The impact of labor income tax progressivity on the fiscal multipliers in the context of fiscal consolidation programs

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1 Introduction

The aftermath of the 2008 financial crisis featured the emergence of fiscal consolidation programs across countries, in which the reduction or stabilization of government deficits and public debt derived from increased taxation or decreased government spending, or a combination of the two (Alesina et al., 2019).

The vast literature on the subject confirms the relevance of correctly assess the impact of those programs on the economy, especially in output, represented by the fiscal multipliers. Even taking in consideration that the short-term effect of fiscal consolidation programs on growth is just one of the many aspects to consider when constructing fiscal policies (Blanchard and Leigh, 2013), an increasing literature related with the impact of fiscal policies on output translates how relevant is to correctly compute fiscal multipliers 1) to better design policies that reduce the risk of setting unachievable fiscal targets or miscalculating the amount of adjustment necessary to control the debt ratio (Eyraud and Weber, 2013); 2) in the context of substantial changes between stimulus and consolidation, fiscal policies may be one of the larger forces impacting output, which means that a correct forecast of the multipliers may lead to a better prediction of output growth. In fact, Blanchard and Leigh (2013) estimated that growth forecast errors were significantly related to under-estimation of fiscal multipliers (Batini et al., 2014).

Notwithstanding, there are great divergences in the size of the fiscal multipliers estimated in the literature. The lack of consensus reflects the degree of difficulty to compute fiscal multipliers, mainly due to the circularity presented in the relationship of the output with fiscal policies (Batini et al., 2014).

Nonetheless, there are already some outstanding results that can be assessed. Fiscal instruments affect differently the economy (more specifically output) according to the states of the economy in which they are employed. The instrument itself used also relates with different impacts in the economy. Also, several distinct aspects of each economy might change how fiscal policies impact output. Altogether, it results in a multiplicity of fiscal multipliers across time and economies (Blanchard and Leigh, 2013).

Jordà and Taylor (2013) documented that austerity has a more recessionary impact on output when applied in times of recession instead in a boom. They estimated that a 1% GDP consolidation represents a loss of 4% of real GDP over five years in the case of the first and only a loss of 1% in the case of the latter.

Gechert and Will (2012) registered that fiscal multipliers also depend on the instrument employed, being that fiscal consolidations based on government spending cuts, instead of tax hikes, are less recessionary. A result also supported by Alesina and Ardagna (2009).

Ilzetzki et al. (2011) study the determinants of fiscal multipliers, however in the context of fiscal stimulus (an increase of government consumption). Nevertheless, their findings still present to be relevant to this analysis. The authors find that the size of fiscal multipliers depend on structural characteristics of each economy, namely degree of openness, exchange regime flexibility, level of development, and level of public debt. More precisely, fiscal multipliers in open economies are lower than the ones on closed economies. The same applies in the case of industrial economies rather than developing ones. For countries with high public debts or operating in a flexible exchange regime, the fiscal multipliers resulting of an increase of government consumption, are close to zero. Openness to trade and public debt as determinants of the size of the fiscal multiplier are also documented in the case of fiscal consolidation by Cugnasca and Rother (2015) who state high degree of openness result in lower multipliers because aggregate demand is diluted through foreign demand and that lower government debt may imply larger multipliers.

Brinca et al. (2017) focus on the impact of income inequality on the multipliers and observed that the higher income inequality, the higher are the recessive impacts of fiscal adjustments.

Even the same measure can have different implications according to the magnitude. Brinca et al. (2019) find that there is no linearity in the response of output to a shock of government spending. More precisely that the fiscal multiplier is increasing with the shock.

This paper contributes to the already existent research by raising the question of whether labor tax progressivity has an impact on the fiscal multipliers of fiscal consolidation programs.

Such question is motivated by the theoretical relationship study in Brinca et al. (2017). The authors state the inability of constrained agents to smooth consumption facing an increase of future income as a result of lower debt-to-GDP ratio. As labor tax progressivity benefits comparatively the bottom agents by exempt them from paying taxes or to have more reduce rates, these agents have lower incentives to incur in precautionary savings, which entail a higher number of constrained agents. The positive relationship between constrained agents and labor tax progressivity leads, then, to lower multipliers.

The relation between progressivity and fiscal multipliers, in the case of increase government spending financed by an increase in lump-sum taxation, is documented in Brinca et al. (2016). It works again as a result of the limitations of borrowing constrained agents to face a change in income. Since constrained agents are not able to borrow from the future to smooth consumption, the lower disposable income today, due to higher taxes, will stimulate constrained agents to increase labor supply in order to keep consumption. Therefore, higher progressivity leads to larger fiscal multipliers. However, the authors conclude that the effect of tax progressivity on the multiplier is close to zero.

Considering spending multipliers, Ferriere and Navarro (2016) concluded that if the increase of government spending is financed by more progressive taxes, the spending multipliers are higher. That result is explained with the lower response of higher-income earners. Such agents do have a higher opportunity costs by ceasing work, which means that they respond less to tax changes, which in turn leads to smaller crowding-out effects. The authors find that the spending multiplier is positive only when financed with more progressive taxes, with a cumulative multiplier of between 0.8 and 1 after three years. Multipliers are initially negative and roughly zero after three years if taxes are regressive.

In order to study the impact of labor tax progressivity on fiscal multipliers, it is analyzed a model for the United States considering different levels of tax progressivity.

The remainder of the paper is organized as follows. Section 2 states some statistics about progressivity, Section 3 describes the model employed in the analysis, Section 4 the calibration method, Section 5, the results obtained and Section 6 concludes.

2 Statistics

Progressivity varies greatly across countries as can be observed in figure 1 in the appendix retrieved from OECD Journal (Joumard et al., 2012). The authors compute the overall progressivity index as well the progressivity of upper and lower ends of the income distribution. Regarding the higher end of the income distribution, Ireland, Sweden and Denmark stand out. While for the lower end the countries that stand out are: Luxembourg, Hungary and Belgium. As for the synthetic index it can be verified that Korea, Japan and Poland have comparatively lower progressivity and that the country of interest, U.S., presents lower progressivity than the OECD average although it has a slightly higher progressivity at the upper end.

Besides, the authors also analysed the evolution of tax progressivity between 2000 and 2009 and concluded that the tax schedule progressivity has been increasing for the majority of OECD countries.

3 Model

This section sets out the description of the model used to study the impact of labor income tax progressivity. It is a standard life-cycle model with heterogenous agents as it is employed in Brinca et al. (2017) and similar to the one developed in Brinca et al. (2016).

3.1 Technology

The model considers a Cobb-Douglas production function of a representative firm:

$$Y_t(K_t, L_t) = K_t^{\alpha}[L_t]^{1-\alpha} \tag{1}$$

being K the capital input and L the labor input, whereby capital evolves as follows:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{2}$$

in which I_t represents gross investment and δ the capital depreciation rate.

Profits are maximized each period (one year in the model) by choosing the amount of labor and capital to hire:

$$\Pi_t = Y_t - w_t L_t - (r_t + \delta)K_t \tag{3}$$

The price of production factors contemplates the case of competitive equilibrium in which each factor price equalizes their marginal products, as follows:

$$w_t = \partial Y_t / \partial\, L_t = (1-\alpha)\left(\frac{K_t}{L_t}\right)^{\alpha} \tag{4}$$

$$r_t = \partial Y_t / \partial K_t - \delta = \alpha \left(\frac{L_t}{K_t}\right)^{1-\alpha} - \delta \tag{5}$$

3.2 Demographics

The model considers a population composed of J overlapping generations of households with finite lives that start life at age 20 and retire at age 65. Retired households have a probability of dying that depends on age, $\pi(j)$, and will certainly die at age 100. The survival probability given the age of the household is then equal to $1 - \pi(j)$, which will be represented by ω(j). So, $\Omega_j = \Pi_{q=65}^{q=J-1}\omega(q)$ gives the number of retired agents that are still alive at any given year. As stated before, a model period corresponds to one year, so there is a total of 45 model periods of active work life.

Economic agents also differ concerning the assets they hold, in the idiosyncratic productivity, in permanent ability (each household starts with a given productivity level) and in their discount factor which is constant over time but can take the value of one of these three: β_1, β_2 and β_3, which are uniformly distributed across households.

Active working households choose every year, the number of hours worked,n, how much to consume, c, and how much to save, k. While retire households make no decisions but receive social security benefits, ψ_t.

Since it is not considered annuity markets that would allow retired households to convert savings into an income stream for the lifetime of the pensioner, a fraction of households leaves bequests. This bequest is distributed between households alive in the form of a lump-sum transfer. The notation of per-household bequest is Γ. Retired households retrieve utility from the bequest they leave when they die that is increasing with the bequest which helps to calibrate the asset holding of retired households.

Each household is endowed with a certain number of efficient units of labor that depend on age (j), permanent ability ($a \sim N(0, \sigma_a^2)$) and idiosyncratic productivity shock (u).

The later follows an AR (1) process: $u_{t+1} = \rho u_t + \epsilon_{t+1}, \epsilon \sim N(0, \sigma_\epsilon^2)$

3.3 Labor income

Individual wages depend on these characteristics as well on the wage per efficient unit of labor w. The equation that gives individual i's wage is the following:

$$w_i(j, a, u) = we^{\gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + a + u} \, , \tag{6}$$

in which, $\gamma_{1\iota}$, $\gamma_{2\iota}$ and $\gamma_{3\iota}$ represent the age profile of wages.

3.4 Preferences

Each household, at each moment, has utility according to the amount of consumption and hours worked that is represented by the utility function of the form:

$$U(c, n) = \frac{c^{1-\sigma}}{1-\sigma} - \chi \frac{n^{1+n}}{1+n} \tag{7}$$

Retired households in its turn have utility derived from the bequest they leave when they die reproduced by:

$$D(k) = \varphi \log(k)) \tag{8}$$

3.5 Government

The model also contemplates the government defining it with a balanced social security system in which employees and employers are taxed at rates τ_{ss} and $\tilde{\tau}_{ss}$, respectively, while retirees receive benefits of ψ_t.

Besides, the government taxes consumption and labor and capital income in order to finance expenses with pure public consumption goods, G_t, interest payments on the national debt, rB_t, and lump-sum redistribution, g_t. While capital income and consumption are taxed at flat rates, τ_c and τ_k, respectively, labor income tax follows the formula:

$$\tau(y) = 1 - \theta_0 y^{-\theta_1} \tag{9}$$

Such functional form was proposed in Benabou (2002) and used in Heathcote et al. (2017) and Holter et al. (2017). Where y represents pre-tax labor income,$\tau(y)$ represents the average tax rate applied in compliance with the pre-tax labor income, θ_0 represents the level of the tax code and θ_1 the progressivity. This function fits the U.S. data, according to Heathcote et al. (2017). Moreover, the model allows for outstanding government debt but fixes the debt-to-output ratio, $B_Y = B_t/Y_t$, across time.

Finally, in steady-state the proportion of government revenues, G_t, g_t, ψ_t to output must remain constant. Which entails that in the steady-state the government budget constraint is of the form:

$$g\left(45 + \textstyle\sum_{j\geq 65} \Omega_j\right) = R - G - rB, \tag{10}$$

$$\psi\left(\textstyle\sum_{j\geq 65} \Omega_j\right) = R^{SS} \tag{11}$$

Where R_t is the government's revenue accrued from labor, capital and consumption taxes and R_t^{SS} is the government's revenue accrued from social security taxes.

3.6 Recursive Formulation of the Household Problem

Households are characterized by their age (j), savings (k), time discount factor that can be one of three $\beta \in \beta_1, \beta_2, \beta_3$, permanent ability (α), and idiosyncratic productivity shock (u). Optimality is formulated by a Bellman equation that writes the problem as a recursive definition of a value function that gives the best value of the objective function as a function of the state variables (k, β, a, u, j).

$$V(k, \beta, a, u, j) = \max_{c, k, n}\left[U(c, n) + \beta E_{u'}[V(k', \beta, a, u, j+1)]\right]$$

$$s.t.:$$

$$c(1 + \tau_c) + k' = (k + \Gamma)\big(1 + r(1 - \tau_k)\big) + g + Y^L$$

$$Y^L = \frac{nw(j, a, u)}{1 + \tilde{\tau}_{ss}}\left(1 - \tau_{ss} - \tau_l\left(\frac{nw(j, a, u)}{1 + \tilde{\tau}_{ss}}\right)\right)$$

$$n \in [0,1], \;\; k' \geq -b, \;\; c > 0 \tag{12}$$

Where Y^L stands for household's after-labor taxes labor income.

Retirees problem is:

$$V(k, \beta, j) = \max\left[U(c, n) + \beta\big(1 - \pi(j)\big)V(k', \beta, j+1) + \pi(j)D(k')\right]$$

s.t.:

$$c(1 + \tau_c) + k' = (k + \Gamma)\big(1 + r(1 + \tau_k)\big) + g + \psi,$$

$$k' \geq 0, \;\; c > 0 \tag{13}$$

3.7 Stationary Recursive Competitive Equilibrium

The following six steps correspond to the stationary recursive competitive equilibrium:

1. The value function $V(k, \beta, a, u, j)$ and the policy functions, $c(k, \beta, a, u, j)$, $k'(k, \beta, a, u, j)$ and $n(k, \beta, a, u, j)$ give the solution to the consumer's optimization problem.

2. Markets clear:

$$K + B = \int k d\Phi$$

$$L = \int \big(n(k, \beta, a, u, j)\big)\, d\Phi$$

$$\int c d\Phi + \delta K + G = K^{\alpha} L^{1-\alpha}$$

3. Factor prices:

$$w = (1 - \alpha)\left(\frac{K}{L}\right)^{\alpha}$$

$$r = \alpha \left(\frac{K}{L}\right)^{\alpha - 1} - \delta$$

4. Government budget balances:

$$g \int d\Phi + G + rB = \int \left(\tau_k r(k + \Gamma) + \tau_c c + n\tau_l \left(\frac{nw(a, u, j)}{1 + \tilde{\tau}_{ss}}\right)\right) d\Phi$$

5. Social Security System Balances:

$$\psi \int_{j \geq 65} d\Phi = \frac{\tilde{\tau}_{ss} + \tau_{ss}}{1 + \tilde{\tau}_{ss}} \left(\int_{j < 65} nwd\Phi\right)$$

6. Uniform distribution of dead assets:

$$\Gamma \int \omega(j) d\Phi = \int \big(1 - \omega(j)\big) k d\Phi$$

3.8 Fiscal Experiment and Transition

As in Brinca et al. (2017), it is considered a 50 year of reduction in government debt, B, financed through a decrease in government spending, G, by 0.2% of benchmark GDP or financed through an increase in labor income tax τ_l by 0.1% for all agents. After 50 periods, regardless the instrument used, it goes back to initial levels.

To capture all the changes of the variables in the maximization problem, another variable is considered, the time state variable (t). The method used to find the numerical solution of the model works by maximizing the problem backward after guessing the paths of all variables that depend on time. Afterwards the guess is updated. A similar method is used in Brinca et al. (2016) and Krusell and Smith (1999).

A more comprehensive definition of the transition equilibrium after the fiscal consolidation is developed in the appendix.

3.9 Definition

The spending fiscal multiplier in the experiment of debt reduction financed by a reduction of G is the ratio of the change in output from period 0 to 1 to the change of government spending from period 0 to period 1:

$$impact\ multiplier\ G = \frac{\Delta Y_0}{\Delta G_0} \tag{14}$$

The impact multiplier resulting from a consolidation financed through increased labor income tax is the ratio of the change in output from period 0 to period 1 to the change in government revenue from period 0 to 1.

$$impact\ multiplier\ \tau_l = \frac{\Delta Y_0}{\Delta R_0} \tag{15}$$

4 Calibration

The benchmark model is calibrated to match moments of U.S. economy ten different times considering ten different levels of labor income tax progressivity, that are set constructing a uniform distribution between the lowest and one of the highest θ_1 in the data found in Brinca et al. (2017). The lowest $\theta_1$corresponds to the levels of progressivity of Slovakia of 0.105 and the highest θ_1 considered corresponds to the levels of progressivity of the Netherlands of 0.254. In between it is considered values of θ_1 of 0.1216, 0.1381, 0.1547, 0.1712, 0.1878, 0.2043, 0.2209, 0.2374.

The macro ratio debt-to-GDP (B/Y), the income profile parameters ($\gamma_1, \gamma_2, \gamma_3$), the Social Security, Consumption and Capital Income Taxes ($\tilde{\tau}_{ss}$,τ_{ss}, τ_c, and τ_k), the parameters related with preferences: Inverse Frisch Elasticity (η) and the Risk aversion parameter (σ), and the parameters related with technology: the Capital share of output (α), the capital depreciation rate (δ), the persistence of the income shock (ρ), and the variance of ability (σ_a) are all set exogenously complying with their corresponding data.

The macro ratio above mentioned is the average of net public debt from 2001-2008 (IMF) and has a value for the United States of 0.428.

The income profile parameters are from the most recent Luxembourg Income Study (LIS) Database (2015) available before 2008 and give the value of 0.265, -0.005 and $3.6 * 10^{-5}$, respectively.

The Social Security Taxes are the average social security withholdings faced by the average earner (OECD) from 2001-7 and take the values of 0.078 and 0.077 respectively while the consumption and capital income taxes have values of 0.047 and 0.364 and are either taken from Trabandt and Uhlig (2011) or calculated using their approach, representing average effective tax rates form 95-07.

The unity inverse Frisch Elasticity complies with the reported values in the literature, such as Trabandt and Uhlig (2011) or Guner et al. (2016). The value of the risk aversion parameter comes as well from the literature and has a value of 1.2. Also, from the literature, are the capital share of output and the capital depreciation rate and take values such as: 0.33 and 0.06, respectively.

A persistence of idiosyncratic shock, ρ, of 0.335 is set according to the data of U.S. from the Panel Study of Income Dynamics (PSID) 1968-1997 and the variance of ability with a value of 0.423 is the corresponding to the European economies average from Brinca et al. (2016).

The logarithmic of the equation that gives the individual wages as reported in section 3.3 gives the life cycle profile of wages:

$$\ln(w_i) = \ln(w) + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 \quad (16)$$

To match the moment variance of log wages, it is calibrated the variance of the idiosyncratic risk, σ_u.

Finally, the labor income tax function considered is described in the appendix and follows the equation proposed in Benabou (2002).

For the U.S., Hans et al. (2017) estimate θ_0 and θ_1 to be 0.887867 and 0.137185, respectively.

Endogenously Calibrated Parameters

On the other hand, endogenously set using the simulated method of moments are the bequest utility (φ), the three different discount factors (β_1, β_2 and β_3) the disutility of work (χ), the borrowing limit (b) and the variance of risk (σ_u).

The goal is to minimize a loss function that is written as the difference between the moments in the model - M_m and the moments in the data - M_d:

$$L(\varphi, \beta_1, \beta_2, \beta_3, b, \chi, \sigma_u) = ||M_m - M_d|| \quad (17)$$

Since there are seven parameters endogenously calibrated it is necessary to have seven data moments in order to have an exactly identified system. The seven targets are the capital to output ratio K/Y, the fraction of hours worked $\bar{n}$, the variance of log wages Var(ln w), the ratio of the average net asset position of households in the age cohort 75 to 80 year old relative to the average asset holdings in the economy $\bar{a}_{75-80}/\bar{a}$, and the three wealth quartiles Q_{25}, Q_{50}, Q_{75}.

According to the Penn World Table 8.0, the capital to output ratio for the United States is 3.074 as for the average yearly hours,$\bar{n}$, the source is the OECD Economic Outlook, and it has a value of 0.248. The variance of log wages for the country in analysis is 0.509 retrieved from the LIS database. The share of wealth held by those between the 1st and the 25th percentile (Q_{25}) is 0.0141, the one held by those between the 1st and 50th percentile (Q_{50}) is 0.0044 and the one held by those between the 1st and 75th (Q_{75}) percentile is 0.1200. As the three quartiles, the ratio of the mean wealth detained by those between 75 and 80 years old to the mean wealth of the population is retrieved from the Luxembourg Wealth Study (LWS) and takes the value of 1.51.

For all cases of progressivity considered, the tax level is calibrated as well to keep the average tax rate constant. Table 1 shows the values obtained for θ_0

Table 1: Values of θ_0 that keeps average tax rate constant when changing θ_1

θ_1	.1050	0.1216	0.1381	0.1547	0.1712	0.1878	0.2043	0.2209	0.2374	0.2540
θ_0	0.881715	0.88495	0.887995	0.8909	0.89359	0.8962	0.89853	0.90049	0.90263	0.90436

As mentioned above, the variance of idiosyncratic risk is calibrated to match the data moment of the variance of log wages. For all progressivity levels,σ_u is then 0.3065.

Moreover, calibrating such that the model matches the other data moments, the model value of $\bar{a}_{75-80}/\bar{a}$, K/Y, Var(ln w) and $\bar{n}$ are fitted to the millesimal. However, in the case of the Wealth Quartiles, the calibration fit varies considerably. Table 2 compiles the model values obtained.

Table 2: Calibration fit Wealth Quartiles

Q \ θ_1	0.1050	0.1216	0.1381	0.1547	0.1712	0.1878	0.2043	0.2209	0.2374	0.2540
Q_{25}	-0.0097	-0.0094	-0.0094	-0.0106	-0.0105	-0.0102	-0.0104	-0.0090	-0.0104	-0.0095
Q_{50}	0.0024	0.0024	0.0021	0.0002	0.0002	0.0010	0.0004	0.0013	-0.0002	0.0005
Q_{75}	0.1214	0.1210	0.1208	0.1207	0.1209	0.1207	0.1208	0.1208	0.1211	0.1209

Finally, the endogenously calibrated variables take the values as can be seen in table 3

Table 3: Parameter Values Estimated by SMM

	β_1	β_2	β_3	χ	b	φ
0.1050	0.9911	0.9370	0.8856	12.68	0.1255	5.645
0.1216	0.9912	0.9360	0.8858	12.495	0.1206	5.673
0.1381	0.9913	0.9356	0.8857	12.310	0.119	5.69
0.1547	0.9915	0.9369	0.8863	12.120	0.133	5.63
0.1712	0.9916	0.9359	0.8900	11.921	0.132	5.64
0.1878	0.9917	0.9238	0.9149	11.71	0.1287	5.661
0.2043	0.9918	0.9243	0.9150	11.505	0.1305	5.661
0.2209	0.99166	0.9310	0.8964	11.28	0.111	5.78
0.2374	0.9919	0.9245	0.9152	11.07	0.129	5.68
0.254	0.99185	0.9237	0.9133	10.843	0.117	5.75

Additionally, it is analysed a different exercise in which the model is not calibrated, but only the values of progressivity are changed as well the level of tax to keep the average tax rate constant, which takes the values outlined in table 4.

Table 4: Values of θ_0 that keeps average tax rate constant when changing θ_1 when not recalibrating

θ_1	.1050	0.1216	0.1381	0.1547	0.1712	0.1878	0.2043	0.2209	0.2374	0.2540
θ_0	0.88173	0.88499	0.88804	0.89091	0.89358	0.89608	0.89839	0.90052	0.90247	0.90425

5 Progressivity and Fiscal Consolidation

The structural model considers a debt-to-GDP reduction obtained to either a reduction of government spending or an increase in taxation. There is a path that occurs at the time of the reduction of government spending. The lower government debt leads households to invest in physical capital instead of saving. The higher physical capital increases the capital to labor ratio which means a higher future marginal product of labor. Then, the expected life-time income increases and, in its turn, it conducts to a decrease of labor supply and consequently a drop in output in the short-run. When tax progressivity increases, so does the percentage of borrowing constrained agents in the economy. Such agents face an impediment to decrease labor today from the higher expected life-time income. All in all, the multiplier, which gives the change in output over the change in spending, will become smaller as tax progressivity increases. An outcome driven from the lower decrease of output over the same change in government spending.

The mechanism study in the model links higher progressivity to lower precautionary savings and, consequently, higher number of constrained agents in the economy who will potentiate the process above mentioned. The model, calibrated for different values of progressivity, yields a weak positive relationship between the percentage of borrowing constrained agents in the U.S. economy and the progressivity of their tax system.

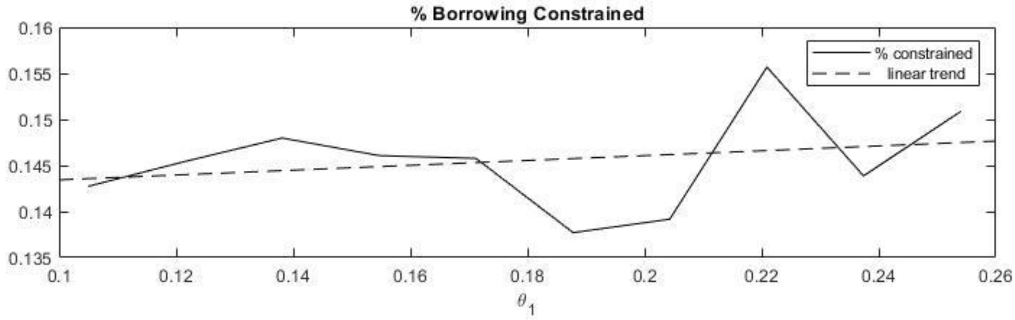

Figure 1: Relationship between the percentage of borrowing constrained agents in the economy and progressivity when the model is calibrated.

Such relation becomes more pronounced if the endogenously calibrated parameters are left untouched and only the tax progressivity and the tax level ($\theta_1$and θ_0) are changed. As progressivity increases, so does the percentage of borrowing constrained.

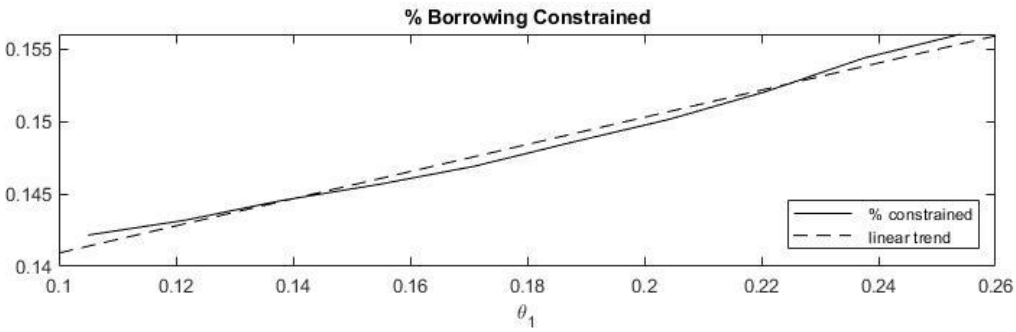

Figure 2: Relationship between the percentage of borrowing constrained agents in the economy and

progressivity when not calibrating.

Thus, the model corroborates the assumption that higher progressivity leads to a higher percentage of liquidity constrained agents in the economy.

The following analysis concerns the relation of progressivity with the multipliers. First, it is studied the interaction of progressivity and the spending multiplier in the scope of fiscal consolidation. As can be verified in the graph, as progressivity is increased the fiscal multiplier resulting from a decrease in government spending, decreases. This refers to the mechanism laid before.

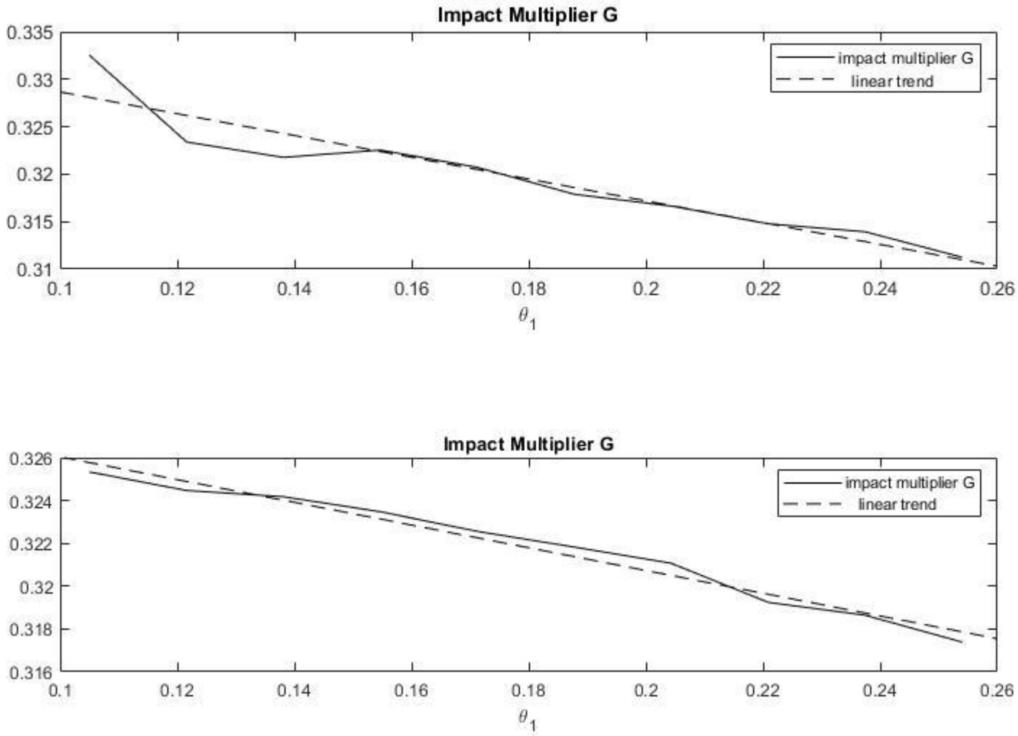

Figure 3: *Impact multiplier for the G-consolidation for different values of progressivity measure. Upper panel: calibrating. Lower panel: without recalibrations.*

The negative relationship is obtained in both exercises, calibrating the endogenous parameters (upper panel) and only changing tax progressivity and level (lower panel). That means that as progressivity increases, the recessionary impact of spending reduction is smaller.

As for the case of consolidation achieved through increased taxation, the multiplier is again smaller as progressivity increases, which in this case means that the recessionary impact is stronger. The association can be verified in figure 4.

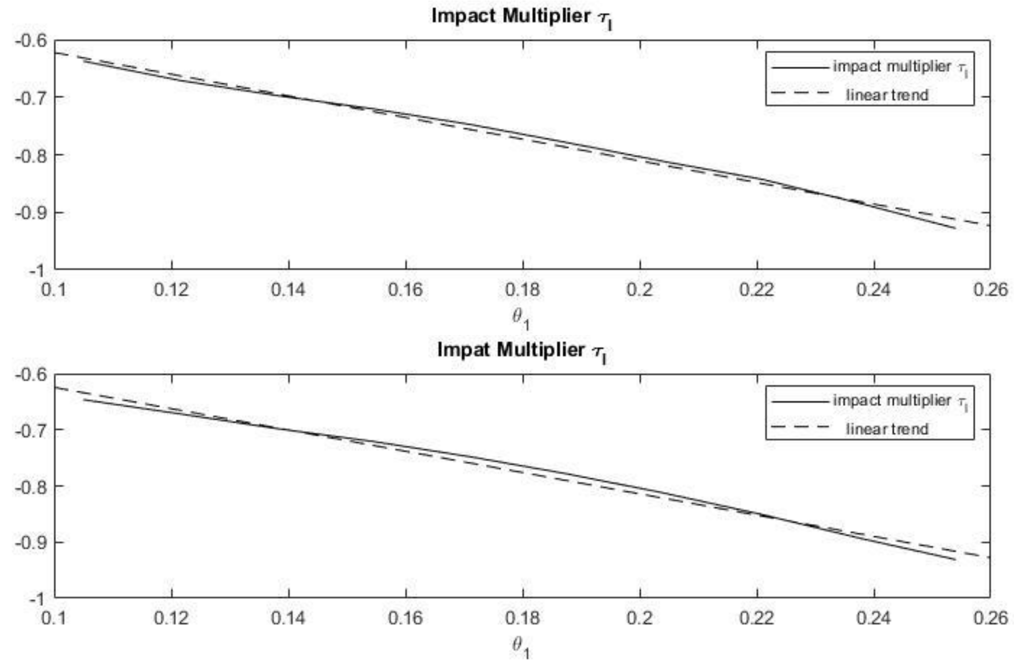

Figure 4: Impact multiplier for the τ_l-consolidation for different values of θ_1 when the model is calibrated (upper panel) and without calibrations (lower panel).

The upper panel illustrates the results of the impact multiplier to a consolidation through tax increase, calibrating endogenously the parameters: φ, β_1, β_2 and β_3, χ, b and σ_u.

The lower panel illustrates the results increasing progressivity and altering the tax level to keep the average tax rate constant.

The mechanism operating in this case is different from the one developed before. The labor supply response to a τ_l - consolidation, in other words the percentage of the labor supply after consolidation of the labor supply in steady state, is decreasing as progressivity increases. This means that all percentiles of the economy, from the poorer to the richer ones, decrease more their labor supply after the consolidation relative to the labor supply observed in the steady-state.

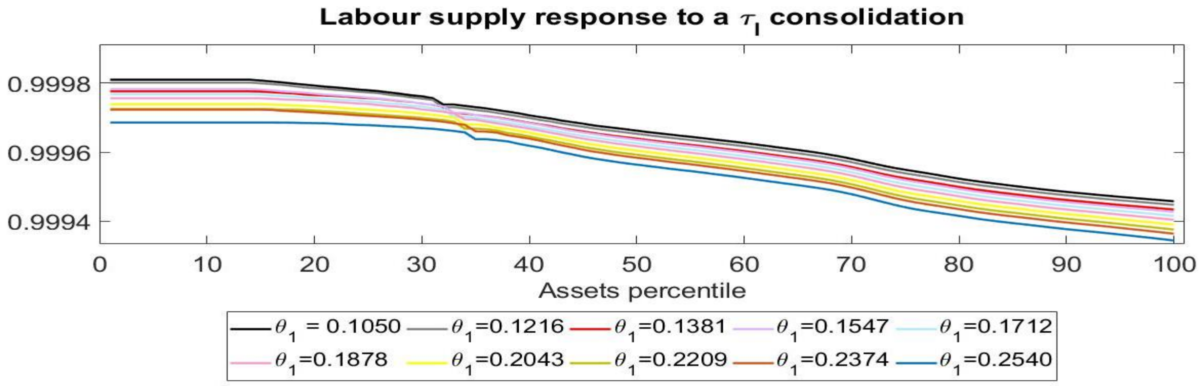

Figure 5: Labor Supply Response to a τ_l consolidation for different values of progressivity measure.

Additionally, observing the income profile of average earning for each age it can be concluded that the expected life time income decreases for all age groups (Appendix 6.4).

The lower multiplier means then, that the higher θ_1 leads to higher distortionary effects in the economy, or in other words it diverges the economy away from optimality.

6 Conclusion

In conclusion, labor income tax progressivity lowers fiscal multipliers for both measures: lower government spending and higher taxes. However, if for the decrease of government spending a lower multiplier means that as progressivity increases the recessionary impact of fiscal consolidation programs is smaller, for the increase of taxes, a lower multiplier means that as progressivity increases the recessionary impact of fiscal consolidation are larger. After the analysis undergo by this paper in which a model with overlapping generations and incomplete markets is calibrated to the United States, proposing different values of progressivity and altering the tax level in order to keep average tax rate constant, it can be concluded that as progressivity increases so does the percentage of borrowing constrained agents in the economy.

On the one hand, it means that after a debt reduction financed by a decrease in government spending, future income increases. It would mean that individuals would reduce their labor supply today, however borrowing constrained agents cannot borrow from the higher future income so they will not reduce their labor supply today. So, as the percentage of such agents increases, the spending multiplier is lower.

On the other hand, if the consolidation is obtained through an increase of taxes, it means that as progressivity increases the distortionary effects of taxes are larger. In that case the economy distances away from efficiency and the reduction of labor supply is bigger leading to lower fiscal multipliers.

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6 Appendix

6.1 Statistics

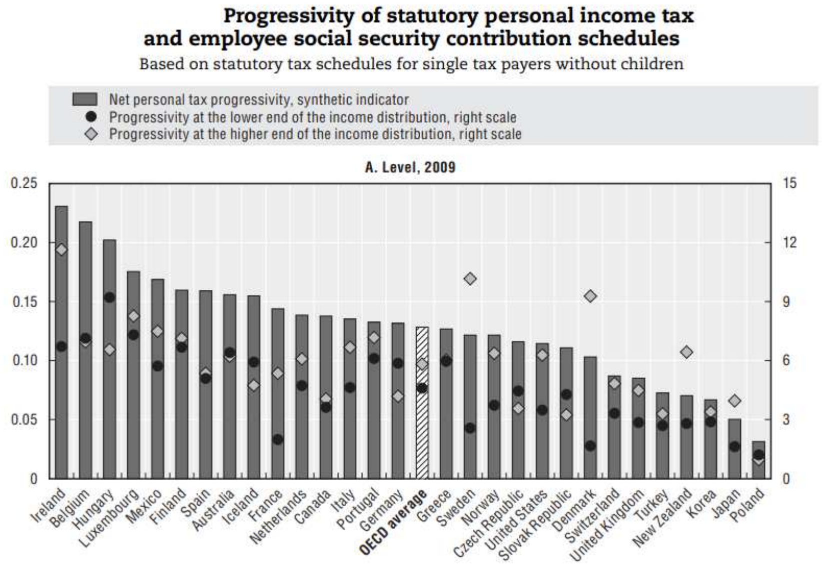

Figure1: Progressivity of statutory personal income tax and employee social security contribution schedules: Based on statutory tax schedules for single tax payers without children. Source: Joumard, Isabelle, Mauro Pisu and Debbie Bloch (2012), "Tackling income inequality: The role of taxes and transfers", OECD Journal: Economic Studies.

6.2 Tax Function

[1]Given the tax function

$$ya = \theta_0 y^{1-\theta_1}$$

Which we employ, the average tax rate is defined as

$$ya = \big(1 - \tau(y)\big)y$$

and thus

$$\theta_0 y^{1-\theta_1} = \big(1 - \tau(y)\big)y$$

and thus

[1] This appendix is borrowed from Holter et al. (2017)

$$1 - \tau(y) = \theta_0 y^{-\theta_1}$$

$$\tau(y) = 1 - \theta_0 y^{-\theta_1}$$

$$T(y) = \tau(y)y = y - \theta_0 y^{1-\theta_1}$$

$$T'(y) = 1 - (1-\theta_1)\theta_0 y^{-\theta_1}$$

Thus the tax wedge for any two incomes (y_1,y_2) is given by

$$1 - \frac{1-\tau(y_2)}{1-\tau(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1}$$

And therefore, independent of the scaling parameter θ_0. Thus, by construction one can raise average taxes by lowering θ_0 and not change the progressivity of the tax code, since (as long as tax progressivity is defined by the tax wedges) the progressivity of the tax code[2] is uniquely determined by the parameter θ_1.

6.3 Definition of a Transition Equilibrium after the Unanticipated Fiscal Consolidation Shock

[3]We define a recursive competitive equilibrium along the transition between steady states as follows:

Given the initial capital stock, the initial distribution of households and initial taxes, respectively K_0,$\Phi_1$and $\{\tau_l, \tau_c,\tau_k, \tau_{ss}, \tilde{\tau}_{ss}\}_{t=1}^{t=\infty}$, a competitive equilibrium is a sequence of individual functions for the household, $\{V_t, c_t, k'_t, n_t\}_{t=1}^{t=\infty}$, of production plans for the firm, $\{K_t, L_t\}_{t=1}^{t=\infty}$, factor prices, $\{r_t, w_t\}_{t=1}^{t=\infty}$, government transfers $\{g_t, \psi_t, G_t\}_{t=1}^{t=\infty}$, government debt, $\{B_t\}_{t=1}^{t=\infty}$, inheritance from the dead, $\{\Gamma_t\}_{t=1}^{t=\infty}$, and of measures $\{\Phi_t\}_{t=1}^{t=\infty}$such that for all t:

[2] Note that $1 - \tau(y) = \frac{1-T'(y)}{1-\theta_1} > 1 - T'(y)$ and thus as long as $\theta_1 \in (0,1)$ we have that $T'(y) > \tau(y)$ and thus marginal tax rates are higher than average tax rates for all incomes.

[3] This appendix is borrowed from Brinca et al. (2017)

1. Given the factor prices and the initial conditions of the consumers' optimization problem is solved by the value function $V(k,\beta,a,u,j)$ and the policy functions, $c(k,\beta,a,u,j)$, $k'(k,\beta,a,u,j)$ and $n(k,\beta,a,u,j)$.

2. Markets clear:

$$K_t + B_t = \int k_t d\Phi_t$$

$$L_t = \int \big(n_t(k_t,\beta,a,u,j)\big)\, d\Phi_t$$

$$\int c_t d\Phi_t + K_{t+1} + G_t = (1-\delta)K_t + K_t^{\alpha} L_t^{1-\alpha}$$

3. Factor prices:

$$w = (1-\alpha)\left(\frac{K_t}{L_t}\right)^{\alpha}$$

$$r = \alpha\left(\frac{K_t}{L_t}\right)^{\alpha-1} - \delta$$

4. The government budget balances:

$$g\int d\Phi_t + G_t + r_t B_t = \int \left(\tau_k r_t(k_t + \Gamma_t) + \tau_c c_t + n_t \tau_l \left(\frac{n_t w_t(a,u,j)}{1+\tilde{\tau}_{ss}}\right)\right) d\Phi_t + (B_{t+1} - B_t)$$

5.The social security system balances:

$$\psi_t \int_{j\geq 65} d\Phi_t = \frac{\tilde{\tau}_{ss} + \tau_{ss}}{1+\tilde{\tau}_{ss}} \left(\int_{j<65} n_t w_t d\Phi_t\right)$$

6.The assets of the dead are uniformly distributed among the living:

$$\Gamma_t \int \omega(j) d\Phi_t = \int \big(1-\omega(j)\big) k_t d\Phi_t$$

7.Aggregate law of motion:

$$\Phi_{t+1} = \Upsilon_t(\Phi_t)$$

6. 4 Expecte Life-time Income per Age

	Income Profile Average									
Age\\θ_1	**0.1050**	**0.1216**	**0.1381**	**0.1547**	**0.1712**	**0.1878**	**0.2043**	**0.2209**	**0.2374**	**0.2540**
20	0.3145	0.3119	0.3094	0.3069	0.3046	0.3023	0.3001	0.2978	0.2956	0.2933
21	0.3662	0.3629	0.3597	0.3565	0.3535	0.3504	0.3475	0.3445	0.3416	0.3386
22	0.4121	0.4084	0.4047	0.4012	0.3976	0.3941	0.3906	0.3872	0.3838	0.3803
23	0.4534	0.4493	0.4452	0.4412	0.4373	0.4332	0.4292	0.4252	0.4213	0.4173
24	0.4920	0.4875	0.4831	0.4786	0.4742	0.4697	0.4651	0.4604	0.4559	0.4512
25	0.5347	0.5297	0.5248	0.5197	0.5146	0.5095	0.5043	0.4990	0.4937	0.4884
26	0.5724	0.5668	0.5613	0.5557	0.5500	0.5444	0.5386	0.5328	0.5269	0.5209
27	0.6113	0.6050	0.5988	0.5925	0.5862	0.5799	0.5735	0.5671	0.5605	0.5539
28	0.6484	0.6415	0.6346	0.6277	0.6207	0.6137	0.6067	0.5996	0.5925	0.5852
29	0.6848	0.6772	0.6696	0.6620	0.6544	0.6467	0.6390	0.6312	0.6235	0.6156
30	0.7157	0.7074	0.6992	0.6909	0.6827	0.6745	0.6662	0.6579	0.6497	0.6412
31	0.7445	0.7358	0.7270	0.7182	0.7094	0.7006	0.6918	0.6830	0.6742	0.6653
32	0.7723	0.7630	0.7538	0.7444	0.7350	0.7257	0.7164	0.7070	0.6977	0.6883
33	0.7929	0.7833	0.7736	0.7639	0.7542	0.7444	0.7347	0.7250	0.7153	0.7056
34	0.8154	0.8052	0.7951	0.7849	0.7748	0.7646	0.7545	0.7443	0.7342	0.7240
35	0.8336	0.8230	0.8125	0.8019	0.7915	0.7810	0.7705	0.7600	0.7495	0.7390
36	0.8483	0.8374	0.8266	0.8158	0.8050	0.7942	0.7835	0.7727	0.7620	0.7513
37	0.8575	0.8464	0.8354	0.8244	0.8136	0.8026	0.7918	0.7808	0.7699	0.7590
38	0.8672	0.8560	0.8448	0.8335	0.8225	0.8114	0.8004	0.7892	0.7781	0.7670
39	0.8673	0.8560	0.8449	0.8337	0.8227	0.8116	0.8007	0.7896	0.7785	0.7675
40	0.8713	0.8600	0.8488	0.8375	0.8264	0.8153	0.8043	0.7932	0.7820	0.7709
41	0.8711	0.8597	0.8486	0.8374	0.8264	0.8153	0.8044	0.7933	0.7822	0.7711
42	0.8687	0.8575	0.8464	0.8353	0.8243	0.8134	0.8025	0.7914	0.7804	0.7694
43	0.8641	0.8530	0.8421	0.8311	0.8203	0.8095	0.7987	0.7878	0.7769	0.7660
44	0.8558	0.8449	0.8341	0.8233	0.8127	0.8020	0.7914	0.7807	0.7700	0.7593
45	0.8517	0.8409	0.8302	0.8196	0.8090	0.7985	0.7880	0.7774	0.7668	0.7561
46	0.8477	0.8370	0.8264	0.8158	0.8054	0.7949	0.7846	0.7740	0.7635	0.7530
47	0.8353	0.8250	0.8147	0.8044	0.7943	0.7842	0.7741	0.7639	0.7536	0.7434
48	0.8222	0.8121	0.8022	0.7922	0.7824	0.7726	0.7628	0.7529	0.7430	0.7331
49	0.8152	0.8053	0.7956	0.7857	0.7761	0.7664	0.7567	0.7470	0.7373	0.7275
50	0.8062	0.7966	0.7870	0.7774	0.7679	0.7584	0.7489	0.7393	0.7298	0.7202
51	0.7953	0.7859	0.7766	0.7672	0.7580	0.7487	0.7395	0.7302	0.7209	0.7115
52	0.7885	0.7794	0.7702	0.7611	0.7520	0.7429	0.7338	0.7247	0.7155	0.7063
53	0.7841	0.7751	0.7661	0.7570	0.7480	0.7390	0.7300	0.7210	0.7119	0.7028
54	0.7810	0.7721	0.7632	0.7542	0.7454	0.7364	0.7276	0.7186	0.7097	0.7006
55	0.7771	0.7683	0.7595	0.7506	0.7419	0.7331	0.7243	0.7154	0.7065	0.6976
56	0.7755	0.7667	0.7580	0.7493	0.7406	0.7319	0.7232	0.7143	0.7055	0.6966
57	0.7788	0.7700	0.7612	0.7525	0.7438	0.7350	0.7262	0.7173	0.7085	0.6996
58	0.7861	0.7772	0.7683	0.7594	0.7506	0.7417	0.7328	0.7238	0.7149	0.7058
59	0.7992	0.7900	0.7809	0.7718	0.7628	0.7536	0.7445	0.7353	0.7261	0.7168
60	0.8160	0.8066	0.7972	0.7878	0.7785	0.7690	0.7596	0.7501	0.7406	0.7310
61	0.8374	0.8276	0.8179	0.8082	0.7985	0.7888	0.7791	0.7693	0.7595	0.7496
62	0.8784	0.8678	0.8574	0.8469	0.8364	0.8259	0.8155	0.8049	0.7944	0.7837
63	0.9281	0.9164	0.9049	0.8934	0.8819	0.8704	0.8589	0.8474	0.8359	0.8242
64	0.9914	0.9781	0.9649	0.9516	0.9386	0.9255	0.9126	0.8996	0.8867	0.8736