rest of the paper is organized as follows. The second section presents the basic analytical model, with its representative actors and its calibration. The third section studies the stabilization of the labor market, and the fourth section the stabilization of the various components of global demand, in case of flexible or rigid wages' fixation. The fifth section recalls the respective advantages of monetary and fiscal policies in the stabilization of negative demand or supply shocks. Finally, the sixth section concludes the paper.

2. THE MODEL

We consider a simple New-Keynesian model of a country, with a representative household maximizing its consumption and a representative firm maximizing its profit. Monetary policy defines the nominal interest rate, whereas governments use four instruments: consumption and labor taxation rates, investment and consumption public expenditure.

2.1. Households

In a given period (t), the representative householdis supposed to maximize the following inter-temporal utility function:

$$max \sum_{k=t}^{\infty} \beta^{k-t} E_t[U_k] \tag{1}$$

Where: Et() is the rational expectation operator conditional on information available at date (t), and (β) is the time discount factor. Prices of goods, interest rates, taxation rates and wages are taken as given by the representative household.

We suppose that the utility function of a representative household is as follows:

$$U_t = \alpha_c \frac{\theta}{(\theta-1)} (C_t)^{\frac{(\theta-1)}{\theta}} + \alpha_g \frac{\theta}{(\theta-1)} (G_t)^{\frac{(\theta-1)}{\theta}} - \alpha_l \frac{1}{(1+\varphi)} (L_t^s)^{(1+\varphi)} \tag{2}$$

With: (C_t): real private consumption; (G_t): public consumption; (L^s_t): labor supply, hours worked. The indices ($0<\alpha_c<1$), ($0<\alpha_g<1$) and ($0<\alpha_l<1$) are the respective weights given to consumption of private goods, consumption of public goods and leisure in this utility function.

So, utility is an increasing and concave function of (C_t), an index of the household's consumption of all goods that are supplied; ($\theta>1$) is the elasticity of intertemporal substitution. Utility is also an increasing and concave function of real public goods and services provided in the home country (G_t). However, in this additive utility function, public consumption doesn't affect the marginal utility of private consumption. Finally, utility is also a decreasing and convex function of the hours worked (L^S_t), where ($\varphi \geq 0$) is the inverse of the Frisch elasticity of labor supply, the inverse of the elasticity of the work effort with respect to the real wage.

This maximization is subject to a life time and inter-temporal nominal budget constraint, for whatever date (t) considered. Regarding its expenditure, the representative household consumes goods (including taxes) and it purchases government bonds. Regarding its resources, the representative household receives labor revenues, as well as gains from government bonds holding from the previous period. For simplicity, we suppose that these financial assets are only riskless one-period nominal government bonds. We also avoid here lump-sum taxation and transfers made to households, as we suppose that both can offset each other. So, a household flow budget constraint for each period (t) is as follows:

$$(1+t_t^c)P_tC_t + B_t = \left(1-t_t^l\right)W_tL_t^s + (1+i_{t-1})B_{t-1} \tag{3}$$

With, in period (t): (P_t): level of consumer prices; (W_t): nominal hourly wage; (t_t^l): taxation rate on labor income; (t_t^c): taxation rate on consumption; (it): nominal interest rate; (B_t): nominal value of riskless one period bonds at the end of period (t).

Summing equation (3) to obtain an intertemporal constraint, with: $\lim_{t\to\infty} B_t$=0, we have:

$$(1+t_t^c)P_tC_t + E_t[\sum_{k=t}^{\infty}\frac{(1+t_{k+1}^c)P_{k+1}C_{k+1}}{(1+i_t)\dots(1+i_k)}]$$

$$= (1-t_t^l)W_tL_t^s + E_t[\sum_{k=t}^{\infty}\frac{\left(1-t_{k+1}^l\right)W_{k+1}L_{k+1}^s}{(1+i_t)\dots(1+i_k)}] + (1-i_{t-1})B_{t-1} < \infty \tag{4}$$

Current consumption and anticipated consumption for all future periods mustn't exceed current labor revenues and anticipated revenues for all future periods. Therefore, in this model, we allow for the possibility to borrow from one period to another, but we limit anticipated future revenues in order to avoid the possibility of Ponzi schemes.

The result of the maximization of equation (1) under the constraint (4) implies the following first order Euler conditions, for whatever period (t):

$$\frac{1}{(1+t_t^c)P_{i,t}}\frac{\partial U_t}{\partial C_t} = \frac{\beta(1+i_t)}{(1+t_{t+1}^c)P_{t+1}}\frac{\partial E_t(U_{t+1})}{\partial C_{t+1}} = \frac{\beta^k(1+i_{t+k-1})\dots(1+i_t)}{(1+t_{t+k}^c)P_{t+k}}\frac{\partial E_t(U_{t+k})}{\partial C_{t+k}} \quad (5)$$

Furthermore, by combining equations (2) and (5), ($\forall t$), we have:

$$C_t = \left[\frac{(1+t_{t+1}^c)E_t(P_{t+1})}{\beta(1+t_t^c)(1+i_t)P_t}\right]^\theta E_t(C_{t+1}) \quad (6)$$

So, in logarithms and in variations from long run (steady state) equilibrium values, we have:

$$c_t = E_t(c_{t+1}) - \theta[i_t - E_t(\pi_{t+1})] - \theta\left|\widehat{t_t^c} - E_t\left(\widehat{t_{t+1}^c}\right)\right] - \theta ln\beta \quad (7)$$

With:$[\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}]$: inflation rate; $x_t = \ln\left(\frac{X_t}{X}\right)$; $\widehat{t_t} = \ln\left(\frac{t_t}{t}\right)$.

Besides, for the representative agent, we obtain the following optimal substitution between private consumption, public consumption and working time 1:

$$\frac{\partial U_{t+k}}{\partial C_{t+k}} = -\frac{(1+t_{t+k}^c)P_{t+k}}{\left(1-t_{t+k}^l\right)W_{t+k}}\frac{\partial U_{t+k}}{\partial L_{t+k}^s} = t_{t+k}^c\frac{\partial U_{t+k}}{\partial G_{t+k}} \qquad (\forall k) \quad (8)$$

Therefore, a higher real wage net of taxes reduces the marginal utility of leisure and increases the one of labor. Furthermore, regarding labor supply, according to equations (2) and (8), in logarithms and in variations from their long run equilibrium values, we obtain[2]:

$$l_t^s = \frac{1}{\varphi}(w_t - \pi_t) - \frac{1}{\varphi}(\widehat{t_t^l} + \widehat{t_t^c}) - \frac{1}{\varphi\theta}c_t \quad (9)$$

So, labor supply increases with the real wage, but it decreases with taxation rates (t_t^l and t_t^c) and with the disutility of working time (φ).

Besides, equations (2) and (8) imply the following variation in public consumption[3]:

$$g_t = c_t + \theta \widehat{t_t^c} \tag{10}$$

Therefore, private consumption increases less than global public expenditure and the budgetary multiplier is smaller than one if the consumption taxation rate increases. However, our model will allow to distinguish the various components of this budgetary expenditure.

2.2. Firms

The representative firm produces a differentiated good in a monopolistic competition setting. It defines prices in order to maximize its profit, taking other variables as given. In this paper, we consider a short run framework where capital is fixed. So, the production function of the representative firm has the following form (lowercase letters for variations):

$$Y_t = (E_t^s)\left(L_t^d\right)^{(1-\nu)}\left(G_t^{inv}\right)^{z_1}(G_t^c)^{z_2} 0 < \nu < 1 \qquad 0 < z_2 < z_1 < 1 \tag{11}$$

$$y_t = (1-\nu) l_t^d + z_1 g_t^{inv} + z_2 g_t^c + e_t^s \tag{12}$$

With: (Y_t): real economic activity; (L_t^d): labor demand by firms; (G_t^{inv}): public investment; (G_t^c): public consumption expenditure; (E_t^s): supply, technology or productivity shock;(1-?): share of labor in the production function; (z_1) or (z_2): productivity of public expenditure.

Indeed, we suppose that public expenditure is made freely available by the government, and can be more (z_1 is high) or less (z_2 is small) efficient in increasing labor productivity. Therefore, investment public expenditure (G_t^{inv}) is supposed to be more productive than consumption public spending (G_t^c), which implies ($z_1 > z_2$), whereas: ($G_t = G_t^{inv} + G_t^c$).

The firm maximizes its nominal profit: $\Pi = P_t Y_t - W_t L_t^d$. So, this implies[4]:

$$\frac{W_t L_t^d}{P_t Y_t} = (1-\nu) = cste \tag{13}$$

In logarithms and in variations, we have: $l_t^d = y_t - (w_t - \pi_t)$ (14)

Therefore, by combining equations (12) and (14), we can obtain:

$$l_t^d = \frac{z_1}{\nu} g_t^{inv} + \frac{z_2}{\nu} g_t^c - \frac{1}{\nu}(w_t - \pi_t) + \frac{1}{\nu} e_t^s \tag{15}$$

Labor demand by firms increases with public expenditure, with the public capital supplied for the production function. Labor demand also decreases with the real wage, but increases with a positive supply and productivity shock.

We consider a Calvo-type framework of staggered priced, where a fraction ($0<\alpha<1$) of goods prices remain unchanged each period, whereas prices are adjusted for the remaining fraction ($1–\alpha$) of goods. Then, New-Keynesian models can define a micro-founded inflation rate [see for example Correia *et al.* (2013)], which is as follows:

$$\pi_t = \beta E_t(\pi_{t+1}) + k_1(mc_t - \pi_t) \qquad with\colon k_1 = \frac{(1-\alpha)(1-\alpha\beta)}{\alpha} > 0 \tag{16}$$

Where (mc_t) is the variation of the nominal marginal production cost of the representative firm.

Using equation (11), the nominal marginal production cost of the quantity (Y_t) is[5]:

$$MC_t = \frac{\partial(W_t L_t^d)}{\partial Y_t} = \frac{W_t(Y_t)^{\frac{\nu}{1-\nu}}}{(1-\nu)(E_t^s)^{\frac{1}{1-\nu}}\left(G_t^{inv}\right)^{\frac{z_1}{1-\nu}}(G_t^c)^{\frac{z_2}{1-\nu}}} \tag{17}$$

Therefore, we obtain the following variation of the real marginal production cost:

$$(mc_t - \pi_t) = (w_t - \pi_t) + \frac{\nu}{(1-\nu)} y_t - \ln(1-\nu) - \frac{1}{(1-\nu)} e_t^s - \frac{z_1}{(1-\nu)} g_t^{inv} - \frac{z_2}{(1-\nu)} g_t^c \tag{18}$$

Besides, according to equations (9) and (14), the real wage offered by the representative firm should increase with economic activity and with taxation rates:

$$(1+\varphi)(w_t - \pi_t) = \varphi y_t + \frac{1}{\theta} c_t + \left(\widehat{t_t^l} + \widehat{t_t^c}\right) \tag{19}$$

Therefore, equations (16), (18) and (19) imply the following inflation rate:

$$\pi_t = \beta E_t(\pi_{t+1}) + \frac{k_1(\nu+\varphi)}{(1-\nu)(1+\varphi)} y_t + \frac{k_1}{\theta(1+\varphi)} c_t - \frac{k_1 z_1}{(1-\nu)} g_t^{inv} - \frac{k_1 z_2}{(1-\nu)} g_t^c$$

$$+\frac{k_1}{(1+\varphi)}\left(\widehat{t_t^l}+\widehat{t_t^c}\right)-k_1\ln(1-\nu)-\frac{k_1}{(1-\nu)}e_t^s \quad (20)$$

Indeed, current prices increase with anticipated future prices. The real wage, real marginal production costs and prices also increase with private economic activity (c_p, y_p), because of the expansionary effect of economic activity on labor demand and employment. However, public expenditure (z_1 and z_2) can improve the efficiency of the production technology and labor productivity, and it can then decrease real production costs. Higher taxation rates (t_t^c, t_t^l) increase the real wage required by households, and thus the inflationary tensions. Obviously, real marginal production costs and prices also decrease with positive supply and technological shocks (e_t^s).

2.3. Global equilibrium

We are now going to derive the equilibrium on the goods market regarding the global demand. Clearing on the goods market in period (t) requires:

$$Y_t = C_t + G_t + E_t^d \quad (21)$$

Therefore, in variations, we obtain: $y_t = (\frac{C}{Y})c_t + (\frac{G}{Y})g_t + e_t^d$ (22)

Where$[e_t^d = \frac{E_t^d}{Y}\ln(E_t^d)]$ is a demandshock, for example related to private investment and to net exports.So, by combining equations (7), (10) and (22), we obtain:

$$y_t = E_t(y_{t+1}) - \theta\frac{(C+G)}{Y}[i_t - E_t(\pi_{t+1}) + ln\beta] - \theta\frac{C}{Y}\left|\widehat{t_t^c} - E_t(\widehat{t_{t+1}^c})\right] + [e_t^d - E_t(e_{t+1}^d)] \quad (23)$$

According to equation (23), higher future expected output increases current output and consumption, because households prefer to smooth consumption. Current output is also a decreasing function of the excess of the real interest rate above its natural and equilibrium level ($-ln\,\beta$), because of the inter-temporal substitution of consumption. Besides, temporary higher consumption taxes decrease, while a temporary demand shock increases, economic growth.

By combining equations (10) and (22), we can also obtain the following variations of the various components of global demand, if we note $(e_t^{g,inv})$ a shock on public investment:

$$c_t = \frac{Y}{(C+G)} y_t - \theta \frac{G}{(C+G)} \widehat{t_t^c} - \frac{Y}{(C+G)} e_t^d \tag{24}$$

$$g_t^{inv} = g_t + e_t^{g,inv} = \frac{Y}{(C+G)} y_t + \theta \frac{C}{(C+G)} \widehat{t_t^c} - \frac{Y}{(C+G)} e_t^d + e_t^{g,inv} \tag{25}$$

$$g_t^c = \frac{G}{G^c} g_t - \frac{G^{inv}}{G^c} g_t^{inv} = \frac{Y}{(C+G)} y_t + \theta \frac{C}{(C+G)} \widehat{t_t^c} - \frac{Y}{(C+G)} e_t^d - \frac{G^{inv}}{G^c} e_t^{g,inv} \tag{26}$$

Furthermore, according to equations (20), (24), (25) and (26), the supply function and the inflation rate is as follows:

$$\pi_t = \beta E_t(\pi_{t+1}) + k_1 k_2 y_t + \frac{k_1}{(1+\varphi)} \widehat{t_t^l} - k_1 \left[\frac{1}{\theta(1+\varphi)} - \frac{(z_1+z_2)}{(1-\nu)}\right] \frac{Y}{(C+G)} \left(e_t^d - \theta \frac{C}{Y} \widehat{t_t^c}\right)$$

$$- \frac{k_1}{(1-\nu)} e_t^s - \frac{k_1}{(1-\nu)} \left(z_1 - z_2 \frac{G^{inv}}{G^c}\right) e_t^{g,inv} - k_1 \ln(1-\nu) \tag{27}$$

$$\text{with: } k_2 = \frac{(\nu+\varphi)}{(1-\nu)(1+\varphi)} - \left[\frac{(z_1+z_2)}{(1-\nu)} - \frac{1}{\theta(1+\varphi)}\right] \frac{Y}{(C+G)} > 0$$

We have already mentioned that inflationary tensions increase with labor taxation rates and with economic activity. Besides, they decrease with a positive supplyshock or with a shock on public investment. The effect of demand shocks or of a variation of the consumption taxation ratewould depend on the calibration of our parameters (see the following section 2.4)[6].

In order to complete this global equilibrium, we suppose that the nominal interest rate increases with the excess of the increase of the current inflation rate above its targeted level (with a weight: α_π^M),and with the excess of the increase of economic activity above its targeted level (with a weight: α_y^M). So, we obtain the following variation of the nominal interest rate:

$$i_t = \alpha_\pi^M (\pi_t - \bar{\pi}) + \alpha_y^M (y_t - \bar{y}) \tag{28}$$

With ($\bar{\pi}$): variation of the targeted inflation rate; ($\bar{y}$): variation of the targeted economic activity.

2.4. Calibration of the Parameters

We consider a standard calibration of the parameters of our model, in conformity with the economic literature. However, in the following sections 3 to 5 of the paper, we will mention and analyze the sensibility of our results to variations of these parameters, in order to know if the propositions derived from the model are always and largely valid, or if they are only valid for some specific calibrations.

The preference for the present (β) is usually calibrated at ($\beta = 0.99$) in the economic literature. Regarding private consumption, the elasticity of intertemporal substitution (θ) has a weak value of (0.5) in Leeper *et al.* (2011) or in Bilbiie*et al.* (2019). It has higher values in other papers, whereas it is assumed to be (1) in Galí*et al.* (2007) or in Coenen and Straub (2005), where consumption appears in logarithm in the utility function (consistent with log preferences). In this paper, we will consider a basic value of: ($\theta = 0.5$). The calibration of the inverse of the Frisch elasticity of labor supply (φ) is very heterogeneous in the economic literature, going from (0.2) in Gali *et al.* (2007), (0.5) in Bilbiie *et al.* (2019), until (2) in Coenen and Straub (2005) or in Leeper *et al.* (2011). In this paper, we will consider ($\varphi = 0.5$).

The EUTAX model of Sorensen (2001) calibrates the share of capital in the production function at ($\nu = 0.33$), and we can retain this value often used in the economic literature. The degree of price rigidity is usually calibrated around ($\alpha = 0.75$).The productivity of public consumption expenditure is estimated around ($z_2 = 0.05$) in Sims and Wolff (2013) or in Carvalho and Martins (2011), whereas the productivity of public capital investment (highly productive) is calibrated at ($z_1 = 0.16$) in Carvalho and Martins (2011).

Eurostat mentions that in the European Union, the share of private households' consumption in GDP and in global demand is around: $\left(\frac{C}{Y} = 0.54\right)$, whereas the share of public consumption in GDP is around $\left(\frac{G}{Y} = 0.20\right)$. Besides, in public expenditure, Gross Fix Capital Formation and public investment expenditure would be quite limited, about 3% of GDP. So, these values imply$[\frac{G^{inv}}{G^c} = \frac{\frac{G^{inv}}{Y}}{(\frac{G}{Y} - \frac{G^{inv}}{Y})} \sim \frac{3}{17}]$, andwe will retain the following value: ($\frac{G^{inv}}{G^c} = 0.18$).

3. THE LABOR MARKET

We can now detail the consequences of a negative supply and demand shock like the COVID on economic variables; we will begin by analyzing the labor market.

Using equations (9) and (24), labor supplied by households is as follows:

$$l_t^s = \frac{1}{\varphi}(w_t - \pi_t) - \frac{1}{\varphi\theta}\frac{Y}{(C+G)}\left(y_t - e_t^d\right) - \frac{1}{\varphi}\widehat{t_t^l} - \frac{1}{\varphi}\frac{C}{(C+G)}\widehat{t_t^c} \tag{29}$$

So, labor supply increases with the real wage ($w_t - \pi_t$), but it decreases with the labor taxation rate(t_t^l) amputating labor remuneration, and with the consumption taxation rate(t_t^c) amputating the real utility to consume. Labor demand by firms is given by equation (14); it increases with economic growth, but it decreases with the real wage. Therefore, the situation and the equilibrium on the labor market depends on the flexibility of the real wage.

3.1. If wages are flexible

Using equations (12), (14), (25), (26), (29), (A1) and (A3) in Appendix A, we obtain the following real wage and labor supply and demand,which allow the equilibrium between labor supply and demand on the labor market[7]:

$$\left[1 + \theta\alpha_y^M \frac{(C+G)}{Y}\right](w_t - \pi_t) = -\frac{(\alpha_y^M - \varphi)}{(1+\varphi)}\left(e_t^d - \theta\frac{C}{Y}\widehat{t_t^c}\right) + \frac{1}{(1+\varphi)}\left[1 + \theta\alpha_y^M \frac{(C+G)}{Y}\right]\widehat{t_t^l} - \frac{1}{\theta(1+\varphi)}\left[1 + \varphi\theta\frac{(C+G)}{Y}\right]\Phi_t \tag{30}$$

$$\left[1 + \theta\alpha_y^M \frac{(C+G)}{Y}\right]l_t = \frac{\left(1 + \alpha_y^M\right)}{(1+\varphi)}\left(e_t^d - \theta\frac{C}{Y}\widehat{t_t^c}\right) - \frac{1}{(1+\varphi)}\left[1 + \theta\alpha_y^M \frac{(C+G)}{Y}\right]\widehat{t_t^l} + \frac{1}{\theta(1+\varphi)}\left[1 - \theta\frac{(C+G)}{Y}\right]\Phi_t \tag{31}$$

$$\Phi_t = f\left[-i_{t+n}, \widehat{t_{t+n}^l}, -e_{t+n}^s, e_{t+n}^d, -\widehat{t_{t+n}^c}, -e_{t+n}^{g,inv}, \bar{\pi}, \bar{y}\right] \quad with\ n \geq 1$$

A negative demand shock increases the real wage, but it decreases the hours worked. A negative supply shock usually decreases both the hours worked and the real wage, as in Brinca*et al.* (2020). However, it is more ambiguous in the framework of our model, where a temporary supply shock would have no consequence on the labor market. Only a future anticipated supply shock would have any impact. A negative demand shock like the COVID usually increases thecurrent real wage [$\frac{\partial(w_t-\pi_t)}{\partial(-e_t^d)}$=0.11 with our basic calibration] and reducescurrent labor demand and supply.[$\frac{\partial l_t}{\partial(-e_t^d)}$ = –0.90 with our basic calibration].Furthermore, the increase of the current real wage is an increasing function of the monetary activism intended to sustain economic activity(α_y^M). Indeed, after a negative demand shock, monetary policy should be more expansionary to sustain global demand. This expansionary monetary policy is then inflationary and increases the real wage[$\frac{\partial(w_t-\pi_t)}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to\infty]{}\frac{1}{(1+\varphi)\theta\frac{(C+G)}{Y}}\sim 1.80$] (see Figure 1). Nevertheless, if monetary activism is weak or constrained (if: $\alpha_y^M<\varphi$), the real wage could also decreaseafter a negative demand shock [$\frac{\partial(w_t-\pi_t)}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to 0]{}-\frac{\varphi}{(1+\varphi)}\sim -0.33$]. On the contrary, if monetary policy is more active and if(α_y^M) is higher, the inflationary consequences can be stronger on the real wage, and labor supply and demand are more reduced on the labor market[$\frac{\partial l_t}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to 0]{}-\frac{1}{(1+\varphi)}\sim -0.67$ whereas: $\frac{\partial l_t}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to\infty]{}-1.80$]..

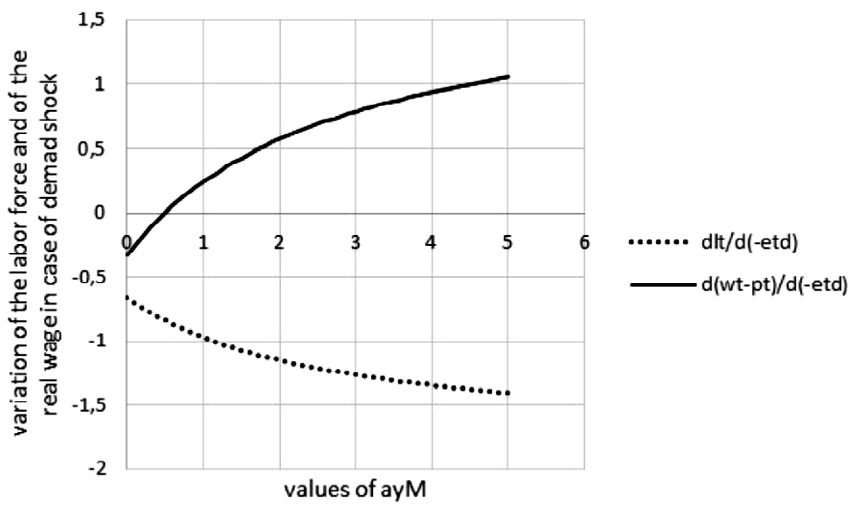

Figure 1: Labor demand and supply and real wage after a negative demand shock of 1%, according to the monetary activism

Besides, a negative demand shock increases the real wage only if the Frisch elasticity of labor supply (1/ φ) is sufficiently high, because a higher wage can then contribute to increase labor supply$[\partial(\frac{\partial l_t}{\partial e_t^d})/\partial\varphi < 0]$ and to compensate for the recessionary consequences of theshock. The increase of the real wage as well as the decrease of labor demand and supply are also accentuated if the share of private consumption and of public expenditure in GDP (C/Y or G/Y) are weak, or if the elasticity of intertemporal substitution of consumption (θ) is weak, because monetary policy is then less efficient to influence economic activity.

3.2. If wages are rigid

However, wages are not empirically fully flexible in developed countries. Therefore, what would be the consequences of a negative demand and supply shock if wages were not flexible but rigid, if: $(w_t - \pi_t) = 0$? In the framework of wages rigidity, equations (14) and (15) imply the following variations of economic activity and labor demand:

$$l_t^{d,R} = y_t^R = \frac{z_1}{\nu} g_t^{inv,R} + \frac{z_2}{\nu} g_t^{c,R} + \frac{1}{\nu} e_t^s \quad (32)$$

Labor supply$(l_t^{s,R})$ could then be stabilized with a specific shock on public investment8. Indeed, whatever the monetary policy, we obtain$(l_t^{s,R}$=0) if and only if:

$$l_t^{d,R} = y_t^R = -\theta \frac{(C+G)}{Y} \widehat{t_t^l} + \left(e_t^d - \theta \frac{C}{Y} \widehat{t_t^c} \right) \quad (33)$$

So, economic activity and labor demand are reduced by a negative demand shock, and the unemployment rate increases exactly proportionately to the negative demand shock, if wages are rigid.Therefore, our macroeconomic modelling would show that in case of a strong negative demand shock, wages rigidity would accentuate the risk of huge increase of the unemployment rate. Is this theoretical teaching supported by empirical data?

Branten *et al.* (2018) show that the frequency of wage changes declined (higher wages rigidity) after the Great Recession in 2008, in particular because of the slower wage growth.Regarding the share of wage cuts prevented by Downward Nominal Wage Rigidity, they estimate that in 2013, it was weaker in Greece (0.57), the United-Kingdom (0.71), the Czech Republic (0.86), Romania (0.87), Germany, Italyor Ireland (0.88), but higher in Spain (0.91), Lithuania (0.93), Latvia (0.94), Portugal (0.96), the Netherlands (0.98), Belgiumor France

(0.99). In parallel, in August 2020, the unemployment rate was weaker in the Czech Republic (2.7%), the United-Kingdom (3.9%), Germany (4.4%), the Netherlands (4.6%), Belgium (5.1%),Ireland (5.2%), Romania (5.3%),but higher in France (7.5%), Portugal (8.1%), Latvia (8.8%), Lithuania (9.6%), Italy (9.7%), Spain (16.2%) or Greece (18.3%).So, wages flexibility could contribute to favor the holding of a weak unemployment rate in the United-Kingdom, the Czech Republic, Romania, Germany or in Ireland, whereas on the contrary, wages rigidity could participate to explain the high unemployment rate in Spain, Lithuania,Latvia, Portugal or in France. Therefore, improving wages flexibilitycould be an efficient economic policy to avoid the harmful consequences in terms of unemployment of ashock like the COVID.

3.3. Optimal fiscal policy regarding taxation rates

Our model shows that there is an optimal budgetary policy which is very efficient to stabilize negative demand shocks. Indeed, whatever the degree of wages rigidity on the labor market, decreasing the consumption taxation rate more strongly than the negative demand shock $[\widehat{t_t^C} = \frac{1}{\theta}\frac{Y}{C} e_t^d \sim 3.70\, e_t^d$ with our basic calibration] avoids any effect on the labor market.More precisely, the consumption taxation rate should decrease more strongly if the elasticity of intertemporal substitution of private consumption (θ) or if the share of private consumption in GDP (C/Y) is small. Indeed, after a negative demand shock, if the elasticity of intertemporal substitution of consumption (θ) is weak, an expansionary monetary policy anda weaker interest rate are less efficient to sustain economic activity andglobal demand. Budgetary policy should then be more active, as a weaker consumption taxation rate and using fiscal policy are more efficient to sustain private consumption and global demand (see Figure 2). In the same way, ifthe share of private consumption in GDP (C/Y) is weak, fiscal policy must be more active.

Empirically, we can mention that to support EU businesses with regards to their VAT obligations, many countries have taken measures for delayed VAT returns and payments. For example, in a decision made on 12 June 2020, Germany approved cuts to VAT rates as part of a COVID-19 economic stimulus package: a temporary reduction of the German VAT rates from 19% to 16% (regular VAT rate) and from 7% to 5% (reduced rate) for the period from 1 July 2020 to 31 December 2020.In the same way, on 23 July 2020, the government of Ireland announced a temporary reduction in the standard VAT rate from

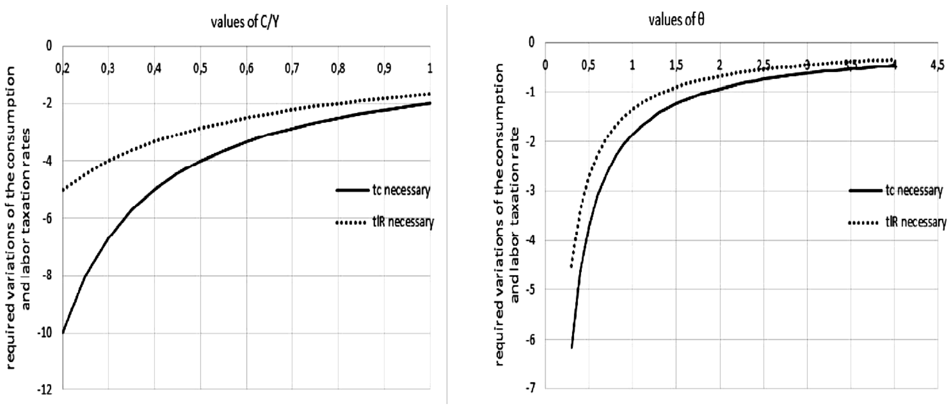

Figure 2: Required variations of the consumption and labor taxation rates to compensate for the effect of a negative demand shock of 1%

23% to 21%, from 1 September 2020 to 28 February 2021. These fiscal policies could have contributed to allow a weaker economic recession in Germany (decrease of -3.14% in GDP) or in Ireland (-1.85% of GDP) than in the rest of the European Union (decrease of -5.73% of GDP in 2020 on average).

Regarding the appropriate variation of the labor taxation rate, our results are more ambiguous, as they depend on the degree of wages rigidity on the labor market. More precisely, if wages are rigid, labor demand and supply don't vary, they are equalized, and equilibrium is reached on the labor market, provided the labor taxation rate decreases in proportion to the negative demand shock[$\frac{\partial \widehat{t_t^{l,R}}}{\partial(-e_t^d)} \sim -2.70$ with our basic calibration]. Indeed, we obtain:

$$\frac{\partial \widehat{t_t^{l,R}}}{\partial(-e_t^d)} = -\frac{1}{\theta}\frac{Y}{(C+G)} < \frac{\partial \widehat{t_t^c}}{\partial(-e_t^d)} = -\frac{1}{\theta}\frac{Y}{C} \quad (34)$$

Otherwise, without such a large decrease of the labor taxation rate, a negative demand shock would risk to increase proportionately the unemployment rate and to imply recessionary consequences on global economic activity. Nevertheless, this decrease of the labor taxation rate is more limited than the necessary decrease of the consumption taxation rate mentioned above. For both rates, the decrease should be accentuated if the elasticity of intertemporal substitution of private consumption (θ) is weak, and if monetary policy is then less efficient to influence global demand. But the decrease of the labor taxation rate should be accentuated if the share of private consumption AND of public expenditure in GDP [((C+G))/Y] is weak.

Furthermore, to stabilize a negative demand shock, decreasing the labor taxation rate could also be efficient if wages are flexible, depending on monetary activism in the framework of our model. Indeed, decreasing the labor taxation rate reduces the inflationary tensions on the real wage$[\frac{\partial(w_t-\pi_t)}{\partial(-\widehat{t_t^l})}=-\frac{1}{(1+\varphi)}]$, and avoids the increase of the purchasing power of households. Besides, a weaker labor taxation rate also increases the equilibrium labor demand and supply on the labor market$[\frac{\partial l_t}{\partial(-\widehat{t_t^l})}=\frac{1}{(1+\varphi)}]$, compensating for the recessionary consequences of the negative demand shock. However, the labor taxation rate should vary (decrease) more if(α_y^M) is high and if monetary policy is more active. Indeed, the necessary variation of the labor taxation rate is much more limited if monetary policy is constrained and less active$[\frac{\partial\widehat{t_t^l}}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to 0]{}\varphi$ for stabilizing real wages,$\frac{\partial\widehat{t_t^l}}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to 0]{}-1$ for stabilizing labor demand and supply]. On the contrary, the necessary decrease of the labor taxation rate is stronger to stabilize the labor market if monetary policy is very active $[\frac{\partial\widehat{t_t^l}}{\partial(-e_t^d)}\xrightarrow[\alpha_y^M\to\infty]{}\frac{\partial\widehat{t_t^{l,R}}}{\partial(-e_t^d)}\sim -2.70]$.

4. VARIOUS COMPONENTS OF GLOBAL DEMAND

The previous section 3 has underlined two potential situations. As in Baqaee and Farhi (2020), either the labor market is flexible, the real wage of equilibrium can clear the labor market; there is then full employment of the labor factor, and production is at its potential level (section 4.1). Or wages rigidity on the labor market implies that the real wage cannot vary sufficiently to clear the labor market; labor demand is then inferior to labor supply, the unemployment rate increases, and production is below its potential level (section 4.2).

4.1. If wages are flexible

If wages are flexible, (19)(24) and (29) imply the following potential economic activity:

$$\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]y_t=\left(e_t^d-\theta\frac{C}{Y}\widehat{t_t^c}\right)-\frac{(C+G)}{Y}\Phi_t \tag{35}$$

Therefore, an anticipated and permanent negative supply shock decreases the current potential economic activity ($\Phi_t > 0$). Indeed, it implies a drop in the productive capacity of the economy by reducing the investment plans of firms, some of them even going bankrupt. A permanent negative supply shock is recessionary, because it implies expectations of lower future incomes and weaker aggregate demand, which in turns depresses current output and employment.It has recessionary consequences on the level of current private consumption, on current public expenditure and on global demand, according to equations (35) and (36). Fornaro and Wolf (2000) formalize such a constant decrease in the productivity growth of labor.

A negative demand shock is also recessionary$[\frac{\partial y_t}{\partial(-e_t^d)} \sim -0.79$ with our basic calibration] in the framework of our model. The recessionary effect is weaker if monetary policy is more active(if α_y^M is high), because monetary policy is then more expansionary (see Figure 3). Indeed, a very expansionary monetary policy could perfectly stabilize economic activity in case of a negative demand shock$[\frac{\partial y_t}{\partial e_t^d} \xrightarrow[\alpha_y^M \to \infty]{} 0]$. According to equation (36), monetary policy should sustain private consumption and public expenditure, to make them increase more than proportionately to the negative demand shock$[\frac{\partial c_t}{\partial(-e_t^d)} = \frac{\partial g_t}{\partial(-e_t^d)} \xrightarrow[\alpha_y^M \to \infty]{} \frac{Y}{(C+G)} \sim 1.35]$. On the contrary, private consumption and global public expenditure don't vary, whereas economic activity varies exactly proportionately to the demand shock,if monetary is highly constrained or in case of strong interest rate smoothing$[\frac{\partial y_t}{\partial(-e_t^d)} \xrightarrow[\alpha_y^M \to 0]{} 1]$.

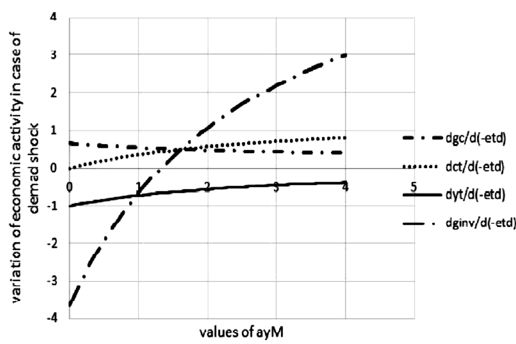

Figure 3: Variation of the components of global demand in case of a negative demand shock of 1% according to the monetary activism

According to equations (24), (25), (26) and (35), if wages are fully flexible, the equilibrium components of global demand are as follows:

$$\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]\left(c_t+\theta\widehat{t_t^c}\right)=\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]g_t=-\theta\alpha_y^M\left(e_t^d-\theta\frac{C}{Y}\widehat{t_t^c}\right)-\Phi_t \quad (36)$$

$$\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]g_t^{inv}=-\frac{G^c}{(z_1G^c-z_2G^{inv})}\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]\left[e_t^s-\frac{(1-\nu)}{(1+\varphi)}\widehat{t_t^l}\right]-f(\Phi_t)$$

$$+\frac{G^c}{(z_1G^c-z_2G^{inv})}\left[\frac{(\varphi+\nu)}{(1+\varphi)}-\alpha_y^M\frac{(1-\nu)}{(1+\varphi)}+\theta\alpha_y^Mz_2\left(1+\frac{G^{inv}}{G^c}\right)\right]\left(e_t^d-\theta\frac{C}{Y}\widehat{t_t^c}\right) \quad (37)$$

$$\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]g_t^c=\frac{G^{inv}}{(z_1G^c-z_2G^{inv})}\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]\left[e_t^s-\frac{(1-\nu)}{(1+\varphi)}\widehat{t_t^l}\right]+f(\Phi_t)$$

$$-\frac{G^{inv}}{(z_1G^c-z_2G^{inv})}\left[\frac{(\varphi+\nu)}{(1+\varphi)}-\alpha_y^M\frac{(1-\nu)}{(1+\varphi)}+\theta\alpha_y^Mz_1\left(1+\frac{G^c}{G^{inv}}\right)\right]\left(e_t^d-\theta\frac{C}{Y}\widehat{t_t^c}\right) \quad (38)$$

Therefore, in case of a negative demand shock, an expansionary monetary policy allows to increase private consumption and global public expenditure[$\frac{\partial c_t}{\partial(-e_t^d)}=\frac{\partial g_t}{\partial(-e_t^d)}\sim 0.28$ with our basic calibration]. However, private consumption increases only if monetary policy is expansionary, if(α_y^M) is high. A more active and expansionary monetary policyα_y^M is higher) increases all components of global demand, except public consumption [see Figure 3 and (38)]. Besides, according to the monetary activism, variations of public investment are much more accentuated than those of public consumption, and public investmenteven decreasesif monetary activism is insufficient[$\frac{\partial g_t^{inv}}{\partial(-e_t^d)}\sim-1.37$ and$\frac{\partial g_t^c}{\partial(-e_t^d)}\sim 0.58$ with our basic calibration].

The recessionary effect of a negative demand shock is also weaker if the elasticity of intertemporal substitution of private consumption (θ) is high, because monetary policy is then more efficient in order to encourage private consumption. If (θ) is high, private and public consumption both increase more strongly, whereas public investment decreases less, according to equations (36) to (38). In the same way, the recessionary effect of a negative demand shock is weaker if the shares of private consumption (C/Y) and of public expenditure (G/Y) in GDP are high (weaker part of the exogenous demand shock). In these conditions, variations of private and public consumption and of public investment can even be more limited.

4.2. If wages are rigid

If wages are rigid, equations (24), (25), (26) and (33) for the global economic activity (y_t) imply the following levels of the components of global demand:

$$\left(c_t^R + \theta \widehat{t_t^c}\right) = g_t^R = -\theta \widehat{t_t^l} \tag{39}$$

$$g_t^{inv,R} = -\frac{\theta}{(z_1 G^c - z_2 G^{inv})}\left[\nu \frac{(C+G)}{Y} G^c - z_2\left(G^c + G^{inv}\right)\right]\widehat{t_t^l} - \frac{G^c}{(z_1 G^c - z_2 G^{inv})} e_t^s + \frac{\nu G^c}{(z_1 G^c - z_2 G^{inv})}\left(e_t^d - \theta \frac{C}{Y}\widehat{t_t^c}\right) \tag{40}$$

$$g_t^{c,R} = \frac{\theta}{(z_1 G^c - z_2 G^{inv})}\left[\nu \frac{(C+G)}{Y} G^{inv} - z_1\left(G^{inv} + G^c\right)\right]\widehat{t_t^l} + \frac{G^{inv}}{(z_1 G^c - z_2 G^{inv})} e_t^s - \frac{\nu G^{inv}}{(z_1 G^c - z_2 G^{inv})}\left(e_t^d - \theta \frac{C}{Y}\widehat{t_t^c}\right) \tag{41}$$

Therefore, after a negative demand shock, if wages are rigid, private consumption and global public expenditure don't vary; so, global economic activity varies exactly in proportion to the negative demand shock [$\frac{\partial y_t^R}{\partial(-e_t^d)} = -1$], which is very recessionary according to the previous equation (33). Besides, whatever the monetary policy, public consumption should increasewhile public investment should decrease in case of a negative demand shock[$\frac{\partial g_t^{inv,R}}{\partial(-e_t^d)} \sim -2.19$ and $\frac{\partial g_t^{c,R}}{\partial(-e_t^d)} \sim 0.39$ with our basic calibration].

In conformity with the theoretical predictions of our model, the large negative shock of the COVD was empirically better mitigated in a liberal country like the United-States, where wages were more flexible[$\frac{\partial y_t}{\partial(-e_t^d)} = -\frac{1}{\left(1+\theta \alpha_y^M \frac{(C+G)}{Y}\right)} > \frac{\partial y_t^R}{\partial(-e_t^d)} = -1$]. Indeed, real GDP only decreased by (-3.5%) in 2020 in the U.S, whereas it decreased by (-9.8%) in more egalitarian economies like France, where wages were more rigid, and where employment and economic activity were strongly sustained by more active social budgetary policies.

5. MONETARY AND BUDGETARY POLICIES TO AVOID THE RECESSION

In the framework of the above mentioned modelling, we can now shed a new light on which monetary and budgetary policies could be efficient in order to limit the recession, in case of a negative demand and supply shock like the COVID.

5.1. Monetary policy

If wages are flexible, equation (A3) in Appendix A and the resolution of the model[9] imply the following optimal nominal interest rate:

$$\left[1+\theta\alpha_y^M\frac{(C+G)}{Y}\right]i_t = \alpha_y^M\left(e_t^d-\theta\frac{C}{Y}\widehat{t_t^c}\right)-\alpha_y^M\theta\frac{(C+G)}{Y}ln\beta+f(\Phi_t) \quad (42)$$

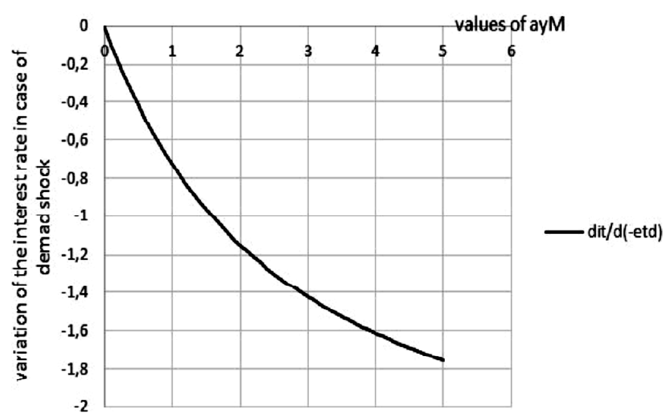

Figure 4: Variation of the interest rate in case of a negative demand shock of 1% according to the monetary activism

So, monetary policy is expansionary and the current nominal interest rate decreases in order to sustain economic activity and to avoid the recession in case of negative demand shocks. However, this decrease of the interest rate can be more limited if monetary policy is more efficient to influence economic variables, i.e: if the elasticity of intertemporal substitution of private consumption (θ) is high, and /or if the shares of private consumption and of public expenditure in GDP (C/Y and G/Y) are high. Besides, in case of negative demand shocks, the interest rate decreases more strongly if(α_y^M) is high and if monetary policy is more active $[\frac{\partial i_t}{\partial e_t^d} \xrightarrow[\alpha_y^M \to 0]{} 0; \frac{\partial i_t}{\partial e_t^d} = \frac{1}{\left[\frac{1}{\alpha_y^M} + \theta\frac{(C+G)}{Y}\right]} \xrightarrow[\alpha_y^M \to \infty]{} \frac{1}{\theta}\frac{Y}{(C+G)} \sim 2.70]$. In case of negative demand shocks, the monetary authority cuts the nominal interest rate in order to sustain global economic activity. Nevertheless, in particular if monetary policy is constrained because the interest rate is already very low (Zero Lower Bound constraint), the decrease of the nominal interest rate can be insufficient to avoid the recession and the lower level of employment.

To the contrary, the interest rate increases with a future anticipated negative supply shock, because such a shock would imply a risk of inflationary tensions, as mentioned below. So, according to equations (42) and to the value of (Φ_t), we obtain: $\frac{\partial i_t}{\partial(-e_{t+n}^s)} > 0$.

Besides, if wages are flexible, the resolution of the model implies:

$$\pi_t = -k_1 \ln(1-\nu) + f(\Phi_t) \tag{43}$$

So, current supply or demand shocks have no consequences on the inflation rate. However, if it is permanent, a future anticipated negative supply shock implies inflationary tensions$[\frac{\partial \pi_t}{\partial(-e_{t+n}^s)} > 0]$ whatever the calibration of the model, as it implies a lower productivity growth, whereas a future anticipated negative demand shock implies deflationary tensions$\left[\frac{\partial \pi_t}{\partial(-e_{t+n}^d)} < 0\right]$[10]. Indeed, as mentioned by Bekaert *et al.* (2020), supply shocks are shocks that move inflation and real activity in opposite directions, whereas demand shocks are defined as innovations that move inflation and real activity in the same direction.

Therefore, monetary policy remains ambiguous in case of a negative both demand and supply shock like the COVID. The nominal interest rate should decrease to stabilize a current or anticipated negative demand shock, but it should increase to avoid the inflationary consequences of a permanent negative supply shock. Indeed, a negative demand and supply shock undoubtedly reduces economic activity. However, the inflationary consequences depend on the relative size of both shocks. Indeed, if supply comes down more than demand, the result is inflationary pressures; conversely, demand falling more than supply results in deflationary pressures. Nevertheless, we can mention that currently, inflationary pressures are not empirically threatening in developed countries. A severe downsizing in production capacity would be necessary to produce broad-based supply shortages, since there is already excess supply (the interest rate is already near its lower bound). And even if capacity constraints were to appear, they would not necessarily produce significant inflationary pressures, owing to the flatness of the Phillips curve, the rise in the unemployment rate and the downward trend of inflation expectations.Therefore, our modelling underlines the limits of monetary policy in such recessionary circumstances with multiple factors. In this framework, is budgetary policy more efficient, and can it be more useful?

5.2. Optimal budgetary policy

We have shown that if wages are flexible as well as if they are rigid, a variation of the consumption taxation rate as mentioned in section 3.3 is the best way to stabilize a demand shock $[\widehat{t_t^C} = \frac{1}{\theta}\frac{Y}{C}e_t^d \sim 3.70\, e_t^d]$. Variation of private consumption then stabilizes the labor market, but also public expenditure and global economic activity. Regarding a decrease of the labor taxation rate to stabilize a negative shock, the results of our model are more ambiguous. Besides, the problem with such fiscal policies decreasing the consumption or the labor taxation rates is to reduce fiscal resources, and therefore, to increase the public indebtedness level.

Furthermore, according to our model, in case of a negative supply shock, the best fiscal policy is to modify the structure of budgetary expenditure, and more precisely, to increase public investment and to decrease public consumption expenditure. Indeed, equations (37) and (38) as well as equations (40) and (41) imply:

$$\frac{\partial g_t^{inv}}{\partial(-e_t^s)} = \frac{\partial g_t^{inv,R}}{\partial(-e_t^s)} = \frac{G^c}{(z_1 G^c - z_2 G^{inv})} \tag{44}$$

$$\frac{\partial g_t^{c}}{\partial(-e_t^s)} = -\frac{\partial g_t^{c,R}}{\partial(-e_t^s)} = -\frac{G^{inv}}{(z_1 G^c - z_2 G^{inv})} \tag{45}$$

According to our basic calibration, public investment should strongly increase$[\frac{\partial g_t^{inv}}{\partial(-e_t^s)} \sim 6.45]$ while public consumption should slightly decrease$[\frac{\partial g_t^c}{\partial(-e_t^s)} \sim -0.65]$ after a negative supply shock. Therefore, a strong effort in terms of public investment would allow to fully compensate for the effect of a negative supply shock. Nevertheless, the increase of public investment can be more limited if the productivity of public investment expenditure (z_1) is high, and if the latter is more efficient to sustain economic activity. On the contrary, the shock on public investment should be slightly accentuated with the productivity of public consumption expenditure (z_2), and with the long term share of public investment in comparison with public consumption expenditure ($\frac{G^{inv}}{G^c}$).

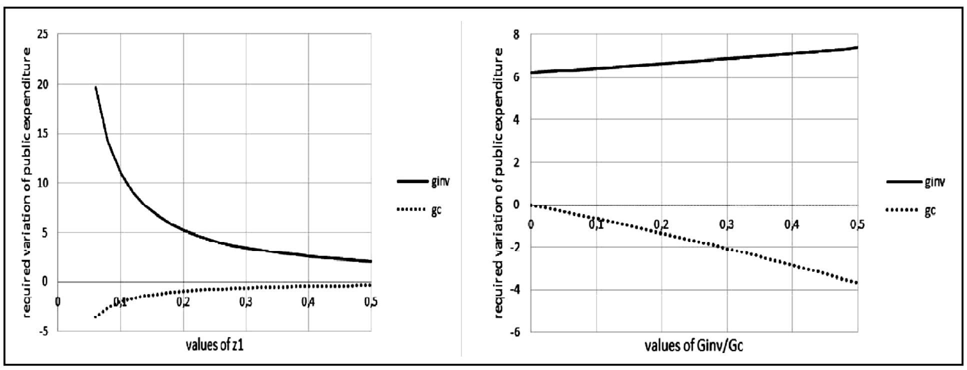

Figure 5: Required variation of public investment and consumption to compensate for the effect of a negative supply shock of 1%

Empirically, to compensate for the consequences of the COVID crisis, the IMF (2020) underlined that some recovery packages contained support for innovation (France), training (Australia, France), and green growth (France, Germany, Italy, Japan, Korea, United Kingdom) or expanded digital infrastructure (Germany, Korea, Japan). Indeed, public investment has the advantage of boosting long term economic growth, and also to support demand and employment in the short run. So, recognizing these advantages, on 21 July 2020, the European Council agreed on the 'Next Generation EU' Recovery Plan, granted with an amount of €750 billion. The guidance document invited countries to spend at least 37% of the funds on green investments and a minimum of 20% on digital expenditures. For example, the Plan aimed at favoring:a massive renovation waveof buildings; a rolling out of renewable energyprojects, especially wind, solar and kick-starting a clean hydrogen economy; or cleaner transport and logistics,including the installation of one million charging points for electric vehicles and a boost for rail travel and clean mobility.

6. CONCLUSION

With a simple macro-economic modelling, the goal of the current paper was to try to better understand the respective potential advantages of monetary and budgetary policies in the framework of a new phenomenon of large global economic recession like the COVID crisis.

First, in case of a strong negative demand shock, wages rigidity would accentuate the risk of huge increase of the unemployment rate; therefore, improving wages flexibility could be an efficient economic policy.Besides, in case of a negative demand shock, the decrease of the nominal interest rate and monetary policy can be constrained by the Zero Lower Bound. Furthermore, an expansionary monetary policy seemsto have ambiguous consequences: inflationary tensions on the labor market if the real wage is flexible, which depresses labor demand and supply. Besides, if wages are rigid or if monetary policy is hardly constrained, a decrease of the nominal interest rate cannot increase private consumption and global public expenditure more than proportionately to the negative demand shock, in order to avoid its recessionary consequences on global economic activity. Therefore, the budgetary policy would be more appropriate to fight the recessionary consequences of such a complex shock.

More precisely, in case of a negative demand shock, decreasing the consumption taxation rate more strongly than this negative demand shock stabilizes labor supply and demand on the labor market, as well as the global economic activity and public expenditure, whereas private consumption increases. The consequences of a variation of the labor taxation rate are more ambiguous. Nevertheless, a fiscal policy decreasing the consumption or the labor taxation rate has also the huge drawback to reduce fiscal resources, and therefore, to increase the public indebtedness level, a question which is beyond the scope of the current paper. Finally, whatever the degree of wages rigidity, increasing the relative share of public investment in comparison with public consumption expenditure would be an efficient economic policy for stabilizing a negative supply shock. Indeed, the economic literature usually finds that budgetary multipliers are higher if the quality of public expenditure is higher.

Nevertheless, suitable economic policies would mainly have to be evaluated in the context of their empirical consequences and results, whereas we still haven't got much empirical step back regarding the huge shock represented by the COVID crisis.

Notes

1. We suppose that according to the budgetary constraint of the government, fiscal resources and expenditures vary in phase: fork≥0, $\partial(t_{t+k}^{c} P_{t+k} C_{t+k} + t_{t+k}^{l} W_{t+k} L_{t+k}) = \partial(P_{t+k} G_{t+k})$.
2. $\frac{\partial U_t}{\partial L_t^s} = -\alpha_l (L_t^s)^{\varphi} = -\frac{(1-t_t^l) W_t}{(1+t_t^c) P_t} \frac{\partial U_t}{\partial C_t} = -\frac{(1-t_t^l) W_t}{(1+t_t^c) P_t} \alpha_c (C_t)^{-\frac{1}{\theta}}$.
3. $\frac{\partial U_t}{\partial G_t} = \alpha_g (G_t)^{-\frac{1}{\theta}} = \frac{1}{t_t^c} \frac{\partial U_t}{\partial C_t} = \frac{\alpha_c}{t_t^c} (C_t)^{-\frac{1}{\theta}}$.
4. Profit maximization and (11) imply: $\frac{\partial \Pi_t}{\partial L_t^d} = (1-\nu) P_t (E_t^s)(L_t^d)^{(-\nu)} (G_t^{inv})^{z_1} (G_t^c)^{z_2} - W_t = \frac{(1-\nu) P_t}{L_t^d} Y_t - W_t = 0$.
5. According to equation (11), the production cost of the quantity (Yt) is: $W_t L_t^d = \frac{W_t (Y_t)^{\frac{1}{1-\nu}}}{(E_t^s)^{\frac{1}{1-\nu}} (G_t^{inv})^{\frac{z_1}{1-\nu}} (G_t^c)^{\frac{z_2}{1-\nu}}}$.
6. $-k_1 \left[\frac{1}{\theta(1+\varphi)} - \frac{(z_1+z_2)}{(1-\nu)}\right] \frac{Y}{(C+G)} \sim -0.12 < 0$ with our basic calibration.
7. The analytical proof is quite long, but it is available upon request from the author.
8. According to equations (25), (26) and (32), economic activity and labor demand are as follows:

   $$\left[\nu \frac{(C+G)}{Y} - (z_1+z_2)\right] y_t^R = -(z_1+z_2)\left(e_t^d - \theta \frac{C}{Y} \widehat{t_t^c}\right) + \frac{(C+G)}{Y} e_t^s + \frac{(C+G)}{Y}\left(z_1 - z_2 \frac{G^{inv}}{G^c}\right) e_t^{g,inv}.$$

   So, according to equations (9) and (24), labor supply $(l_t^{s,R})$ is stabilized if:

   $$e_t^{g,inv} = -\frac{\theta G^c}{(z_1 G^c - z_2 G^{inv})}\left[\nu \frac{(C+G)}{Y} - (z_1+z_2)\right] \widehat{t_t^l} - \frac{G^c}{(z_1 G^c - z_2 G^{inv})} e_t^s + \frac{\nu G^c}{(z_1 G^c - z_2 G^{inv})}\left(e_t^d - \theta \frac{C}{Y} \widehat{t_t^c}\right).$$
9. The analytical proof is available upon request from the author.
10. $\frac{\partial \pi_t}{\partial(-e_{t+1}^s)} = \frac{k_1 \beta}{(1-\nu)} = 0.13$ and $\frac{\partial \pi_t}{\partial(-e_{t+1}^d)} = -\frac{k_1 \beta(\nu+\varphi)}{(1-\nu)(1+\varphi)} = -0.07$ with our basic calibration.

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Appendix A: Optimal economic activity, inflation rate and interest rate

Equations (23) and (27) imply the following economic variables, for ($n \geq 1$):

$$y_t = -\theta \frac{(C+G)}{Y}(i_t + ln\beta) + \left(e_t^d - \theta \frac{C}{Y}\widehat{t_t^c}\right) + f\left[i_{t+n}, \widehat{t_{t+n}^l}, e_{t+n}^s, e_{t+n}^d, \widehat{t_{t+n}^c}, e_{t+n}^{g,inv}\right] \quad \text{(A1)}$$

$$\pi_t = -\theta k_1 k_2 \frac{(C+G)}{Y}(i_t + ln\beta) + \frac{k_1(\nu+\varphi)}{(1-\nu)(1+\varphi)}\left(e_t^d - \theta \frac{C}{Y}\widehat{t_t^c}\right) + \frac{k_1}{(1+\varphi)}\widehat{t_t^l} - \frac{k_1}{(1-\nu)}e_t^s$$

$$-k_1 \ln(1-\nu) - \frac{k_1}{(1-\nu)}\left(z_1 - z_2 \frac{G^{inv}}{G^c}\right)e_t^{g,inv} + f\left[i_{t+n}, \widehat{t_{t+n}^l}, e_{t+n}^s, e_{t+n}^d, \widehat{t_{t+n}^c}, e_{t+n}^{g,inv}\right] \quad \text{(A2)}$$

Putting (A1) and (A2) in equation (28), we obtain the equilibrium interest rate:

$$\left[1 + \theta\left(\alpha_\pi^M k_1 k_2 + \alpha_y^M\right)\frac{(C+G)}{Y}\right] i_t = \alpha_\pi^M \frac{k_1}{(1+\varphi)}\widehat{t_t^l} - \alpha_\pi^M \frac{k_1}{(1-\nu)}e_t^s - \alpha_\pi^M k_1 \ln(1-\nu)$$

$$+\left[\alpha_\pi^M \frac{k_1(\nu+\varphi)}{(1-\nu)(1+\varphi)} + \alpha_y^M\right]\left(e_t^d - \theta \frac{C}{Y}\widehat{t_t^c}\right) - \alpha_\pi^M \frac{k_1}{(1-\nu)}\left(z_1 - z_2 \frac{G^{inv}}{G^c}\right)e_t^{g,inv} - \alpha_\pi^M \bar{\pi}$$

$$-\theta \frac{(C+G)}{Y}(\alpha_\pi^M k_1 k_2 + \alpha_y^M)ln\beta - \alpha_y^M \bar{y} + f\left[i_{t+n}, \widehat{t_{t+n}^l}, e_{t+n}^s, e_{t+n}^d, \widehat{t_{t+n}^c}, e_{t+n}^{g,inv}\right] \quad \text{(A3)}$$