Risk Aversion and Recessive Impacts of Austerity

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Risk Aversion and Recessive Impacts of Austerity *

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Abstract

This paper aims to contribute for the vast literature on the impact of country-specific characteristics on fiscal multipliers. We argue that countries have relevant differences in risk attitudes, and that those differences are economically significant in determining output responses to fiscal consolidation programs. We start with an empirical analysis, estimating the coefficient of relative risk aversion for nine European economies, finding relevant heterogeneity across countries. Using the coefficients found, we calibrate an incomplete markets overlapping generations model and study the impacts of an unanticipated fiscal consolidation shock. We find a positive relationship between fiscal multipliers and risk aversion when there is a spending-based consolidation, showing that recessive impacts from austerity are stronger the larger the degree of risk aversion. The underlying mechanism depends on the effect of risk aversion on precautionary savings behavior and so on the share of constrained agents. Larger risk aversion induces more precautionary savings, thus shrinking the share of constrained agents. Credit-constrained agents have a less responsive labor supply with respect to spending-based fiscal consolidation shocks.

Keywords: Fiscal Multipliers, Fiscal Consolidation, Relative Risk Aversion

JEL Classification: E21; E62; H31; H63; I31

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1 Introduction

Before the Great Recession of 2008, the economic research on fiscal macroeconomic policy was a backwater when compared to the developments in monetary policy. Two explanations for this tendency are commonly pointed in the literature. One is the fact that most economists and policy makers, at the time, were confident that monetary policy was the right answer to smooth economic cycles. Blanchard and Summers (2020), for instance, argue that this was both due to theoretical reasons, as nominal rigidities are at the core of inefficient output fluctuations, and for practical reasons, since monetary policy not only has a lower implementation lag but is also protected from political winds. At the same time, public debt sustainability issues did not raise major concerns, except as a result of long-term spending pressures arising from aging and pension spending. This was particularly true for advanced economies, although the role of fiscal fragilities in emerging economies continued to be regarded as relevant in triggering economic crises.

After the Great Recession, this paradigm changed and fiscal policy regained importance. Initially, because the magnitude of the economic downturn allied with all-time low interest rates, which tied Central Banks' hands concerning conventional monetary policy, forced Governments to use fiscal expansionary instruments. Moreover, after 2010, a couple of European countries implemented severe fiscal consolidation plans, as a result of public finances deterioration that raised debt sustainability concerns. This large set of fiscal shocks motivated a renewed research interest in fiscal policy, namely regarding its short-run effects on output. Macroeconomists turned the focus to an old relevant question: how large are fiscal multipliers?

The answer to this question is not a mere research curiosity. Estimating fiscal multipliers is crucial to guide fiscal policy, predict how output will respond and, ultimately, how people will be impacted. This became a clear evidence after the strong impacts that fiscal consolidation programs had in Europe, during the sovereign debt crisis. Blanchard and Leigh (2013) found that fiscal multipliers that guided austerity packages proposed by the IMF were underestimated. Besides this finding, they were unable to identify what led to such sub-estimation. This set the tone for extensive literature on what factors are relevant in determining the size of fiscal multipliers, acknowledging the idea that there is no such thing as a *single fiscal multiplier*. As now standard in the literature, fiscal multipliers differ across countries and time, since they depend on the state of the economy (see Baum et al. (2012)), on the type and dimension of fiscal instruments used (see Auerbach and Gorodnichenko (2012), Alesina et al. (2017) and Brinca et al. (2019)) and on country-specific characteristics.

Regarding the impact of country-specific characteristics, Ilzetzki et al. (2013) found that fiscal multipliers depend crucially on the level of development, exchange rate regime, openness to trade, and public indebtedness. Brinca et al. (2016), using an overlapping generations model with heterogeneous agents, found that wealth inequality plays a significant role in the output response to a temporary rise in Government expenditures financed by a temporary reduction of lump-sum transfers. Also, Brinca et al. (2021), using the same model but with a bequest motive, showed that cross-country discrepancies in income inequality can account for significant differences in the observed impacts of fiscal consolidation programs in European countries: larger inequality is associated with less constrained agents, which have a larger labor supply elasticity with respect to income shocks. Under a similar mechanism, Basso and Rachedi (2018) concluded that fiscal multipliers depend on the age structure of the population, and Bernardino (2019) showed the importance of asset liquidity when studying the impact of wealth inequality on fiscal multipliers.

This paper contributes for the literature by focusing on a key aspect that has been neglected in all of the studies mentioned, namely that countries may differ in terms of markets structures that are not explicitly modelled and that can be observationally equivalent to differences in *risk attitudes*. Despite the consensus about the relevance of risk aversion in economic decisions, its specific value for countries remains disputed, largely because of limitations in estimating it empirically. This is the most likely explanation for the lack of consistent literature on the impact that risk attitudes have on fiscal policy. These become relevant when assessing the fiscal policies in environments with incomplete insurance markets, be it in terms of the response of the economy to fiscal shocks (see Oh and Reis (2012), McKay and Reis (2021), Kaplan and Violante (2014), and Brinca et al. (2016)) be it in terms of optimal tax structures in response to phenomena as investment-specific technological change (see Brinca et al. (2019)) or climate change (see Malafry and Brinca (2022)).

Kilponen et al. (2015) found different effects of risk aversion across models, while Grancini (2021) presented positive, although not significant, effects of risk aversion on fiscal multipliers.[1] During several years, the most common methodology to estimate risk aversion for country-level was through consumption-based capital asset pricing models (CCAPM). Hansen and Singleton (1983) using CCAPM found a coefficient of relative risk aversion (RRA) very close to 1 for the US, while Mankiw and Shapiro (1984) estimated a coefficient of 1.85. Some years later, Neely et al. (1995) warned about the limitations of using this methodology, essentially due to the unpredictability of consumption growth. New methodologies have been applied since then. Chetty (2006) brought a novel proposal to estimate RRA for countries, using data on labor supply behavior, relying on the idea that more risk averse agents have a faster declining marginal utility of consumption, and so have a stronger income effect on labor supply when the wage rate rises. Layard et al. (2008) presented an alternative method, using happiness data to estimate how fast the marginal utility of income declines as income increases, assuming a constant relative risk aversion (CRRA) utility function. Debate aside, one can highlight two main conclusions from this vast literature: The most commonly accepted measures of the RRA coefficient lie between zero and three, and the RRA varies significantly across countries.

Our work focuses on output responses to fiscal consolidation shocks and the quantitative relevance of introducing country-level heterogeneity in risk aversion. The first part of this paper - Section 2 - consists in an empirical exercise where we estimate the coefficient of relative risk aversion for nine European economies: Austria, Belgium, Spain, France, Italy, Netherlands, Germany, Portugal and Slovakia. We do this following the methodology suggested in Layard et al. (2008), using the most recent version of the European Social Survey. [2] We find maximum-likelihood estimates for country-level RRA that range from 0.72 in Germany to 1.29 in Italy, showing relevant cross-country heterogeneity regarding risk attitudes.

The second part of the paper studies how country-level risk aversion impacts fiscal multipliers,

[1] Both rely on a compilation of published empirical estimates, which can have comparability issues.
[2] ESS9 edition 3.1 (published in 17.02.21).

and whether the estimated differences in the RRA coefficient across countries can explain discrepancies in fiscal multipliers. This is done using the model proposed in Brinca et al. (2021), which contains overlapping generations with heterogeneous agents, incomplete markets, exogenous credit constraints, uninsurable idiosyncratic risk and a bequest motive. We calibrate the model using the RRA estimates found, and we implement the same fiscal consolidation experiment to all economies: starting from the steady-state and without any previous announcement, Government reduces public debt by 10% of GDP, during 50 years, through a decrease in Government spending.

The results from the experiment show that the standard approach used to estimate country specific values for risk attitudes yields economically meaningful differences in terms of fiscal impacts of a budget consolidation program financed by reducing Government expenditure. We find that output drops in the short-run, as a results of the debt reduction policy, and that this drop is larger the larger the RRA. In other words, fiscal multipliers resulting from spending-based fiscal consolidation depend positively on the RRA coefficient. For instance, through simulations in a benchmark economy, initially calibrated to France, we show that varying the RRA coefficient strongly affects the fiscal multiplier - increasing RRA can lead up to 10% larger output drop. Also, when comparing output response in Italy and Germany, we find that Italy, with larger RRA coefficient, presents a more recessive response, while the calibration without considering RRA differences would lead to the opposite conclusion. Finally, when performing a cross-country analysis, we find that countries with a higher RRA coefficient have a larger multiplier, i.e. more recessive impact. We observe a 25% variation in the impact multipliers across countries.

The relevant mechanism to understand our results works as follows: the larger the degree of risk aversion, the higher the level of precautionary savings when facing a certain income risk. An economy with higher level of precautionary savings has a lower share of credit constrained agents. As public debt is reduced, the capital stock and, consequently, the marginal product of labor (wages) rise, thus expected lifetime income increases. This produces both a positive lifetime income effect, inducing more leisure today, and an inter-temporal substitution effect, as is it more attractive to delay work given the larger expected wage. Both effects lead to lower labor supply today, and so output falls in the short-run. Credit constrained agents, however, cannot borrow in order to decrease labor supply today, i.e. have a marginal propensity to consume goods and leisure out of future income equal to zero. This way, economies with larger risk aversion, and so less agents constrained, experience a larger aggregate labor supply reduction, causing a higher variation in output.

The remainder of the paper is organized along these lines. Section 2 presents our empirical estimation for the RRA coefficient. In Section 3 we characterize the OLG model with heterogeneous agents and the households' problem and define the competitive equilibrium. Section 4 explains how we calibrate the model to match the relevant moments of each country. In Section 5 we show the main results. Section 6 concludes.

2 Risk Aversion: Empirical Analysis

This section is dedicated to the estimation of the coefficient of relative risk aversion (RRA) for nine European economies. We do so by following the methodology proposed by Layard et al. (2008).

2.1 Relative Risk Aversion Coefficient (RRA)

The estimation of RRA should express how fast the marginal utility of income falls as income rises. This implies that we need to assume a general utility function to characterize households' preferences. Layard et al. (2008) uses CRRA preferences, a standard assumption in literature. Besides other attractive features and computational simplicity, CRRA preferences have a constant elasticity of marginal utility with respect to income, i.e constant relative risk aversion. This is the same class of preferences used in the model by Brinca et al. (2021). The utility as function of income presents the following shape:

$$U(y)\begin{cases}\frac{y^{1-\sigma}-1}{1-\sigma} & \text{if } \sigma \neq 1,\\ \ln y & \text{if } \sigma = 1\end{cases} \tag{1}$$

where σ is the RRA coefficient, and y income.

Note that the RRA coefficient (Arrow–Pratt measure of relative risk aversion) is by definition given by: $RRA = \frac{-yu''(y)}{u'(y)}$, and given the type of preferences in (1), $RRA = \sigma$.

2.2 Estimation strategy

The first issue when estimating σ is the fact that utility is not directly observed and difficult to measure. Instead, we use self-reported happiness data as a proxy, with the assumption that individuals generate a numeric answer to the happiness question by applying an idiosyncratic, strictly increasing function f_i to u_i. This way, self-reported happiness for individual i is given by:

$$h_i = f_i(u_i) \tag{2}$$

According to (2), self-reported happiness would be an ordinal non-comparable measure of true utility, because each individual is applying its own function (f_i) to u_i. Similarly to Layard et al. (2008), we make a more restrictive assumption imposing that f_i is linear and common to all individuals up to a random additive term, that is:

$$h_i = f_i(u_i) = f(u_i) + v_i = u_i + v_i \tag{3}$$

The assumption of linearity in f_i is crucial given our interest in estimating the decline of marginal utility to income, therefore we need to rule out the possibility that happiness reports are concave in true utility. Regarding the utility function, in (1) we show the assumed relationship between utility and income. In order to estimate σ, we augment the utility function to include j other relevant control variables such as education, gender, age and employment status. According to these assumptions, our goal is then to estimate σ in the following regression model:

$$h_i = \gamma \frac{y_i^{1-\sigma} - 1}{1 - \sigma} + \sum_{n=1}^{j} \beta_j x_{ij} + \epsilon_i \tag{4}$$

where $\gamma \frac{y_i^{1-\sigma}-1}{1-\sigma} + \sum_{n=1}^{j} \beta_j x_{ij} = u_i$ and $\epsilon_i = v_i + \epsilon_i'$, with ϵ_i' being the regression error term. Our empirical strategy consists in two steps: Evaluate the logarithmic hypothesis ($\sigma = 1$) for the combined sample and perform the non-parametric/ maximum likelihood estimation of σ based on equation (4) for each country.

We are aware of the limitations of using self-reported happiness as a proxy for utility. For instance, the concept might vary a lot between individuals, it is to a large extent inborn or genetically determined, and actual choices and happiness-maximising choices, despite positively correlated, are not identical (see Benjamin et al. (2012)). Despite this, Happiness Economics and Normative Economics have been relying increasingly more on this method, supported by empirical evidence. In Section 7.1 of the appendix, we provide supporting arguments for the use of self-reported happiness.

2.3 Data

The methodology used by Layard et al. (2008) was also the basis of subsequent work on estimating the country-level degree of risk aversion (see Gandelman and Hernández-Murillo (2015)). Our main empirical contribution is the use of an updated data set. We rely on the last edition of the European Social Survey, from 2018. We turn our focus into nine European economies: Austria, Belgium, Spain, France, Italy, Netherlands, Germany, Portugal and Slovakia. This allowed us to gather more than 13 000 cross-section observations.

Concerning self-reported happiness (h_i), the survey asks individuals how happy they are, [3] in a scale ranging from zero (extremely unhappy) to ten (extremely happy). Regarding income, we are provided only with information of the respective decile in national income distribution. Using the survey appendix documentation, we can understand the income brackets for each decile in each country. We consider the midpoint of the interval for all deciles, except for respondents in the lowest income band, where we assume an income of two thirds of the upper limit of the band, and for respondents in the highest income band, where we assume an income of 1.5 of the lower income limit of the band. Due to different purchasing power and paycheck periodicity, we transform the income variable to be a share of country average income reported. Finally, for the set of control variables we use gender, number of education years (and its square value), age and employment status. [4] Table 2 displays summary statistics for the explanatory variables and h_i.

[3]"Taking all things together, how happy would you say you are?"

[4]Other variables such as Marital Status were tested, but showed to be statistically insignificant.

2.4 Results

We start by evaluating the general case where happiness depends linearly on log of income, i.e. where $\sigma = 1$. To do so, we perform an OLS regression of the happiness index on the set of control variables and on the logarithm of income as well as its square value.[5] We can see that the relationship between self-reported happiness and log of income is not linear. The regression results displayed on Table 3 allow us to see that, although the coefficient on log income is positive, the coefficient on the square value of log of income is negative and significant, thus suggesting that the relationship is not linear.

Discarding the logarithmic case, we estimate the parameters from (4) following an iterative maximum likelihood procedure, for each country in separate. To find the maximum likelihood estimate, the algorithm computes the log likelihood for values of σ between zero and three, which is the commonly accepted interval in the literature, and then uses a quadratic approximation in the vicinity of the maximum.

Table 1 reports the RRA estimates for the nine countries in our sample. The estimates range between 0.72 and 1.29. Also, for each country, we present Wald tests of the null hypotheses that σ equals zero, one, or two, respectively. [6] Our estimates are significantly different from zero and two in most countries. In turn, the null hypothesis that it equals one is rejected at the 5 percent level only in Italy. These results are in line with relevant literature [7], confirming RRA coefficients close to one and different across countries.

3 Model

In this section, we go over the model that will be used to evaluate the output response to fiscal consolidation shocks in different countries, and in particular, how different RRA coefficients affect

[5]Addressing whether the relationship with log income is truly linear, benefits from adding the term log income squared.

[6]In order to compute the value of the Wald-Test, we resort to the inverse of the Hessian Matrix from the likelihood function as a general approximation to the variance-covariance matrix of the parameters.

[7]See, for example, Chetty (2006); Campo et al. (2011); Friend and Blume (1975); Gandelman and Hernández-Murillo (2013); Garcia, Lugar, and Renault (2003); Gordon and St-Amour (2004); Hansen and Singleton (1983); Kapteyn and Teppa (2011); Layard, Mayraz, and Nickell (2008); Mankiw (1985); Szpiro (1986); and Weber (1975).

Table 1: Relative Risk Aversion by country. Note: The chi-square statistics correspond to the likelihood ratio tests for the null hypotheses that σ= 0, σ=1, or σ=2. * indicates statistical significance at the 5 percent level, and ** at 1 percent level. No. obs., number of observations.

Country	σ	χ^2 $H_0 : \sigma = 0$	χ^2 $H_0 : \sigma = 1$	χ^2 $H_0 : \sigma = 2$	No. Obs.
Austria	0.92	31.9**	0.24	44.1**	2028
Belgium	0.94	31.3**	0.13	39.7**	1620
France	1.18	5.4*	0.12	2.6	1763
Germany	0.72	2.7	0.40	8.4**	2086
Italy	1.29	83.1**	4.20*	25.2**	1498
Netherlands	0.86	68.7**	1.82	12.7**	1384
Portugal	0.94	49.7**	0.20	63.2**	838
Slovakia	1.07	2.4	0.01	1.8	815
Spain	0.97	17.4**	0.02	19.6**	1179

the conclusions. The model is the one used in Brinca et al. (2021), an overlapping generations model with heterogeneous agents, incomplete markets and bequest motive.

3.1 Firms and Production

The model assumes a representative firm that produces one good, output, using labor and capital inputs, according to a standard Cobb-Douglas production function:

$$Y_t(K_t, L_t) = K_t^{\alpha} L_t^{1-\alpha} \tag{5}$$

with K_t being the capital input in period t and L_t the number of efficient units of labor force used in production in period t. The law of motion of capital is:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{6}$$

with δ expressing the annual depreciation rate of capital stock and I_t the value of gross investment in period t. In order to maximize profit, the firm chooses L_t and K_t for each period:

$$\max_{L_t, K_t} \Pi_t = Y_t - [w_t L_t + (r_t + \delta) K_t] \tag{7}$$

In a set up of competitive equilibrium, the factor prices, real wage rate (w_t) and real rental price (r_t) will be equal to the marginal product of labor and capital, as follows:

$$w_t = \frac{\partial Y_t}{\partial L_t} = (1-\alpha)\left(\frac{K_t}{L_t}\right)^{\alpha} \tag{8}$$

$$r_t = \frac{\partial Y_t}{\partial K_t} = \alpha\left(\frac{L_t}{K_t}\right)^{1-\alpha} - \delta \tag{9}$$

3.2 Demographics

In each period t, there are J overlapping generations of households. Households start working at age 20 and necessarily exit the labor market at age 65, entering retirement. The household's age is represented by j. Retired households face an age-dependent probability of dying, $\pi(j)$, and at the age of 100, they die for certain. Time is discrete in this model, with periods of 1 year, meaning a 45-years period of active work life. Moreover, we assume that population is constant over time. Each cohort's size is normalized to one. Using the law of large numbers and $\omega(j) = 1 - \pi(j)$ to refer to the age-dependent probability of survival, the mass of retired agents of age $j \geq 65$ still living at period t is equal to $\Omega_j = \prod_{q=65}^{q=J-1} \omega(q)$.

Heterogeneity is introduced in the model from the household's side. Brinca (2020) summarizes the importance of using models that account in greater detail for characteristics that differ across households. In this model, they are different in respect to their age, asset holdings, idiosyncratic productivity, subjective discount factor, and the permanent ability. The subjective discount factor can be any of the three values $\beta \in \{\beta_1, \beta_2, \beta_3\}$ with equal probability, and it is constant for each household throughout their lifetime. Households realize their permanent ability at birth.

The model assumes no annuity markets, so a share of households leaves unintended bequests that are equally redistributed across the living households, through lump-sum transfers. We use Γ to denote the per-household bequest. Moreover, we assume that retired households' utility is increasing in the bequest they leave when they die.[8]

[8] The introduction of bequests is useful in the model calibration to better match asset holdings of elderly households

3.3 Labor Income

Individuals have different wage rates. The wage of an individual, w_i, in the model is given by:

$$w_i(j, a, u) = we^{\gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + a + u} \tag{10}$$

where w consists in the wage per efficient unit of labor from the competitive market equilibrium, γ_1, γ_2 and γ_3 express the age profile of wage, $a \sim N(0, \sigma_a^2)$ is the permanent ability and u the (persistent) idiosyncratic productivity shock that occurs every period. This idiosyncratic shock evolves according to the following AR(1) process:

$$u_{t+1} = \rho u_t + \epsilon_{t+1}, \epsilon_{t+1} \sim N(0, \sigma_\epsilon^2) \tag{11}$$

where ρ is the persistence of the idiosyncratic shock.

3.4 Households' Preferences

The momentary utility function of a household, $U(c, n)$, depends positively on consumption, c and negatively on hours of work, $n \in]0, 1]$, and takes the following form:

$$U(c, n) = \frac{c^{1-\sigma} - 1}{1 - \sigma} - \chi \frac{n^{1+\eta}}{1 + \eta} \tag{12}$$

where σ is the risk-aversion parameter (RRA coefficient), χ the disutility of working factor and η the Frisch elasticity. Retired households, despite not having the term related to the hour worked, n, have an additional term related with the bequest they leave when they die:

$$D(k) = \varphi log(k) \tag{13}$$

Retired households do not supply labor but receive a social security payment, Ψ, constant over time and across households.[9]

[9] Even if Ψ_t was a function of the income received during the active life, the results would not be different.

3.5 Government

The Government, in this model, performs social security insurance and fiscal policy actions. Regarding the social security system, the Government pays benefits Ψ_t to retirees, financed by taxes on the employees and the employer (the representative firm) at the rate τ_{SS} and $\tilde{\tau}_{SS}$, respectively. Concerning the policy action, the Government purchases pure public goods, G_t, provides a lump-sum redistribution, g_t, and pays interests on public debt to the debt-owners (households), in the amount rB_t. These expenditures are financed with taxes on consumption, capital, and labor. Consumption and capital are taxed at flat rates, τ_c and τ_k. Regarding the labor income tax, it is assumed a progressive system based on the non-linear functional form proposed in Benabou (2002):

$$\tau(y) = 1 - \theta_0 y^{-\theta_1} \tag{14}$$

where y stands for the pre-tax labor income and $\tau(y)$ is the average tax rate given the pre-tax income of y. The parameters θ_0 and θ_1 determine the level and the progressivity of the tax system, respectively.[10] Heathcote et al. (2017) showed this function fits the U.S. data well.

The model assumes the existence of some outstanding Government debt, but that Government debt-to-output ratio, $B_y = \frac{B_t}{Y_t}$, does not change over time. Besides this, in a steady-state, the ratios of Government revenue-to-output and expenditure-to-output remain constant, which imply no new debt being issued. Denoting R_t as the value of Government's revenue from the taxes collected on labor, capital and consumption, and R_t^{SS} as the Government's revenues from social security taxes, the Government budget constraints take the following form:

$$g\left(45 + \sum_{j \geq 65} \Omega_j\right) = R - G - rB \tag{15}$$

$$\psi\left(\sum_{j \geq 65} \Omega_j\right) = R^{SS} \tag{16}$$

[10] In the appendix 7.2, we present more details on the properties of this tax function.

3.6 Recursive Formulation of the Household Problem

In every time period, t, the household is characterized by the vector (k, β, a, u, j), where k is the value of savings, $\beta \in \{\beta_1, \beta_2, \beta_3\}$ is the time discount factor, a the permanent ability, u is the idiosyncratic shock, and j is the age of the household. Households will choose how much to consume, c, how many hours to work, n, and how much to save, k' [11], to maximize their utility and the discounted continuation value:

$$
\begin{aligned}
V(k, \beta, a, u, j) &= \max_{c,k',n} \Big[U(c, n) + \beta E_{u'} \big[V(k', \beta, a, u', j+1) \big] \Big] \\
\textbf{s.t. } c(1+\tau_c) + k' &= (k + \Gamma)(1 + r(1-\tau_k)) + g + Y^L \\
Y^L &= \frac{nw(j,a,u)}{1+\tilde{\tau}_{SS}} \left(1 - \tau_{SS} - \tau_l \left(\frac{nw(j,a,u)}{1+\tilde{\tau}_{SS}} \right) \right) \\
n &\in]0,1], \quad k' \geq -b, \quad c > 0
\end{aligned} \tag{17}
$$

Y^L represents the labor income after taxes (social security and income). $\tilde{\tau}_{SS}$ and τ_{SS} are the social security taxes paid by the employee and by the employer, respectively. The problem of a retired household is identical to the one of active agents, except that it does not supply labor, it has an age-dependent probability of dying $\pi(j)$ and it takes positive utility, $D(k)$, from leaving a bequest:

$$
\begin{aligned}
V(k, \beta, j) &= \max_{c,k'} \Big[U(c, 0) + \beta(1-\pi(j)) V(k', \beta, j+1) + \pi(j) D(k) \Big] \\
\textbf{s.t.: } c(1+\tau_c) + k' &= (k + \Gamma)(1 + r(1-\tau_k)) + g + \psi \\
k' &\geq 0, \quad c > 0
\end{aligned} \tag{18}
$$

3.7 Stationary Recursive Competitive Equilibrium

Let $\Phi(k, \beta, a, u, j)$ be the measure of households with the corresponding characteristics. The stationary recursive competitive equilibrium is defined as follows:

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

[11] Households can have negative savings, i.e. borrow funds, but this is limited to the borrowing limit b

and $n(k, \beta, a, u, j)$.

2. Assets, Labor and Goods markets are in equilibrium:

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

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

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

3. The factor prices satisfy: $w = (1-\alpha)\left(\frac{K}{L}\right)^{\alpha}$, $r = \alpha\left(\frac{L}{K}\right)^{1-\alpha} - \delta$

4. The 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. The social security system balances:

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

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

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

3.8 Fiscal Experiment and Transition

The fiscal experiment analysed is the same as in Brinca et al. (2021). The Economy starts in the steady-state and without any previous announcement, Government reduces public debt (B) by 10% of GDP, during 50 periods. The policy used to achieve this reduction consists in a decrease in Government spending, G, of 0.2% of the steady-state GDP every period. After the 50 periods of consolidation, the Government spending returns to the initial level. Then, we assume that the economy takes another 50 periods to converge to the new steady-state equilibrium with the lower debt-to-GDP ratio. Furthermore, the lump-sum transfer, g, is set to clear the Government budget.

The definition of a transition equilibrium after the fiscal experiment is in appendix 7.3. The main difference comparing to the steady-state is that the dynamic-programming problem of households requires another state variable: time, t, capturing all the changes in policy and price variables relevant in this maximization problem along the transition to the final steady state, with lower debt-to-GDP ratio.

3.9 Definition of the Fiscal Multiplier

Impact and cumulative multipliers are defined as in Brinca et al. (2021):

$$impact\ multiplier = \frac{\Delta Y_0}{\Delta G_0} \tag{19}$$

where ΔY_0 is the change in output from period 0 to period 1 and ΔG_0 represents the change in Government spending from period 0 to period 1. During a consolidation via G, τ_l (and the overall tax structure) and g are kept unchanged.

$$cumulative\ multiplier\ (T) = \frac{\sum_{t=0}^{t=T} \left(\prod_{s=0}^{s=T} \frac{1}{1+r_s} \right) \Delta Y_t}{\sum_{t=0}^{t=T} \left(\prod_{s=0}^{s=T} \frac{1}{1+r_s} \right) \Delta G_t} \tag{20}$$

where ΔY_t is the change in output from period 0 to period t and ΔG_t is the change in Government spending from period 0 to period t.

4 Calibration

The model presented in Section 3 is calibrated accordingly with the methodology used in Brinca et al. (2016) and Brinca et al. (2021) to match moments of eight economies: Austria, France, Germany, Italy, the Netherlands, Portugal, Slovakia, and Spain.[12] Seven model parameters are not

[12]Sample determined by data availability. We left out Belgium, for which we estimated the RRA, because of data limitations.

empirically observable, and so they are calibrated using a Simulated Method of Moments (SMM) approach. The remaining parameters have direct empirical counterparts, thus can be calibrated exogenously. Appendix 7.4 presents all the calibration values.

4.1 Wage Profile

In order to estimate the parameters from equation (10) we use data from the Luxembourg Income Study (LIS) and run, separately for each of the eight countries, the following regression:

$$ln(w_i) = ln(w) + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + \epsilon_i \tag{21}$$

where w is the wage rate derived in equation (8) and j is the age of individual i. The equation was estimated in efficient units and the estimated values of γ_1, γ_2 and γ_3 are reported in table 4.

The parameter for the variance of the ability, σ_a, is held constant across countries, calibrated with a value equal to the average of the European countries in Brinca et al. (2016). The parameter for the persistence of idiosyncratic shock, ρ, was also held constant across countries and equal to the value used in Brinca et al. (2016), who use U.S. data from the Panel Study of Income Dynamics (PSID). The reason to set this parameter constant across European nations, and equal to the value estimated for the US, is the lack of consistent panel data on income dynamics in Europe. Finally, the variance of the idiosyncratic risk, σ_ϵ is endogenously calibrated using the SMM that we will describe.

4.2 Household's Problem

Regarding households' preferences, expressed in equation (12), we need to calibrate the model for each country with values for σ, the RRA coefficient, for η, which expresses the value of Frisch elasticity of labor supply, and for χ, the disutility of work. Regarding σ, we calibrate the model with the values estimated in Section 2. This differs from the original calibration exercise in Brinca et al. (2021), that held this coefficient constant across countries, and equal to 1.2.

The value of Frisch elasticity of labor supply, η, causes a large debate in the literature.[13] We

[13]For a complete literature review, see Reichling and Whalen (2012).

calibrate this parameter with a value of 1.0, as many relevant papers (see Guner et al. (2014) or Trabandt and Uhlig (2012)). The parameter that expresses the disutility from work, χ, the discount factors, $\beta_1, \beta_2, \beta_3$, and the borrowing limit, b, are calibrated so that selected model moments match the respective data moments, as we will describe below. In order to ensure that the age-profile of wealth is empirically plausible, we include a bequest motive as in Brinca et al. (2021), endogenously calibrating φ.

4.3 Taxes and Social Security

The labor income tax function of equation (14) is the one suggested by Benabou (2002). To estimate θ_0 and θ_1, we rely on U.S. labor income tax data from the OECD, for different family types. Then, in order to estimate a tax function for the single individual households in our model, we compute a weighted average of θ_0 and θ_1, where the weights are each family type's share of the population.[14]

Regarding the employer social security rate, $\tilde{\tau}_{SS}$, and the employee social security rate, τ_{SS}, they were calibrated with the value of the average tax rates between 2001-2007 for each country. The consumption tax rate, τ_c, and the capital tax rate, τ_k, were taken from Trabandt and Uhlig (2012), for each of the analysed countries. Table 4 presents the tax rates values for the entire sample.

4.4 Endogenously Calibrated Parameters

There are 7 parameters that do not have any direct empirical counterpart: $\varphi, \beta_1, \beta_2, \beta_3, b, \chi$ and σ_ϵ. Our strategy to calibrate these parameters relies on a SMM, where we minimize the following Loss function:

$$L(\varphi, \beta_1, \beta_2, \beta_3, b, \chi, \sigma_\epsilon) = ||M_m - M_d|| \tag{22}$$

where M_m and M_d are model moments and data moments chosen. Since we have seven parameters to calibrate, in order to have a precisely identified system, we need 7 data moments. The data moments chosen are in line with those in Brinca et al. (2021), but following also the contribution given by Bernardino (2019), that suggested the use of financial wealth moments as calibration targets, instead of net wealth, as in the original exercise.[15]

[14]The weights used were based in US data as some countries do not have detailed demographic data.
[15]In table 6 we summarize the calibration targets.

Therefore, the seven data moments used are: average yearly hours, taken from the OECD Economic Outlook, the ratio of capital-to-output, $\frac{K}{Y}$, taken from the Penn World Table 8.0, the variance of log wages, taken from the Luxembourg Income Study (LIS), the three quartiles of the cumulative financial wealth distribution [16], taken from the Household Finance and Consumption Survey (HFCS), and the mean asset position held by the households with 75 to 80-years old, relative to the mean wealth in the economy, from the Luxembourg Wealth Study (LWS). [17] Table 6 shows the target moments and table 7 exhibits the endogenously calibrated parameters and the associated Loss Function, for each of the eight economies considered. The average margin of error from our calibration exercise was 1.86%.

5 Results

What we show in this section is that, in our model, the relationship between risk aversion and fiscal consolidation multipliers arises from the effect of the first on precautionary savings behavior, and consequently, on the share of constrained agents. The mechanism works as follows: when facing the same uninsurable income risk, economies with larger risk aversion will respond with larger precautionary savings - the certain equivalent is larger - thus the share of agents with financial constraint is lower. This is crucial to determine the labor supply response after a fiscal shock, since the marginal propensity to work for credit constrained agents is less responsive to income shocks. Summing up, an economy with higher RRA, has a lower percentage of hand-to-mouth agents due to precautionary savings behavior and a higher aggregate elasticity of labor supply with respect to our fiscal experiment. Therefore, fiscal consolidation will be more recessive on impact in economies with higher relative risk aversion coefficient.

To illustrate this mechanism, we start from the steady-state situation, resultant from the calibration exercise, for the eight economies and then we implement the unanticipated fiscal consolidation

[16] the wealth held by those between the 1^{st} and the 25^{th} percentile, between the 1^{st} and the 50^{th} percentile, and between the 1^{st} and the 75^{th} percentile

[17] Since there is no detailed data for the population share of each family for European countries, we use U.S. family shares, similarly to Holter et al. (2017).

experiment described in Subsection 3.8. In Subsection 5.1 we display the mechanism in detail for our benchmark economy, France, reporting how the impact fiscal multiplier varies for different risk aversion coefficients. Then, we present in Subsection 5.2 a comparison between Germany and Italy, since these two economies are in opposite sides of the risk-aversion range. Finally, in Subsection 5.3 we evaluate the robustness of the mechanism by presenting a cross-country analysis with the eight economies studied.

5.1 Benchmark Economy: France

France was chosen as a benchmark economy to illustrate the mechanism we argue. In Section 2 we found a RRA coefficient of 1.18 for France, and we calibrated the model accordingly, finding the steady-state. In this Subsection we perform the following experiment: gradually change σ (RRA), using values between 0.9 and 1.3, re-calibrating the model and applying the fiscal shock. This is the closest we can be to a perfect experiment, since we have the same country, with almost the same relevant characteristics [18], only differing on the RRA coefficient.

Our first premise is that a higher risk-aversion drives the economy to larger precautionary savings, a relationship widely confirmed in the literature. This is essentially because more risk-averse agents are willing to pay more to avoid income risk (i.e. have a larger certain equivalent) as pointed out in the original work by Bernoulli (1954), which in a life-cycle framework is expressed by larger savings. In Figure 1 we plot the value of precautionary savings per capita [19], in the steady-state, for different values of σ. We find, in line with our expectations, that larger risk aversion produces larger precautionary savings, when facing the same income uncertainty.

Pursuing the analysis of the mechanism, we then evaluate whether the effect of risk aversion on precautionary savings behavior is reflected on the share of constrained agents, i.e. hand-to-mouth households. Recursive calibrations of our model, show that indeed if one increases the RRA in France the share of agents constrained shrinks, as shown in Figure 2.

The link between risk aversion and the share of agents with financial constraint helps us un-

[18]For each σ we need a new calibration to keep a loss function bellow 2%, and so one or two parameters need to be adjusted, as χ or ϕ.

[19]This was computed as the difference between savings per capita when $\sigma_e = 0.506$, the value endogenously calibrated for France, and when σ_e is close to 0, meaning no income risk.

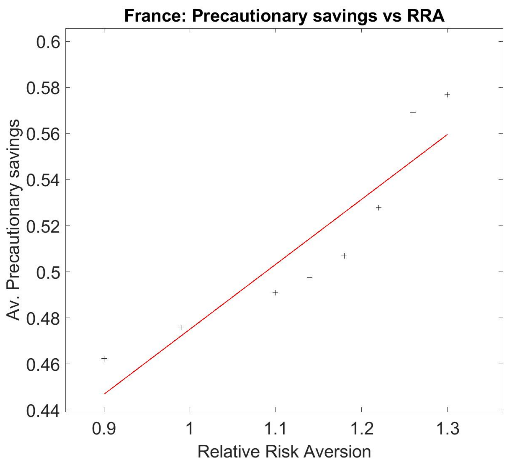

Figure 1: Steady-state Precautionary savings per capita, in France, for different degrees of relative risk aversion. (correlation coefficient of 0.847, p-value 0.0012).

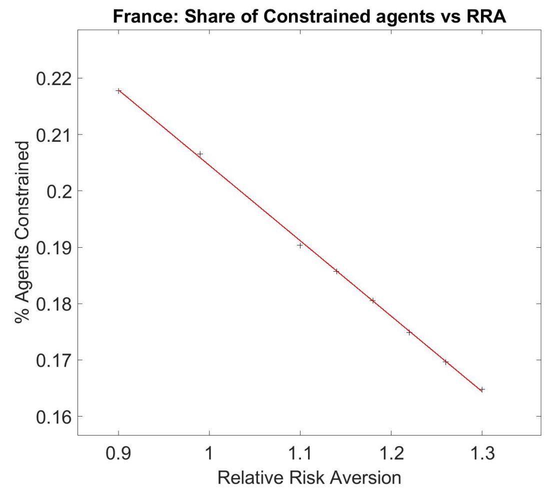

Figure 2: Share of agents constrained, in France, for different degrees of relative risk aversion. (correlation coefficient of 0.98, p-value$\leq$ 0.0001).

derstand the different responses of the economy after the spending-based consolidation shock. We implement the fiscal experiment, through a reduction in Government spending. This shock produces no intra-temporal substitution effect on labor choice, since it is not distortionary, as well as no income effect, as the Government keeps the same tax structure and lump-sum transfers. However, it generates an inter-temporal effect: The consolidation causes a reduction in Government debt, which will gradually cause a shift in households' savings to physical capital, rising the capital to labor ratio. The marginal product of labor (and so the real wage rate) increases in future time periods and for households this generates a positive shock to expected life-time income, which causes a decrease in labor supply in the short run. Not only the income effect points to lower labor Supply today, but also the inter-temporal substitution effect: a relatively higher wage rate in the future, makes it more attractive to delay labor supply, replacing it with more leisure today. In any case, not all agents can borrow in order to reduce labor supply today: constrained agents cannot use the borrowing channel, and so they cannot adjust current labor supply as a response to a change in the expected future lifetime budget, smoothing consumption. We plot in Figure 3 the impact decrease in labor supply, in France, after the Government spending cut for different % of agents constrained. It is possible to observe that, in fact, the larger the steady-state share of agents constrained, the lower the labor supply response. Equivalently, the larger the risk aversion, and so the lower the %

of hand-to-mouth agents, the stronger the response in labor supply after the fiscal shock.

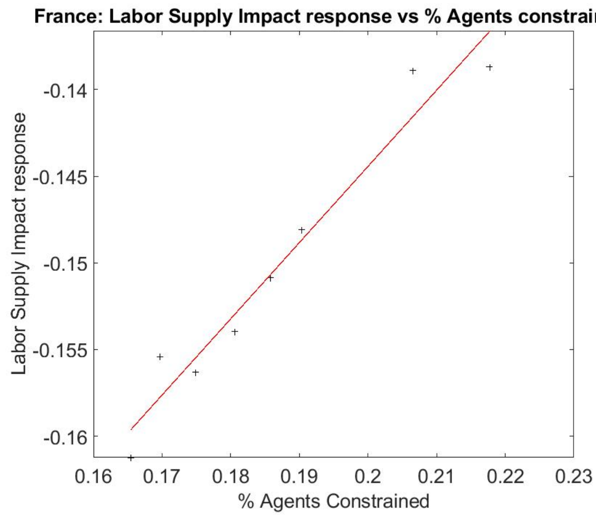

Figure 3: Labor Supply impact decrease, in France, for shares of agents constrained. (correlation coefficient of 0.95, p-value$\leq$ 0.0001).

The magnitude of labor supply response is, ultimately, what determines the response of output to the fiscal shock, since this is a supply side model.

In Figure 4 we depict the impact fiscal multipliers, resulting from the cut in Government spending, for different calibrated RRA. This closes the mechanism, corroborating that recessive impacts are stronger the larger the risk aversion. Larger risk aversion induces more precautionary savings, shrinking the share of hand-to-mouth agents. Less agents with financial constraint allow a more intense labor supply contraction when predicting future rises in the wage rate, thus output drop is more pronounced, i.e. larger RRA leads to larger fiscal multipliers. The change of RRA from 0.9 to 1.3, in France, means a 10% larger impact multiplier, i.e. a 10% larger fall in output.

5.2 Germany vs Italy

Pursuing the attempt of illustrating the effect of risk aversion on fiscal multipliers, we turn now our attention to the comparison between the effects of consolidation in Italy and in Germany, two European countries on the opposite side of the spectrum in terms of RRA, according to the estimation in Section 2. Germany with the lowest coefficient of RRA, 0.72, and Italy with the largest value, 1.29. When comparing these two countries, we should be aware that, contrarily to the analysis done in Subsection 5.1, we are no longer in perfect set-up where only the RRA varies: these

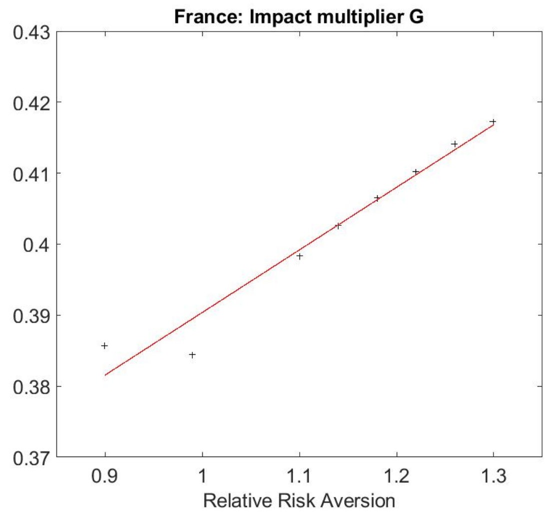

Figure 4: Impact fiscal multiplier, in France, for different degrees of relative risk aversion. (correlation coefficient of 0.96, p-value 0.0001).

two countries differ along several dimensions, among them we highlight the fact that the variance of the idiosyncratic income risk is 0.214 in Italy while in Germany it is 0.439. The difference observed in the RRA parameter sustains the resulting steady-state discrepancies in the share of constrained agents between these 2 economies: Italy has 10%, while Germany has 22%. In Figure 5 we plot the cumulative output multiplier and labor supply response to Government spending consolidation respectively, for the two countries. Both the labor supply response and the output multiplier are larger in Italy, where estimated risk aversion is greater.

These results are in line with the mechanism previously suggested: as Italy has a larger degree of risk aversion, it has a lower share of constrained agents, and so the recessive response of output is larger. This short comparative exercise is of major importance to understand the relevance of considering cross-country risk aversion heterogeneity: if one had assumed the same risk aversion degree for Germany and Italy, as in Brinca et al. (2021), then the model would predict the exact opposite result, as plotted in Figure 8. Since income inequality is larger in Germany, for the same risk aversion, Germans would have more precautionary savings, less agents constrained, and so larger fiscal multipliers. The results from this exercise show precisely the importance of this study: to link income inequality to fiscal responses, we have a much more complete view if we also consider risk attitudes. In fact, Germans face a larger income risk that Italians, but since Italians

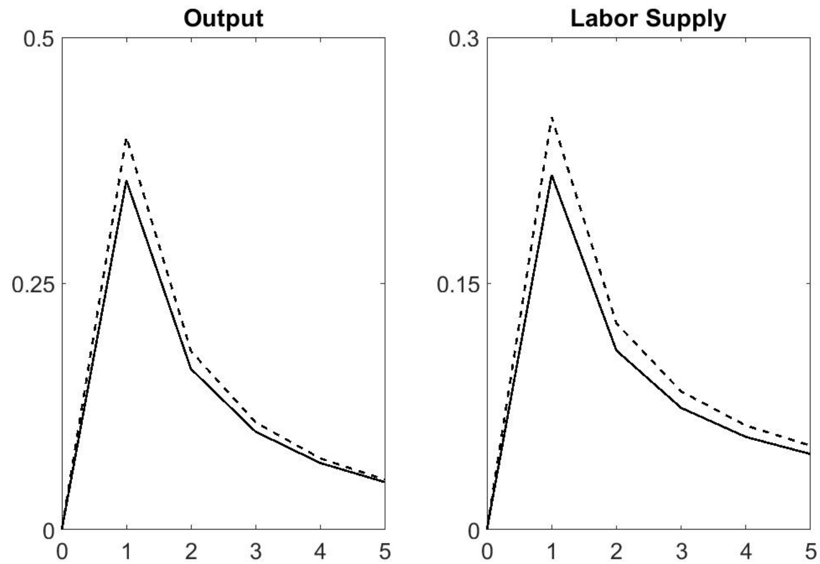

Figure 5: Output cumulative fiscal multiplier (left panel) and Labor Supply cumulative multiplier (right panel) in the first 5 periods in Germany (solid line) and Italy (dashed line)

are considerably more risk averse, they end up having more intense precautionary saving behavior.

5.3 Cross-country Analysis

In this section we perform a final exercise to test, inside our model, how robust is the relationship described between risk aversion and fiscal multipliers. We calibrate our model, as described in Section 4, to match a wide range of different country characteristics, where, in addition to the distributions of income and wealth, we match data on taxes, social security and Government debt. After implementing the spending-based fiscal consolidation described in Subsection 3.8, we show in Figure 6 that even when introducing substantial country heterogeneity, the model reproduces a cross-country positive relationship between relative risk aversion and the size of fiscal multipliers for eight European nations: countries with higher RRA coefficient have larger impact multiplier.

In fact, this cross-country analysis supports the premise that countries more averse to risk experience larger output drops on impact, for spending based consolidations. These effects are large and economically meaningful, as stated by the correlation coefficient of 0.62 and a p-value of 2%. The underlying mechanism, corroborated in Subsections 5.1 and 5.2, that larger RRA generates a lower share of agents constrained is also validated in this extended exercise. In Figure 7, the negative relationship is documented for the eight countries calibrated.

When comparing our results with those from the original exercise in Brinca et al. (2021) [20], where the RRA coefficient was held constant across countries and equal to 1.2, we obtain lower impact multipliers for all countries, except Italy. This is in line with our findings, as our RRA estimates are below 1.2 for all countries (except Italy), and lower risk aversion is associated with lower fiscal multipliers. Finally, when introducing this relevant additional source of cross-country heterogeneity (risk aversion), the model still reproduces a positive relationship between income inequality and the size of output response from spending-based consolidation. This can be seen in Figure 9.

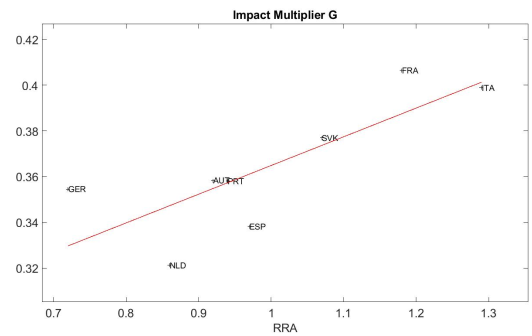

Figure 6: Impact multiplier and RRA. Cross-country data for a consolidation done by decreasing G (correlation coefficient 0.62, p-val 0.02).

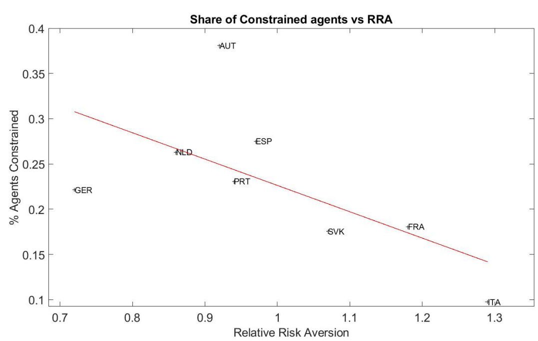

Figure 7: Share of constrained agents and RRA. Cross-country data from the steady-state calibration (correlation coefficient 0.40, p-val 0.09)

[20]Including also the contribution of Bernardino (2019).

6 Conclusion

Relevant empirical and structural work, over the last years, has focused on the impact of country-specific characteristics on the output response to fiscal shocks, i.e. fiscal multipliers. We now know that income and wealth inequality play an important role in determining the size of fiscal multipliers, and so does the age structure of the population or the exchange rate regime, for example. This paper leans over a key aspect that has been neglected in the literature: the country-level risk aversion.

We use the pioneering methodology proposed by Layard et al. (2008) to estimate the RRA coefficient for some European economies. Relying on data from the most recent version of the European Social Survey, we find coefficients ranging between 0.72 and 1.29, that are predominantly close to 1, as in most studies in this area. After documenting heterogeneity in the country-specific values for risk attitudes, the focus is turned to the potential impact that this heterogeneity can have on the size of fiscal multipliers.

In order to evaluate how the relative risk aversion of a country affects its output response to a fiscal shock, we use the model presented in Brinca et al. (2021), an overlapping generations economy with uninsurable labor market risk. We calibrate the model to match relevant data characteristics of eight European countries, namely using the RRA coefficients found for each country. This differs from the original exercise in Brinca et al. (2021), that used the same RRA for all countries, setting it equal to 1.2. We subject the economies to a spending-based fiscal consolidation shock, where the Government shrinks its purchases during 50 years, in pursuance of debt reduction.

We find a positive relationship between fiscal multipliers resulting from our fiscal experiment and the coefficient of relative risk aversion. In other words, we document stronger recessive impacts from austerity in countries with larger risk aversion. The economic mechanism that supports this conclusion relies essentially on the effect of risk aversion on precautionary savings behavior, and consequently, on the share of households with financial constraint. In economies with higher risk aversion, agents have stronger precautionary savings behavior, and so there is less financially constrained agents and more flexible labor supply. This way, output falls more in a country with relatively higher risk aversion.

In a period of time where there is large consensus that monetary policy cannot be "the only game in town", understanding the mechanisms through which fiscal policy affects the real economy is crucial. Future studies should focus more on understanding the sources of measured heterogeneity in risk attitudes with the goal of having a better understanding of fiscal policy.

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7 Appendix

7.1 Empirical Analysis

Happiness Economics and Normative Economics are relying more and more on the use of self-reported happiness as a proxy for utility, benefiting from a growing number of large surveys across the world: Gallup World Data, General Social Survey, World Values Survey, European Social Survey, European Quality of Life Survey, German Socio-Economic Panel, British Household Panel Survey. Naturally, economist are aware of the risks carried by this method. However, empirical studies have been providing evidence that supports this methodology. First, as argued by Layard et al. (2008), data suggests that respondents report their degree of happiness in a way that is compatible with other significant measures of their utility. Diener and Suh (2003) shows that when "third parties" (friends and independent observers) are asked to rate a person's happiness level, their responses are positively correlated with the person's own assessment. Second, neuropsychologists have ways for measuring the degree of activity in the brain areas that experience positive and negative affect. Both among people and over time, these levels of activity are well linked with the subject's self-report (Davidson, 1992, Davidson, 2000, Davidson et al., 2000). Third, another important exercise in validation is to ask whether the self-reported happiness measure relates to external factors (e.g: income, employment status) in an expected manner. All the evidence that we have is that it does. Our paper also validates this. Larger relative income is associated with larger reported happiness, as well as, employed people report (on average) higher happiness.

Table 2: Summary statistics. Note: Income variable, as explained, is a percentage of average national income

Variable	Mean	SD	Max	Min	N.o obs
Self-reported happiness	7.59	1.68	8.03	6.54	13193
Income (%)	0.95	0.60	0.88	1.02	13193
Years of completed education	13.12	4.45	14.48	10.79	13193
Female (%)	0.52	0.5	0.57	0.48	13193
Age	51.17	18.24	56.1	48.4	13193
Employed (%)	0.54	0.49	0.62	0.43	13193

Table 3: OLS results

VARIABLES	(1) OLS regression
Gender	0.0409
	(0.0282)
Years Education	0.0335
	(0.0312)
Years Education (sq)	-0.000645
	(0.000810)
Employment status	0.0424
	(0.0414)
Age	-0.00493
	(0.00305)
log Income	0.430***
	(0.0550)
log Income (sq)	-0.133***
	(0.0385)
Constant	7.642***
	(0.309)
Observations	13,193
R-squared	0.051
F-statistic	318.91
Prob (F-statistic)	0.000

Robust standard errors in parentheses with Country Cluster
*** p<0.01, ** p<0.05, * p<0.1

7.2 Tax Function

[21] Given the tax function

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

which we employ, the average tax rate is defined as

$$ya = [1 - \tau(y)]y$$

and thus

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

and thus

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

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

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

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

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

$$1 - \frac{1 - \tau(y_2)}{1 - \tau(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1} \tag{23}$$

and therefore independently 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

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

progressivity is defined by the tax wedges) the progressivity of the tax code[22] is uniquely determined by the paramenter θ_1

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

[23] The economy is at the steady state before the fiscal shock is implemented. After the shock, it will take time to converge back to a new steady state. The recursive competitive equilibrium in this transition phase between steady states is defined in the same way as in Brinca et al. (2021):

Given the initial capital stock, the initial distribution of households and initial taxes, respectively K_0, ϕ_0 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, $\{r_t, w_t\}$, government transfer $\{g_t, \Psi_t, G_t\}_{t=1}^{t=\infty}$, 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:

1. Given the factor prices and the initial conditions 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. Labor, Capital and Goods Market are in equilibrium:

$$K_{t+1} + B_t = \int k_t \, d\Phi_t$$

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

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

[22]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.

[23]This appendix is borrowed from Brinca et al. (2021)

3. The factor prices satisfy:

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

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

4. The Government budget balances:

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

5. The social security system balances:

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

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

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

7. Aggregate law of motion:

$$\phi_{t+1} = \gamma_t(\phi_t)$$

7.4 Calibration and Results: Additional Figures and Tables

Table 4: Parameters calibrated exogenously

Country	Age profile parameters			Taxes					
	γ_1	γ_2	γ_3	θ_0	θ_1	$\tilde{\tau}_{SS}$	τ_{SS}	τ_c	τ_k
Austria	0.155	-0.004	3.0e-05	0.939	0.187	0.217	0.181	0.196	0.240
France	0.384	-0.008	6.0e-05	0.915	0.142	0.434	0.135	0.183	0.355
Germany	0.176	-0.003	2.3e-05	0.881	0.221	0.206	0.210	0.155	0.233
Italy	0.114	-0.002	1.4e-05	0.897	0.180	0.329	0.092	0.145	0.340
Netherlands	0.307	-0.007	4.9e-05	0.938	0.254	0.102	0.200	0.194	0.293
Portugal	0.172	-0.004	2.6e-05	0.937	0.136	0.238	0.110	0.194	0.293
Slovakia	0.096	-0.002	1.7e-05	0.974	0.105	0.326	0.131	0.181	0.151
Spain	0.114	-0.002	1.4e-05	0.904	0.148	0.305	0.064	0.144	0.296

[1] $\gamma_1, \gamma_2, \gamma_3$ are estimated according to equation (21), using the Luxembourg Income Survey from 2007. Data for Portugal comes from "Quadros de Pessoal" 2009 database;
[2] θ_0, θ_1 are estimated according to equation 14;
[3] $\tilde{\tau}_{SS}, \tau_{SS}$ are the average social security taxes paid by the employer and by the employee, respectively, using OECD data of 2001-2007;
[4] τ_c and τ_k come from Trabandt and Uhlig (2012) or calculated using their approach. They represent the average effective tax rate from 1995-2007.

Table 5: Parameters held constant across countries

Parameter	Value	Description	Source
α	0.33	Capital share of output	Literature
δ	0.06	Annual Depreciation rate of capital	Literature
ρ	0.335	Persistence in equation 11	Estimated with PSID 1968-1997
σ_a	0.423	Variance of the ability	Brinca et al. (2016)
η	1	Frisch Elasticity	Trabandt and Uhlig (2012)

Brinca et al. (2020) explores the relevance of considering labor-share heterogeneity, by estimating $1-\alpha$. In future work, we can take advantage of their findings, and calibrate the parameter for capital share of output with specific values for each country.

Table 6: Calibration Targets - M_d

Country	Q1	Q2	Q3	K/Y	$\bar{n}$	Var ln(w)
Austria	0.0056	0.0395	0.1480	3.359	0.226	0.199
France	0.0045	0.0328	0.1418	3.392	0.184	0.478
Germany	0.0063	0.0544	0.2234	3.013	0.189	0.354
Italy	0.0087	0.0595	0.2012	3.943	0.200	0.225
Netherlands	0.0106	0.0812	0.3119	2.830	0.200	0.282
Portugal	0.0039	0.0283	0.1399	3.229	0.249	0.298
Slovakia	0.0131	0.0631	2166	3.799	0.204	0.250
Spain	0.0041	0.0275	0.1314	3.378	0.183	0.225

[1] The average share of wealth held by the households in the cohort of 75-80 years old relative to the total population mean is the 7^{th} target. Similarly to Brinca et al. (2021), we used the U.S. value which is equal to 1.5134 for all countries;
[2] Q1, Q2 and Q3 are the three quartiles of the cumulative distribution of liquid wealth extracted from 1st version of Household Finance and Consumption Survey (HFCS). These were computed in Bernardino (2019)
[3] K/Y was computed as an average of the ratio between 1990 and 2011, with data from Penn World Tables version 8.0.
[4] $\bar{n}$ represents average hours worked per capita derived from OECD data 1990-2011;
[5] Var ln(w) is the variance of log wages, computed with data from Luxembourg Income Survey 2007. For Portugal we used data from "Quadros de Pessoal" 2009 database.

Table 7: Values of endogenously calibrated parameters and respective error estimated by Simulated Method of Moments

Country	β_1	β_2	β_3	b	χ	φ	σ_ϵ	Error (%)
Austria	0.9200	0.9995	0.8837	-0.06	10.32	5.3	0.1757	2.70
France	0.9035	1.0145	0.9170	-0.06	18.21	4.19	0.5060	0.85
Germany	0.9104	0.9840	0.9226	-0.17	9.05	4.02	0.4386	1.95
Italy	0.9755	1.0200	0.9755	-0.12	22.8	6.3	0.2144	1.27
Netherlands	0.9300	0.9800	0.9200	-0.42	10.5	4.5	0.2625	2.61
Portugal	0.8965	0.9921	0.8900	0.00	9.2	6	0.361	1.86
Slovakia	0.9410	1.00	0.900	-0.15	17.6	7.8	0.3269	1.78
Spain	0.916	0.997	0.8920	-0.027	18.35	5.6	0.2372	1.92

[1] The value of the Error (%) corresponds to the value of the Loss function in equation (22). Our average margin of error is 1.86%, and most macroeconomic models point to 2% as the maximum desirable Loss Function.

Table 8: Impact Multipliers for the Benchmark economy exercise

	Multiplier G	RRA (σ)
France	0.3857	0.90
	0.3844	1.00
	0.3984	1.10
	0.4026	1.14
	0.4065	1.18
	0.4102	1.22
	0.4141	1.26
	0.4172	1.30

Table 9: Cumulative Multipliers for Germany vs Italy exercise

Country	Period	Multiplier G	Multiplier Labor Supply
Germany	1	0.3545	0.2162
	2	0.1636	0.1092
	3	0.0996	0.0742
	4	0.0678	0.0565
Italy	1	0.3984	0.2515
	2	0.1808	0.1258
	3	0.1090	0.084
	4	0.0725	0.063

Table 10: Impact Multipliers for the cross-country exercise

Country	Multiplier G	RRA (σ)
Austria	0.3583	0.92
France	0.4065	1.18
Germany	0.3545	0.72
Italy	0.3984	1.29
Netherlands	0.3212	0.86
Portugal	0.3571	0.94
Slovakia	0.3769	1.07
Spain	0.3382	0.97

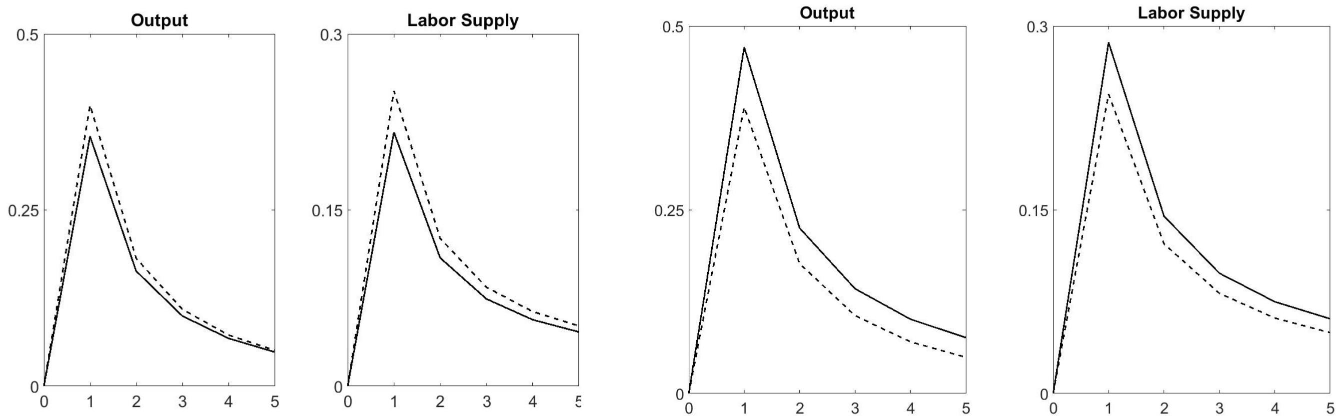

Figure 8: Output cumulative fiscal multiplier and Labor Supply cumulative multiplier, during the first 5 periods of shock in Germany (solid line) and Italy (dashed line) when using the RRA coefficients found in 2, while on the right panel we have the cumulative multipliers for Output and Labor Supply if we assume the same RRA for the 2 countries, equal to 1.2

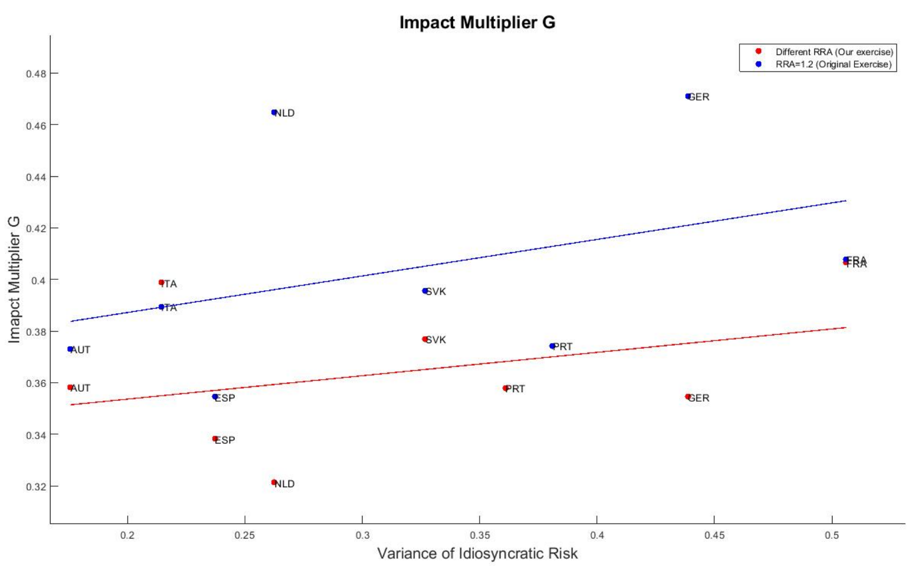

Figure 9: Impact multiplier and σ_e. In Red, we have the results for our exercise, when calibrating the model with RRA found in 2. In Blue, we show the results from the original exercise (Brinca et al. (2021), that calibrated all countries with RRA=1.2