Fiscal Consolidations: Welfare Effects of the Adjustment Speed

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Abstract

This work studies the response of social welfare to fiscal consolidations, by focusing on a less debated characteristic of fiscal plans: the speed of deleveraging. A neoclassical overlapping generations model is calibrated to the German economy, and a sequence of reductions of the same size in the debt-to-GDP ratio are simulated considering different adjustment periods. Welfare gains are found to be larger in slow, delayed fiscal consolidations, due to the presence of incomplete markets. It is also found that the aggregate welfare response depends on the distribution of wealth and the type of fiscal instrument used.

Keywords: Fiscal Consolidation, Wealth Inequality, Incomplete Markets, Consumption Smoothing Hypotesis

JEL Classification: E13, E21, E62, H63,

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1 Introduction

The 2008 Great Recession left behind a legacy in the form of the highest public debt burdens ever registered and[1], as of 2019, some of the world's most important economic areas such as the Eurozone still face debt-to-GDP ratios higher than 100%. These high levels of sovereign debt are associated with several economic issues, such as increased exposure to market sentiment, or the loss of flexibility in the implementation of fiscal policy, especially important as a stabilization mechanism in times where monetary policy is constrained by the low interest rate environment. Furthermore, as discussed in **OECD (2010)**, in the near future government finances will face additional pressures due to the ageing of the population. Considering the issues at hand, there are arguments in favor of a further consolidation effort. However, reducing debt also has downsides, the most important being the recessive impacts it brings on the economy, extensively documented throughout the literature, e.g., **Alesina et al. (2015b)**, **Guajardo et al. (2014)**, **Yang et al. (2015)**.

The design of fiscal plans is then a delicate task for policymakers, which must balance the pros and cons of reducing debt. This paper intends to add to the discussion on plan design, by focusing on an often-overlooked feature of fiscal consolidations, the speed of deleveraging. One can define speed as the decision of how long to extend a consolidation program, after the size of the debt reduction has been chosen. In other words, for a given debt reduction target, authorities can choose to pay debt quickly, or spread out the adjustment for a longer number of periods. The importance of considering this feature in fiscal plan design was highlighted by **Blanchard and Leigh (2013)**. In their article, the authors criticized the lack of discussion on the timing of adjustments, presenting arguments in favor of both fast and slow consolidations. This work intends to bring this debate into formal research, by addressing the following questions: How do fiscal consolidations affect social welfare? What is the optimal speed for fiscal consolidations? Does the fiscal instrument used matters when defining speed?

To answer these questions, this work builds on the neoclassical macroeconomic model

[1] Considering only non-war times.

of **Brinca et al. (2018)**, featuring heterogeneous agents and incomplete markets, to study the response of social welfare to fiscal consolidations and to different speeds of adjustment. Firstly, the model is calibrated to match key characteristics of the economy of Germany. Secondly, a sequence of fiscal consolidations consisting of 10 percentage points reductions in the debt-to-GDP ratio is performed. The reduction of debt is financed either with a decrease in government spending, or with an increase in the labor income tax. The number of periods (years) of adjustment is changed across simulations, and the social welfare implications of doing so are quantified. The number of years are chosen to vary between 5 and 70 years. This decision is made with basis on historical data on fiscal consolidations, obtained via the creation of a novel dataset, resulting from the merger of data included in **Alesina et al. (2015a)** and **Alesina, Favero and Giavazzi (2015b)**.

Three main results arise from the experiments: i) Fiscal consolidations are welfare improving on the aggregate, but the welfare effects are heterogeneous across the wealth distribution. More concretely, due to lower real interest rates during the debt reduction path, borrowers win and savers lose out. The aggregate response depends on the relative strength of these effects. ii) Welfare improvements are larger in spending-based than in tax-based consolidations. iii) Ideally, the speed of fiscal consolidations should be as slow as possible. This is the case since credit constrained agents are unable to borrow in response to adjustments, and thus benefit from a more gradual adjustment path, which helps them achieve a better smoothing of consumption. The remainder of the paper is structured as follows: Section 2 discusses related literature. Section 3 describes the overlapping generations model and the competitive equilibrium. Section 4 deals with the calibration procedure along with relevant data sources. Section 5 introduces the dataset used to delimit the experiment range and details the profile of the fiscal experiments. Section 6 portrays the experiments' results while explaining the relevant macroeconomic dynamics that drive them. Section 7 concludes.

2 Literature Review

There are three branches of literature related with this work. i) Firstly, one that relates factors such as country characteristics or the fiscal instrument used with the consequences of fiscal consolidations. ii) Secondly, a more closely related branch that studies the welfare implications of fiscal consolidations, with basis on theoretical macroeconomic modelling. iii) Thirdly, a very narrow selection of papers that address the topic of the speed of fiscal adjustments.

i) **Ilzetsky et al. (2013)** found that the size of fiscal multipliers depended on country specific characteristics, such as the income level of the country, or the sovereign debt burden. **Anderson et al. (2016)** used a calibrated Keynesian model with sticky prices to show that economic agents responded differently to fiscal shocks, depending on individual characteristics such as age, income and wealth levels. In turn, **Brinca et al. (2018)** developed a neoclassical life-cycle economy to find that wealth levels and credit constraints were key factors in explaining heterogeneity in the impacts of consolidations. **Alesina et al. (2015b)** concluded that taxation-based consolidations originated larger recessive impacts than consolidations with basis on public spending decreases. The main takeaways in the scope of this work are that the impacts of consolidations are contingent on country characteristics, namely on wealth inequality, and also on the instrument used.

ii) The relationship between fiscal consolidations and social welfare is often studied with resource to macroeconomic modelling. Following the seminal contribution of **Aiyagari (1994)**, most theoretical frameworks in nowadays' research admit agent heterogeneity and credit market incompleteness. **Aiyagari and McGrattan (1998)** built on this contribution to study the welfare implications of public debt, finding that opposite effects appeared. On the benefit side, higher debt loosened borrowing constraints and allowed for a better smoothing of consumption. On the negative side, however, public debt crowded out capital, hence lowering real wages. They finished concluding that the debt-to-GDP ratio that maximized welfare hovered around 2/3. More recently, **Röhrs and Winter (2017)** revisited this topic, finding that steady state welfare was at the maximum when the debt-to-GDP ratio was negative and around -0.8, in stark contrast with **Aiyagari**

and McGrattan (1998). Their results were unlike since the calibration in **Röhrs and Winter (2017)** presented more realistic levels of wealth and earnings inequality, again showing the relevance of these variables in determining welfare effects. However, the authors also found that when considering the transition path to the new steady state, fiscal consolidations became welfare reducing, highlighting the importance of transitional analysis, and motivating the focus on this aspect in the present work.

iii) In general, the literature on optimal fiscal policy focuses on the welfare effects of debt, as seen in ii), with other components of the fiscal plan, such as the speed of debt reduction being less discussed. In this essence, **Philippon and Roldán (2018)** studied paths of reduction in government debt, finding that the optimal speed of adjustment varied amongst agents, depending on their asset position. Finnally, the paper that stands closest to this work is that of **Romei (2017)**, which uses a calibrated, heterogeneous agents, incomplete markets neoclassical economy to study the welfare implications of the fiscal instrument and the speed of consolidation. The main finding is in accordance with **Philippon and Roldán (2018)**, households' preference over the mix of speed and instrument of consolidation hinges on the distribution of wealth. **Romei (2017)** argued that the real interest path resulting from a certain combination of fiscal instrument and speed of adjustment would determine household preference over the shock. Wealth inequality again played a key role, as savers favoured an increasing path in the interest rate, while borrowers would rather face a decreasing one. In the own words of the author, these results led to the research only taking a positive view, describing the winners and losers, and absconding from commenting on optimal policy.

This paper intends to pick up where **Romei (2017)** left, by adding a normative facet to the analysis, with the goal to not only characterize the impacts of different plan speeds on welfare, but also to find an optimal policy for the speed of public debt reductions. In order to achieve a better characterization of optimal policy in a societal context, the model used is the one of **Brinca et al. (2018)**, that relaxes the infinitely lived households assumption of **Romei (2017)** and considers a bequest motive for a better calibration of assets over the life-cycle.

3 Model

The model chosen to study the optimal speed of fiscal consolidations is a neoclassical life-cycle economy, with heterogeneous agents, incomplete markets and uninsurable income risk. The model is close to the one used in **Brinca et al. (2016)**, but a bequest motive was introduced to better approximate the wealth levels of the older population to reality, in the same manner as in **Brinca et al. (2019)**.

Technology

A representative firm produces output following a Cobb-Douglas production function:

$$Y = (K_t, L_t) = K_t^a L_t^{1-a} \tag{1}$$

where K_t represents the capital input at time t and L_t represents the efficient units of labor input at time t. Capital varies across time according to the equation:

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

with I_t standing for gross investment in period t, and δ for the capital depreciation rate. In each period, firms decide on the amount of capital and labor used in production, as to maximize profits:

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

In a competitive equilibrium, factors of production are paid according to their marginal productivity, therefore factor prices will be given by:

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

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

Demographics

The population consists of J overlapping generations of households, with finite lifespans, and is assumed constant across time [2]. Households start life at age 20, and reach retirement by age 65, implying that there are 45 model periods of working life (a period in the model corresponds to 1 year). After retirement, households face an age-dependent probability of dying, $\pi(j)$, where j represents the household's age. Consequently, the age-dependent probability of survival is given by $\omega(j) = 1 - \pi(j)$. At age 100 households die with certainty[3], $\pi(100) = 1$. Moreover, the size of each age group in the model is normalized to 1. As a consequence, the total normalized workforce population will be 45 at all times, and, by the law of large numbers, the mass of retired agents of a determined age group j (with $j \geq 65$), alive at any given period will be equal to $\Omega_j = \prod_{i=65}^{i=j} \omega(i)$. Then, the total retired population will be equal to $\sum_{j=65}^{j=100} \Omega_j$ and the overall normalized population level equal to $\left(45 + \sum_{j=65}^{j=100} \Omega_j\right)$.

Households are also heterogeneous with respect to asset holdings, idiosyncratic productivity, their subjective discount factor and permanent ability. Differing in asset holdings simply means households are allowed to have different wealth levels. Idiosyncratic productivity concerns individual's own unknown characteristics that may affect his productivity. The discount factor can take one out of three values $\beta \in \{\beta_1, \beta_2, \beta_3\}$ with the same probability, and is constant over time for each household. This implies households can weigh differently future utility when making their consumption, savings and working decisions. The permanent ability component corresponds to the starting productivity level at birth, different across households.

Deceased households leave behind bequests that are assumed to be redistributed in a lump-sum fashion between the households that are alive. The per-household bequest is denoted by Γ. Retired households' utility is increasing in the bequest left behind at time of death. This way, it is assured that retirees leave behind some wealth when they die, which ultimately is necessary to calibrate the asset holdings of old households.[4]

[2] There is no population growth, the newborns exactly offset the deceased.

[3] Consequently $J = 81$

[4] As retired households don't work, their utility depends singlely on consumption, therefore by optimizing, retirees would consume as much as possible, running out savings until death. In the U.S., households

Labor Income

Due to household heterogeneity, wages will depend on individual characteristics. The wage of each individual, w_i, is given by:

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

where j represents age, $a \sim N(0, \sigma_a^2)$ permanent ability, $\gamma_1, \gamma_2, \gamma_3$ capture the age profile of wages, ω the wage per efficient unit of labor (determined in a competitive equilibrium as depicted on the previous subsection) and u represents the idiosyncratic productivity shock, which follows an AR(1) process:

$$u_{t+1} = \rho u_t + \epsilon_{t+1}, \epsilon \sim N(0, \sigma_\epsilon^2) \tag{7}$$

Preferences

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

$$U(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \chi \frac{n^{1+\eta}}{1+\eta} \tag{8}$$

where σ represents the risk aversion coefficient, χ the parameter for the disutility of work, and η the inverse Frisch elasticity of labor supply. In addition to this, the utility of retired households is also increasing in the bequest left at time of death:

$$D(k) = \varphi log(k) \tag{9}$$

where φ represents the coefficient of bequest utility.

Government

The government runs both a social security system, and its own budget, used for public expenditure.

aged more than 75 years old held, on average, 50990 dollars just in assets at financial institutions, being the richest age group according to U.S. Census Bureau data from 2016. Having zero assets at time of death, or even very low average assets in the age group is then not empirically plausible, hence the introduction of the bequest motive.

The social security system is balanced. Employees and employers are taxed at rates τ_{ss} and $\tilde{\tau}_{ss}$, respectively, with the tax proceedings flowing to the social security payments to the elderly, Ψ_t.

As stated, the government also runs its own budget for policy. It levies taxes on consumption, labor and capital income and uses them to finance public consumption goods, G_t, interest payments on debt, rB_t, and a lump-sum redistribution, g_t. Consumption and capital income are taxed at flat rates τ_c and τ_k, respectively. Labor income tax takes a non-linear form, as introduced by **Bénabou (2002)** in dynamic macro models with heterogeneous agents, and used in **Brinca et al. (2018)**:

$$\tau_l(y) = 1 - \theta_0 y^{-\theta_1} \tag{10}$$

where y represents labor income (pre-tax) and $\tau_l(y)$ the tax rate given a pre-tax income y, a level of taxation, θ_0, and a progressivity of taxes of θ_1. If $\theta_1 = 0$, then $\tau_l = 1 - \theta_0$ implying that there is no progressivity and all levels of income are taxed at the same flat rate. For $\theta_1 > 0$, the tax system becomes progressive. **Heathcote et al. (2017)** demonstrated that this function was an adequate fit for U.S. tax/transfer scheme data.[5].

In steady state, public debt, government revenues and expenditures are assumed proportional to output. Denoting government revenues from labor, capital and consumption taxes by R and government revenues from social security taxation by R^{ss}, the steady state government budget constraint takes the form:

$$g\left(45 + \sum_{j=65}^{j=100} \Omega_j\right) + G + rB = R, \tag{11}$$

$$\Psi\left(\sum_{j=65}^{j=100} \Omega_j\right) = R^{ss}. \tag{12}$$

with equation (11) representing the government's policy budget and (12) the social security system.

[5] Appendix 8.1 contains a more detailed description of the properties of the non-linear tax function.

Recursive Formulation of the Household Problem

Each household is characterized by the vector of parameters (k, β, a, u, j), with k representing household savings, $\beta \in \{\beta_1, \beta_2, \beta_3\}$ the time discount factor, a the permanent ability component, u the idiosyncratic productivity shock and j the age of the household. At each given time, the household will choose the optimal amount of consumption (c), hours worked (n), and future asset holdings (k')[6]. This optimization problem can be formulated recursively as:

$$V(k,\beta,a,u,j) = \max_{c,k',n} \Big[U(c,n) + \beta E_{u'} \Big[V(k',\beta,a,u,j+1) \Big] \Big] \tag{13}$$

$$s.t:$$

$$c(1+\tau_c) + k' = (k+\Gamma)(1+r(1-\tau_k)) + g + Y^L \tag{14}$$

$$Y^L = \frac{nw(j,a,u)}{1+\tilde{\tau}_{ss}} \left[1 - \tau_{ss} - \tau_l \left(\frac{nw(j,a,u)}{1+\tilde{\tau}_{ss}} \right) \right] \tag{15}$$

$$n \in [0,1], k' \geq -b, c > 0$$

Households maximize utility and the expected future value, discounted for intertemporal preference, as seen in (13). Their consumption and savings decisions are limited by available wealth and disposable income[7], represented by the budget constraint (14). Equation (15) denotes household's after-tax labor income[8], Y^L.

Retired households optimize with the additional features of not making the labor supply decision, having a probability $\pi(j)$ of dying, recieving utility from leaving a bequest[9],

[6] b represents the borrowing limit.

[7] Disposable income is devided between after-tax capital income, $(k+\Gamma)(r(1-\tau_k))$, after-tax labor income, Y^L, and the lump-sum transfer recieved from the government, g. Wealth at period t is denoted by $(k+\Gamma)$.

[8] Where $\tilde{\tau}_{ss}$ and τ_{ss} are the social security taxes paid by the employer and employee respectively, and τ_l is the labor income tax.

[9] Notice that the older the household gets, the higher its probability of dying is, and thus, a higher weight is given to the bequest utility in his optimization problem. This way it is ensured that the older he gets, the more he will be inclined to save in each period, in proportion to consumption. This allows the calibration of the model for retirees' assets.

$D(k')$, and recieving the social security payment, Ψ:

$$\begin{aligned} V(k,\beta,j) &= \max_{c,k'} \left[U(c) + \beta \Big[(1-\pi(j))V(k',\beta,j+1) + \pi(j)D(k') \Big] \right] \\ & s.t: \\ c(1+\tau_c) + k' &= (k+\Gamma)(1+r(1-\tau_k)) + g + \Psi \\ k' &\geq 0, c > 0 \end{aligned} \tag{16}$$

Stationary Recursive Competitive Equilibrium

Considering $\Phi(k,\beta,a,u,j)$ as a measure of households with the corresponding characteristics, the stationary recursive competitive equilibrium is defined by:

1. 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:

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

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

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

3. The factor prices satisfy:

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

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

4. The government budget balances:

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

5. The social security system balances:

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

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

$$\Gamma \int_{j<65} d\Phi + \Gamma \int_{j\geq 65} \omega(j)d\Phi = \int (1-\omega(j))kd\Phi$$

4 Calibration

The model of Section 3 is calibrated to match the economy of Germany, using the methodology of **Brinca et al. (2018)**. Germany was chosen as the proxy economy due to its relevance in the context of the EU. The calibration is divided in two steps. Firstly, there is a set of parameters for which there is available data and thus are introduced directly in the model. These are shown in Table 5 of Appendix 8.2. Secondly, there are unobserved parameters that must be calibrated endogenously, as there are no direct empirical counterparts. This second step is carried out using the simulated method of moments (SMM), and the resulting values for the parameters are shown in Table 6 of Appendix 8.2. The remainder of this section describes the most relevant steps in the calibration process.

Labor Income

The estimation of the life cycle profile of wages, equation 6, was retrieved from **Brinca et al. (2018)**. Using data from the Luxembourg Income Study (LIS), they estimate the following regression for each country:

$$ln(w_i) = ln(w) + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + \epsilon_i, \tag{17}$$

where j is the age of individual i and w the equilibrium real wage as determined by equation 4. Naturally, there is no available data for the permanent ability, a, and idiosyncratic productivity shock, u, which integrate the error term, ϵ_i. The variance of the permanent ability, σ_a, and the persistence of the income shock, ρ, are assumed constant across countries and set equal to the values found by **Brinca et al. (2016)** in their calibration. Finally, taking these two parameters as a given, the variance of the idiosyncratic income risk, σ_u, is calibrated endogenously to match the model variance of wages with the correspondent value from the data, to be further explained below.

Preferences

The risk aversion coefficient, σ, is set equal to 1.2, a value consistent with the literature. In the same manner, the Frisch elasticity of labor supply is set equal to 1, in accordance with the recent pieces of **Trabandt and Uhlig (2011)** and **Guner et al. (2014)**. The parameters for the disutility of work, χ, the coefficient of bequest utility, φ, the discount factors, $\{\beta_1, \beta_2, \beta_3\}$ and the borrowing limit, b, are all amongst the parameters calibrated endogenously.

Government

The level of taxation and the progressivity of taxes from the labor income tax function, θ_0 and θ_1, were also taken from **Brinca et al. (2018)**, which uses U.S labor income tax data from the OECD for its estimation. The social security taxes paid by the employee and employer were calibrated using the average rates for each country from 2001 to 2007, with data also retrieved from the OECD. The tax on consumption and capital, t_c, t_k, were set for each country according to the values in **Trabandt and Uhlig (2011)**.

Endogenously calibrated parameters

The following parameters don't have a direct empirical counterpart:$\{\varphi$, β_1, β_2, β_3, b, χ, $\sigma_u\}$ As previously stated, these parameters must be calibrated endogenously, resorting to the Simulated Method of Moments. The method consists in minimizing the subsequent loss function[10]:

$$L(\varphi, \beta_1, \beta_2, \beta_3, b, \chi, \sigma_u) = \|M_m - M_d\| \tag{18}$$

M_d corresponds to the data moment and M_m to the analogue model moment. The ensuing value of the loss function can be understood as the percentual error in the model

[10]The full expression of the loss function is depicted in appendix 8.3.

calibration i.e the distance of the model moments to the real-life data. As there are seven unknowns, seven data moments are necessary to have a just identified equation system. The chosen calibration targets, M_d, and the corresponding model moments, M_m are:

Table 1: Calibration Targets and Model Fit

Calibration target	Description	Data value M_d	Model value M_m
K/Y	Capital-output ratio	3.013	3.017
$\bar{n}$	Average hours worked per capita	0.189	0.189
Var $\ln(\omega)$	Variance of log wages	0.354	0.354
$\overline{W}_{75-80}/\overline{W}$	Mean wealth age 75-80 / Mean wealth	1.513	1.514
Q_1, Q_2, Q_3	Wealth Quartiles	-0.0036, 0.0273, 0.1788	-0.0057, 0.0245, 0.1799

Note: Data for Q_1, Q_2, Q_3 and $\overline{W}_{75-80}/\overline{W}$ was taken from the Luxembourg Wealth Study (LWS), while Var $\ln(\omega)$ came from the Luxembourg Income Study (LIS). The capital-output ratio was retrieved from the Penn World Table 8.0 and $\bar{n}$ from the OECD Economic Outlook.

The targets concerning the wealth distribution, $\{Q_1,\ Q_2,\ Q_3\}$ and $\overline{W}_{75-80}/\overline{W}$, were chosen in order for the calibrated model to present a realistic distribution of wealth over the population and the life-cycle, respectively. Hours worked and the variance of wages are necessary to approximate labor market features to reality, especially important considering that in this model most short-run effects from fiscal shocks materialize through variations in the supply of labor. The capital-output ratio characterizes the production sector of the economy. The values of the endogenous parameters are then adjusted until the error given by the loss function is as small as possible. The simulated economy is calibrated with an error of 0.83%. The endogenously calibrated parameters are shown on Table 6 of Appendix 8.2.

5 Fiscal Experiment

5.1 Description

The calibration of Section 4 describes the steady-state equilibrium. The fiscal experiments depart from this equilibrium, and consist of 10 percentage points reductions in the debt-to-GDP ratio, B_t/Y_t, occurring during a different number of periods (years) in each experiment. The number of years in each simulation is denoted by the parameter N. The experiment processes as follows: the reduction in government debt will be financed either through a decrease in government spending, G_t, or an increase in the labor income tax, τ_l. The government surplus in each period will correspond to $10/N$ per cent of that year's GDP, ensuring that the debt-to-GDP ratio is reduced at the same rate each year. This constant rate of adjustment will be denoted by "average yearly adjustment", A, and due to the linear relation with N, it is is considered an analogue measure of speed in the context of the experiments. After the N periods of adjustment are concluded, the value of government spending or the labor income tax rate go back to their initial levels. To reach a new steady state, it is assumed that the economy takes an additional $100 - N$ number of years, with the lumpsum transfer, g, set to clear the government budget.

The formal definition of the transition equilibrium during the experiment is stated in Appendix 8.3. The difference in relation to the steady-state equilibrium is the presence of the state variable time, t. The numerical solution of the model involves guessing the paths for all time dependent variables, and then solving the maximization problem backwards, after which the guess is updated. This method is in line with **Krusell and Smith (1999)**. The next section will define an empirically plausible range for the parameter governing the number of years of adjustment, N.

5.2 Empirical background

The range for the parameter N was defined with basis on historical fiscal consolidation data. For that purpose, a dataset was constructed by merging data from **Alesina, Favero and Giavazzi (2015b)** with data from **Alesina et al. (2015a)**. The first paper's data is based on the **Devries et al. (2011)** dataset on fiscal consolidations for 17 OECD countries, from the period 1978-2009. The second paper is a complement to the first, since for the same countries it depicts only data for the period 2009-2013, especially relevant due to containing the fiscal programs enforced during the 2010 European sovereign debt crisis. In both pieces, the authors use the "narrative approach" pioneered in **Romer and Romer (2010)** to identify exogenous fiscal consolidations. This approach selects fiscal consolidation episodes via a review of historical documents, choosing only the improvements in government finances caused by the direct intent to reduce deficits or debt. This way, all the variations in the improvements in government accounts caused by the business cycle or other types of governmental policy are filtered out. The final dataset containing 60 fiscal plans for 17 OECD countries during 1978-2013, along with methodological changes applied, can be consulted in Appendix 8.4. Figure 1 summarizes the dataset, by ploting the fiscal plans by both the number of years of consolidation, N, and the average yearly adjustment of each plan[11], A.

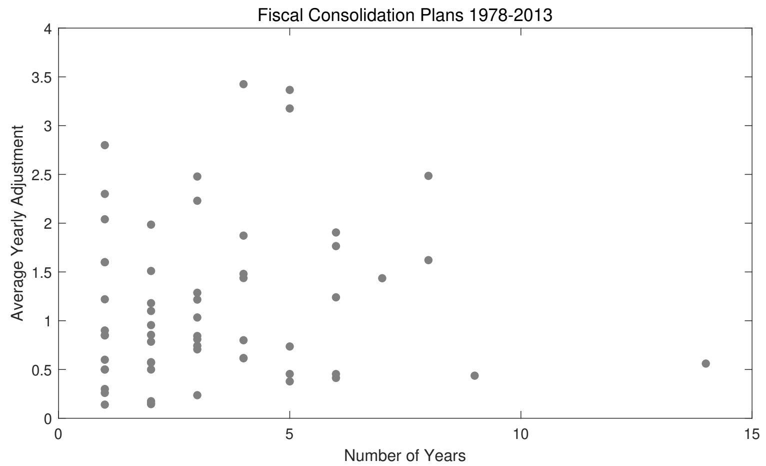

Figure 1: Historical data on the speed of fiscal consolidations

To calibrate the speed of adjustment from empirical data, the average yearly adjustment, A, is chosen to define the upper and lower bounds for the debt repaying periods. It represents the speed of adjustment well since it shows the pace at which governments have reduced debt in a per year basis, in past consolidations. The maximum and minimum values ever registered, correspond to 3.43 in Portugal 2010-2013 and to 0.14 in USA 1978, respectively. Considering these rates of adjustment in the expression pioneered in Section 5.1[12], in the context of the experiment, N will be delimited by:

$$Min_N = 10/3.425 = 2.91 \qquad\qquad Max_N = 10/0.140 = 71.42$$

To simplify computations, the range will be normalized to $N \in [5; 70]$. Furthermore, due to the amount of time and computational effort to run each simulation, inside the

[11]From the data, the average yearly adjustment (A), was calculated in each plan by computing the average of the fiscal improvements as a % of GDP throughout the plan's years. It can be interpreted as the average pp reduction in the debt-to-GDP ratio each period, had government accounts been initially balanced and no other changes made to the budget other than the ones depicted by the consolidation data, in the same sense as it was defined in the context of the experiment. Please consult Appendix 8.4 for a more detailed explanation.

[12]In the experiment, the average yearly adjustment formula corresponds to $A = 10/N$ and therefore, for a given level of A, the number of periods of adjustment is given by $N = 10/A$

defined range, simulations will be run for $N = \{5, 10, 20, 50, 70\}$. These simulations will be made, either with taxation, or spending. The results will be summarized and explained in Section 6.

5.3 Definition of the Welfare Measure

The welfare measure used to compare the impacts of changing the number of years, N, across fiscal experiments, is the expected life-time social welfare at time t, and is defined as:

$$SW_t = E\big[V\big]_t = \frac{1}{\int d\Phi}\left[\int_{j<65} V(k,\beta,a,u,j)_t \, d\Phi + \int_{j\geq 65} V(k,\beta,j)_t \, d\Phi\right] \tag{19}$$

This measure is an average of the sum of life-time utility at time t, for all individuals in all generations. The goal is to compare initial steady-sate welfare at $t = 1$, with the corresponding welfare in $t = 1$ in a state of the world where the consolidation is put in practice. This way, the variation in the social welfare between the two states captures the average life-time utility gain (or loss) from the fiscal consolidation.

6 Results

This section details the results of the fiscal experiments, explaining the mechanisms that drive them. On a first stage, Section 6.1 focuses on the welfare effects of debt reductions, both in spending-based and tax-based consolidations. Section 6.2 follows, detailing how the welfare effects vary when the number of years of consolidation, N, is changed.

In the first section, the role of wealth inequality is highlighted as the main factor in explaining welfare gains (or losses) from the consolidations. More concretely, due to changes in the real interest rate during the adjustment, the wealth-poor and wealth-rich have opposite reactions to fiscal consolidations. Furthermore, they also disagree in the preference for the fiscal instrument. The aggregate welfare response will depend on the relative strength of the preferences among the two groups. In the second section, the presence of borrowing constrained agents is argued to be the main dictator of the aggregate response to different speeds of adjustment.

6.1 Welfare Effects of Reducing Debt

This section will lay out the macroeconomic dynamics behind fiscal consolidations, and the intuition behind the ensuing welfare effects. As stated, to understand the aggregate variation, the welfare changes will be decomposed and evaluated by wealth group. The following discussion begins, considering firstly the case where the fiscal consolidation is spending-based, and then develops.

Key Dynamics

The economy is initially in a steady state equilibrium when the government unexpectedly implements a fiscal consolidation, by decreasing expenditures, G. When authorities start running down debt, the saving pattern of households is affected. Foreseeing higher future income[13], households desire to reduce savings and consume more in each period. However, some of them are credit constrained, and thus, are unable to dissave as much as they wanted. As households can either save in the form of capital or government bonds, with savings decreasing by less than the fall in the amount of bonds, the capital stock will increase. In turn, this drives the economy's capital-to-labor ratio up. There is a crowding-in of capital. When each worker is equipped with a higher level of capital, its productivity increases, and, therefore, according to the market clearing equation 4, wages will be higher. Thus, the first main consequence of reducing debt is a rising path of wages. In turn, the path of wages generates both an income effect and an inter-temporal substitution effect on the supply of labor. Regarding the income effect, the prospects of a higher lifetime income induces households to decrease their supply of labor in each period, and enjoy more leisure. Besides this, workers will also desire to trade-off hours worked today for hours worked tomorrow, when wages will be higher. This is the inter-temporal substitution effect. Thus, labor supply contracts sharply on the short run, and then trends upwardly accompanying the growth of wages. This results in a fall in output in the short run, but in higher long run output, since both capital and labor will increase across time.

[13]Both in spending-based and tax-based consolidations, when the debt repayment period is over, both G, and τ_l go back to the initial levels, while the interest payments of the government, rB_t, are smaller. This implies a higher level of government transfers, g, and thus, higher income.

Overall, lifetime consumption will be higher. In summary, labor market effects from consolidations increase welfare for the whole working population, since in each period they work less, while still benefiting from higher lifetime levels of consumption.

On the other hand, however, real interest rates are decreasing throughout the consolidation period. Higher levels of productive capital imply that the marginal productivity of the next unit of capital is lower, and, therefore, that the interest rates face a falling path during the consolidation. The relations described above can be observed in Figure 2, which plots the path of the capital stock, labor supply, the interest rate and the wage rate, during the transition period, for both a spending-based, and a tax-based consolidation spanning 50 periods.

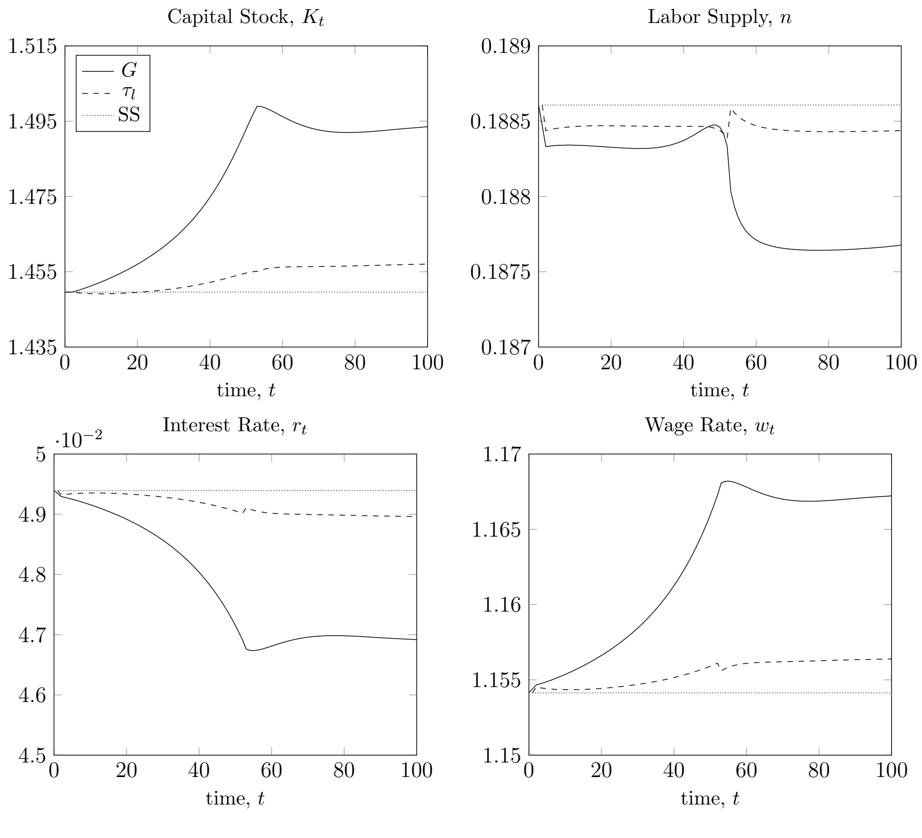

Figure 2: Comparison between the transition paths of the capital stock, labor supply, interest rate and after-tax wage rate, between spending-based plans (smooth dark line), tax-based plans (dashed line) and the state of the world where the economy remains in the initial steady state (lighter straight line). The fiscal plan represented consists in a 10 percentage points reduction in the debt-to-GDP ratio, concluded in 50 periods, $N = 50$.

Contrary to the labor market effects, the impacts of lower interest rates on welfare are not as clear cut, as they depend on agents' asset position. Intuitively, borrowers will desire to face lower rates, while the opposite holds for savers. This way, wealth-poor agents benefit from reductions in debt, while the wealth-rich lose out. The aggregate response of welfare to a fall in the interest rate is then determined by the relative strength of the two groups. In this case, since the wealth-poor are also the consumption-poor, they have a higher marginal utility of consumption, that is, they value more one more unit of income than rich people and consequently their utility responds more strongly to variations in income. However, and by observation of Table 2 below, this effect is countered by the fact that the amount of capital income loss by the rich is also bigger than the capital gains by the poor, as their stock of positive wealth outweighs the negative stock of the poorest. Adding to this, rich individuals also lose via more expensive self-insurance[14]. Considering the opposite forces at hand, the effect of the fall in interest rates in aggregate welfare is ambiguous. Nonetheless, one can conclude that the fraction of the population that enjoyed welfare gains, was the one more reliant on labor income than capital income, corresponding to the first three wealth quintiles depicted below.

Table 2: Welfare Effects in a spending-based plan, G

Quintiles	Wealth Level	ΔWelfare
Q_1	-0.09 - 0.00	+0.2795%
Q_2	0.00 - 0.22	+0.2262%
Q_3	0.22 - 0.84	+0.1303%
Q_4	0.84 - 3.64	−0.0494%
Q_5	3.64 - 15.13	−0.1591%
Total	–	+0.0760%

Note: The wealth levels are interpretable only on a comparative basis, and not on absolute terms. Δ Welfare represents the response to changing from the initial steady state, to a state of the world where the consolidation is undertaken, with $N = 50$.

Although the individuals in the Q_2 and Q_3 have a positive level of wealth, and thus lose from lower interest rates, the capital losses are offset by the labor income gains they make due to higher wages. This is the case since they derive the primary source of income from working. In conclusion, due to the marginal utility effect, and due to the fact that there is a larger fraction of the population more dependent on labor income, there will be

[14]When markets are incomplete, wealthier agents incur in precautionary behavior, since there are no insurance markets, hence 'incomplete markets'. Lower interest rates imply that agents get rewarded less for self-insurance, and thus lose out, see **Aiyagari and McGrattan (1998)**

an aggregate welfare gain from the consolidation, despite the rich losing out.

Considering now consolidations where the government increases labor income taxation, τ_l. In this case, household's disposable income is directly affected by the government policy, and will be lower during the transition, in comparison with the spending-based consolidations. Since unconstrained households desire to smooth consumption, they will borrow more in initial periods, and thus savings will decrease. Due to this behavior, savings are reduced further than in spending-based consolidations, and the capital stock will be lower too. In turn, this implies a lower path of wages, and thus, a higher path of interest rates, in comparison with consolidations with G. These relations can be observed in the previously shown Figure 2. As seen from the previous analysis, these dynamics will prejudice the most labor income dependent agents and the wealth-poor, which constitute the larger fraction of society. Therefore, tax-based consolidations have lower aggregate welfare gains than spending-based consolidations. Notice also, that although the wealth-rich prefer tax-based consolidations, their welfare still decreases, as ideally for them the optimal would be for debt to increase. The results are summarized on Table 3 below.

Table 3: Welfare Effects in a tax-based plan, τ_l

Quintiles	Wealth Level	ΔWelfare
Q_1	-0.09 - 0.00	+0.0496%
Q_2	0.00 - 0.22	+0.0400%
Q_3	0.22 - 0.84	+0.0229%
Q_4	0.84 - 3.64	−0.0089%
Q_5	3.64 - 15.13	−0.0281%
Total	–	+0.0134%

Note: The wealth levels are interpretable only on a comparative basis, and not on absolute terms. Δ Welfare represents the response to changing from the initial steady state, to a state of the world where the consolidation is undertaken, with $N = 50$.

The findings from the welfare analysis are remarkable: with debt reductions (or increases), governments have substantial redistributive power in hands. Via the wage and real interest rate effects, governments can influence which fraction of society wins or loses. Furthermore, in aggregate terms, consolidations with G are more desirable than consolidations with τ_l, a finding that is in line with the literature, e.g. (**Blanchard and Perotti (2002)**; **Alesina et al. (2015b)**), despite the rich and poor disagreeing on the instrument choice.

6.2 Welfare and the Speed of Fiscal Consolidations

Now that the dynamics of consolidations and the ensuing welfare effects are well understood, the explanation moves on to the timing of debt reductions. Straight away, the results from the simulations performed with a different number of adjustment periods are presented in Table 4, for both types of fiscal instruments.

Table 4: Welfare Effects and the Speed of Adjustment

Fiscal Instrument	Number of years of adjustment, N				
	$N = 5$	$N = 10$	$N = 20$	$N = 50$	$N = 70$
Government Spending, G	0.0024%	0.0060%	0.0158%	0.0760%	0.1764%
Labor Income Taxation, τ_l	0.0004%	0.0011%	0.0027%	0.0134%	0.0337%

Note: Aggregate welfare variations from the initial steady state in $t = 1$, to the same period in the state of the world where the consolidation is undertaken, for different timings of debt reduction.

From observation, one concludes that welfare gains are at the maximum when the fiscal adjustment is extremely back-loaded, spanning the maximum number of periods available. In the context of the experiments, the optimal occurs when N=70, but due to the corner nature of the solution, the optimal N would always be equal to the maximum number of periods available for deleveraging.

The mechanism that explains the results interlinks three features of the model: credit constraints, wealth inequality and the consumption smoothing hypothesis. As explained on the previous section, in response to the fiscal shock, individuals desire to dissave and to work less hours. While this verifies for unconstrained agents, this does not hold for two types of agents: the borrowing constrained and the wealth-poor. In the case of the constrained, they are unable to borrow anymore and thus are “hand-to-mouth”. In the case of the wealth-poor, they respond less to future income changes because after starting to run down savings in response to the shock they will become constrained too. This way, both types of agents have a more rigid elasticity of labor supply, since they can't just decrease hours worked and borrow to compensate for it at will. For example, they are forced to work more hours during the transition path than they desire. Optimally, they would want to work less and borrow to maintain consumption stable, postponing working hours to later when the wage rates would become higher. As they are unable to do so, the trade-off between consumption and leisure is sub-optimal and even though the consolidation is beneficial for them, they lose out on some utility due to this inefficiency.

This is where the government plays a determinant role. By delaying the consolidation, the government makes the debt reduction path and the subsequent response of the macroeconomic variables inherently more smooth. If the adjustment is smoothed out for a longer number of periods, although the hand-to-mouth are still unable to borrow, their desire to do so is much smaller, as the per period shocks to income are lower. The slower the consolidation, the more credit constrained agents' behavior will resemble unconstrained ones, and thus, more optimal is the trade-off between consumption and leisure, increasing their utility. It is also important to revisit the fact that the borrowing constrained are the poorest of all individuals in the economy, and therefore boast the higher marginal utility of consumption. Thus, there are large aggregate gains to be made from a slower consolidation speed, via increased consumption and utility levels for hand-to-mouth agents and the wealth-poor.

7 Conclusion

This paper contributed to the literature on fiscal consolidations, by studying the welfare effects of debt reductions, with particular focus on a less studied feature of fiscal plans, the speed of deleveraging *i.e.* the number of years authorities take to achieve a given debt reduction target. To do so, a neoclassical macroeconomic model was calibrated to match key characteristics of the economy of Germany. Then, a sequence of reductions of the same size in the debt-to-GDP ratio was implemented in the simulated economy, with varying speeds of debt reduction in each simulation.

The experiments culminated in three main results: i) Fiscal consolidations have a positive aggregate effect on welfare, but the welfare effects are heterogeneous across the wealth distribution. The reason being that when debt is reduced, there is a positive welfare effect via higher wages, but an ambiguous aggregate effect via lower interest rates, which depends on the wealth position of households. While borrowers win, savers lose out. Overall, in the experimental economy consolidations are found to improve aggregate welfare since there is a larger fraction of the calibrated population reliant on labor income, with this fraction also being the one whose utility responds more strongly to marginal increases in income. The aggregate gains, come, however, at the expense of the the rich, which optimally desire no consolidation. ii) Welfare improvements are larger in spending-based than in tax-based consolidations, albeit the rich and the poor disagree on the preference for the fiscal instrument. iii) Ideally, the speed of fiscal consolidations should be slow, and the adjustment as smooth as possible. It is argued that by spreading the adjustment, the government helps credit constrained agents and the wealth-poor to smooth out consumption, which otherwise would be impossible due to the inability of these agents to borrow. As these individuals derive the most value from an additional unit of income, their utility increases substantially, and thus there are aggregate welfare gains to be made from slowing down the pace of adjustment.

Future expansions of this work will firstly consider relaxing the closed economy assumption. The welfare effects depicted depended on the direct influence of government debt on the economy's macro variables. With most countries nowadays having a large portion of debt owned by foreigners, the significance of this influence could be starkly reduced were the model set for an open economy. Still, there is empirical evidence for the predictions of the neoclassical model regarding government debt holding, see **Laubach (2009)**. Furthermore, some of the next steps in this research would be to test the robustness of the mechanisms by calibrating the model to other economies, or to consider a different mix of fiscal instruments in testing the welfare response, such as capital or consumption taxation. Finally, a more advanced stage of this work could evolve to a New-Keynesian framework with nominal rigidities and a role for monetary policy.

In terms of real life policy implications, firstly, there is evidence for governments holding some redistributive power in debt reductions (or increases) via the real interest rate channel, when debt is nationally owned. This is especially relevant in the context of the 21st century, with wealth and income inequality being amongst the most hotly debated social and economic issues. Furthermore, this work is a further argument for the indebted OECD countries to implement a slow, gradual deleveraging process, and to take advantage of the current favorable market sentiment that will allow them to do so.

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8 Appendix

8.1 Tax Function

Given the tax function [15]:

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

which we employ, the average tax rate is defined as

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

and thus

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

implying that,

$$\begin{aligned} 1 - \tau(y) &= \theta_0 y^{-\theta_1} \\ \tau(y) &= 1 - \theta_0 y^{-\theta_1} \\ T(y) &= \tau(y)y = y - \theta_0 y^{1-\theta_1} \\ T'(y) &= 1 - (1 - \theta_1)\theta_0 y^{-\theta_1} \end{aligned}$$

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

$$1 - \frac{1 - \tau(y_2)}{1 - \tau(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1} \tag{20}$$

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[16]

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

[16]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

$$T'(y) > \tau(y)$$

is uniquely determined by the parameter θ_1.

8.2 Calibration data

Table 5: Germany: Exogenously calibrated parameters

Description	Parameter	Value	Source
Preferences			
Inverse Frisch elasticity	η	1.000	Trabandt and Uhlig (2011)
Risk aversion parameter	σ	1.2000	Literature
Labor Income			
Parameter 1 age profile of wages	γ_1	0.176	Brinca et al. (2016)
Parameter 2 age profile of wages	γ_2	-0.003	Brinca et al. (2016)
Parameter 3 age profile of wages	γ_3	0.000	Brinca et al. (2016)
Variance of permanent ability	σ_a	0.423	Brinca et al. (2016)
Persistence of idiosyncratic risk	ρ_u	0.335	Brinca et al. (2016)
Technology			
Capital Share of Output	α	0.330	Literature
Depreciation rate	δ	0.060	Literature
Government and Social Security			
Consumption tax rate	τ_c	0.155	Trabandt and Uhlig (2011)
Capital income tax rate	τ_k	0.233	Trabandt and Uhlig (2011)
Tax scale parameter	θ_0	0.881	Brinca et al. (2018)
Tax progressivity parameter	θ_1	0.160	Brinca et al. (2018)
Government debt-to-GDP	B/Y	0.489	FRED
SS tax employers	$\tilde{\tau}_{ss}$	0.206	OECD
SS tax employees	τ_{ss}	0.210	OECD

Table 6: Germany: Endogenously calibrated parameters

Description	Parameter	Value
Discount Factor 1	β_1	0.951
Discount Factor 1	β_2	0.997
Discount Factor 3	β_3	0.952
Disutility of work	χ	16.93
Borrowing Limit	b	0.090
Variance of idiosyncratic risk	σ_u	0.439
Bequest utility	φ	0.36

8.3 Definition of the Transition Equilibrium

As in **Brinca et al. (2018)**, between the initial and final steady states, the recursive competitive equilibrium is formally defined as follows:

Given the initial stock of capital, the initial distribution of households and tax system, denoted respectively by 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: i) individual functions for the household, $\{V_t, c_t, k_t', n_t\}_{t=1}^{t=\infty}$; ii) 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 households $\{\Phi_t\}_{t=1}^{t=\infty}$ such that for all t:

Ġiven 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. Markets clear:

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

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

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

3. The factor prices satisfy:

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

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

4. The government budget balances:

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

5. The social security system balances:

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

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

$$\Gamma_t \int_{j<65} d\Phi_t + \Gamma \int_{j\geq 65} \omega(j) d\Phi_t = \int (1-\omega(j)) k_t d\Phi_t$$

7. Aggregate law of Motion:

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

8.4 Dataset on Multi-Year Fiscal Plans (1978-2013)

Table 1 illustrates the merger of the data in Appendix 1 of **Alesina, Favero and Giavazzi (2015b)** with the data on the Web Appendix of **Alesina et al. (2015a)**, along with the modifications introduced in the scope of this work. There are two methodological changes compared with the authors' fiscal plans:

1. Years where the improvement in government finances was 0 were excluded. The authors report in the data years for which fiscal measures were announced for subsequent periods, but in which there was no consolidation. In coherence with the fiscal experiment, only positive shocks are considered as part of fiscal plans. The excluded data points are: Canada 1983, Denmark 2010, France 1988 and 1998, Spain 1991.

2. Years with negative fiscal adjustments were excluded, for the same reason as in point 1. The excluded data points are: France 1989 and 1999-2000, Germany 1998, Portugal 2003, Spain 1990, USA 1979, 1983-1984 and 1987.

In addition to the authors' data, Table 8 presents for each fiscal plan, the measures of speed detailed in Section 5.1, the number of years of the plan, N, and the average yearly adjustment, A. The average yearly adjustment (A), was calculated in each plan by computing the average of the fiscal improvements as a % of GDP throughout the plan's years. Below is an example of the calculations, for the fiscal plan Portugal 2010-2013.

Table 7: Portugal 2010-2013

Fiscal Plan	Years	Fiscal adjustment (%GDP)
Portugal 2010-2013	2010	1.16
	2011	3.94
	2012	5.20
	2013	3.40

$$A = \frac{1.16 + 3.94 + 5.20 + 3.40}{4} = 3.43$$

It can be interpreted as the average pp reduction in the debt-to-GDP ratio each period, had government accounts been initially balanced and no other changes made to the budget but the ones depicted by the consolidation data. This way, in the first period the debt-to-GDP would have improved by 1.16pp, in the second by 3.94 and so on. In these conditions, the debt-to-GDP ratio would improve, on average, 3.43 pp each year of the fiscal episode.

Table 8: Fiscal Plans Data 1978-2013

Fiscal Plan	Years	Fiscal adjustment (%GDP)	Average yearly adjustment	N° Years
Australia 1985-1988	1985	0.45	0.6175	4
	1986	1.02		
	1987	0.9		
	1988	0.1		
Australia 1994-1999	1994	0.25	0.41	6
	1995	0.50		
	1996	0.62		
	1997	0.70		
	1998	0.37		
	1999	0.04		
Austria 1980-1981	1980	0.80	1.18	2
	1981	1.56		
Austria 1984	1984	2.04	2.04	1
Austria 1996-1997	1996	2.41	1.99	2
	1997	1.56		
Austria 2001-2002	2001	1.02	0.79	2
	2002	0.55		
Austria 2011-2013	2011	0.69	0.81	3
	2012	0.89		
	2013	0.85		
Belgium 1982-1985	1982	1.66	1.44	4
	1983	1.79		
	1984	0.69		
	1985	1.61		
Belgium 1987	1987	2.80	2.80	1
Belgium 1990	1990	0.60	0.60	1
Belgium 1992-1994	1992	1.79	1.29	3
	1993	0.92		
	1994	1.15		
Belgium 1996-1997	1996	1.30	0.86	2
	1997	0.41		
Belgium 2010-2013	2010	1.03	1.48	4
	2011	0.70		
	2012	2.46		
	2013	1.73		
Canada 1984-1997	1984	0.20	0.56	14
	1985	1.03		
	1986	0.99		
	1987	0.28		
	1988	0.30		
	1989	0.31		
	1990	0.86		
	1991	0.40		
	1992	0.21		
	1993	0.35		
	1994	0.49		
	1995	0.99		
	1996	0.97		
	1997	0.47		

Table 9: Fiscal Plans Data 1978-2013 (continuation)

Fiscal Plan	Years	Fiscal adjustment (%GDP)	Average yearly adjustment	Nº Years
Denmark 1983-1985	1983	2.77	2.23	3
	1984	2.38		
	1985	1.54		
Denmark 1995	1995	0.30	0.30	1
Denmark 2011-2013	2011	1.00	1.03	3
	2012	0.90		
	2013	1.20		
Finland 1992-1997	1992	0.91	1.91	6
	1993	3.71		
	1994	3.46		
	1995	1.65		
	1996	1.47		
	1997	0.23		
France 1979	1979	0.85	0.85	1
France 1987	1987	0.26	0.26	1
France 1991-1992	1991	0.25	0.18	2
	1992	0.10		
France 1995-1997	1995	0.28	0.71	3
	1996	1.34		
	1997	0.50		
France 2011-2013	2011	2.48	2.48	3
	2012	2.12		
	2013	2.84		
Great Britain 1979-1982	1979	0.27	0.62	4
	1980	0.08		
	1981	1.58		
	1982	0.53		
Great Britain 1994-1999	1994	0.83	0.45	6
	1995	0.28		
	1996	0.30		
	1997	0.79		
	1998	0.31		
	1999	0.21		
Great Britain 2010-2013	2010	0.40	0.80	4
	2011	0.92		
	2012	0.86		
	2013	1.02		
Ireland 1982-1988	1982	2.80	1.44	7
	1983	2.50		
	1984	0.29		
	1985	0.12		
	1986	0.74		
	1987	1.65		
	1988	1.95		

Table 10: Fiscal Plans Data 1978-2013 (continuation)

Fiscal Plan	Years	Fiscal adjustment (%GDP)	Average yearly adjustment	Nº Years
Ireland 2009-2013	2009	4.80	3.37	5
	2010	4.70		
	2011	3.32		
	2012	1.95		
	2013	2.06		
Italy 1991-1998	1991	2.77	2.49	8
	1992	3.51		
	1993	5.12		
	1994	1.43		
	1995	4.20		
	1996	0.35		
	1997	1.82		
	1998	0.68		
Italy 2010-2013	2010	0.42	1.87	4
	2011	1.47		
	2012	3.40		
	2013	2.20		
Japan 1979-1983	1979	0.12	0.38	5
	1980	0.21		
	1981	0.43		
	1982	0.71		
	1983	0.42		
Japan 1997-1998	1997	1.43	0.96	2
	1998	0.48		
Japan 2003 - 2007	2003	0.48	0.45	5
	2004	0.64		
	2005	0.28		
	2006	0.72		
	2007	0.15		
Netherlands 1981-1988	1981	1.75	1.62	8
	1982	1.71		
	1983	3.24		
	1984	1.76		
	1985	1.24		
	1986	1.74		
	1987	1.48		
	1988	0.05		
Netherlands 1991-1993	1991	0.87	0.84	3
	1992	0.74		
	1993	0.92		
Netherlands 2004-2005	2004	1.70	1.10	2
	2005	0.50		
Germany 1982-1984	1982	1.18	0.74	3
	1983	0.87		
	1984	0.18		

Table 11: Fiscal Plans Data 1978-2013 (continuation)

Fiscal Plan	Years	Fiscal adjustment (%GDP)	Average yearly adjustment	Nº Years
Germany 1991-1995	1991 1992 1993 1994 1995	1.11 0.46 0.11 0.91 1.09	0.74	5
Germany 1997	1997	1.60	1.60	1
Germany 1999-2000	1999 2000	0.30 0.70	0.50	2
Germany 2003-2004	2003 2004	0.74 0.40	0.57	2
Germany 2006	2006	0.50	0.50	1
Germany 2011-2012	2011 2012	0.43 0.72	0.58	2
Portugal 1983	1983	2.3	2.3	1
Portugal 2000	2000	0.50	0.50	1
Portugal 2002	2002	1.60	1.60	1
Portugal 2005 - 2007	2005 2006 2007	0.60 1.65 1.40	1.22	3
Portugal 2010-2013	2010 2011 2012 2013	1.16 3.94 5.20 3.40	3.43	4
Spain 1983-1984	1983 1984	1.90 1.12	1.51	2
Spain 1989	1989	1.22	1.22	1
Spain 1992-1997	1992 1993 1994 1995 1996 1997	0.70 1.10 2.40 0.74 1.30 1.20	1.24	6
Spain 2009-2013	2009 2010 2011 2012 2013	0.30 2.90 2.54 3.80 6.35	3.18	5
Sweden 1984	1984	0.90	0.90	1
Sweden 1993-1998	1993 1994 1995 1996 1997 1998	1.81 0.78 3.50 2.00 1.50 1.00	1.77	6

Table 12: Fiscal Plans Data 1978-2013 (continuation)

Fiscal Plan	Years	Fiscal adjustment (%GDP)	Average yearly adjustment	Nº Years
USA 1978	1978	0.14	0.14	1
USA 1980-1981	1980	0.06	0.15	2
	1981	0.23		
USA 1985-1986	1985	0.21	0.16	2
	1986	0.10		
USA 1988	1988	0.85	0.85	1
USA 1990-1998	1990	0.33	0.44	9
	1991	0.58		
	1992	0.53		
	1993	0.32		
	1994	0.90		
	1995	0.53		
	1996	0.29		
	1997	0.30		
	1998	0.15		
USA 2011-2013	2011	0.04	0.24	3
	2012	0.14		
	2013	0.53		