Fiscal Multipliers and Wealth Heterogeneity in the 21st century*

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Abstract

The literature on fiscal multipliers has brought forth the notion that there is no such thing as *a* fiscal multiplier. These depend on country characteristics, state of the economy and type of fiscal instrument. Running VARs for a large number of countries, we document a strong correlation between wealth inequality and the magnitude of fiscal multipliers. To explain this finding, we develop a life-cycle, overlapping generations economy with uninsurable labor market risk. The results of a simple experiment where we calibrate our model to match the U.S. social security system, tax structure, wealth distribution and key macroeconomic ratios, show that for a change in the distribution of agents with regard to wealth holdings, the impact of the same fiscal stimulus is higher for the economy with higher inequality. Comparing two models calibrated to economies at the opposite ends of wealth inequality in our sample, namely the U.S. and Finland, we still find that the economy with higher wealth inequality, the U.S., experiences a larger response of output to a fiscal policy shock. Future work will focus on extending the analysis to other countries in the Euro-zone and the effects of different fiscal policy shocks.

Keywords: Fiscal Multipliers, Wealth Inequality, Government Spending, Taxation

JEL: E21, E62, H50

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1 Introduction

Modern macroeconomics has evolved from the study of economic aggregates such GDP, consumption and wealth to the study of the distribution of these variables across agents in an economy - see Krueger, Perri, Pistaferri, and Violante (2010a). On the other hand classic questions in macroeconomics that had been addressed in the context of a representative agent framework are now being revisited in the context of heterogeneous agents and studied to what extent several dimensions of heterogeneity across agents in an economy can contribute to differences in macroeconomic outcomes. One such question regards fiscal multipliers. Do observable differences in the distribution of wealth across countries lead to economically meaningful differences in their respective aggregate response to fiscal instruments? We propose a calibrated modeling approach to answer this question.

In the current context of fiscal austerity measures, it is fundamental to have an assessment of the impact of fiscal shocks with regard to macroeconomic aggregates. The recent experience of the Great Recession has brought the effectiveness of fiscal policy back into focus for both practitioners and researchers. After the 2008 financial crisis, economies were faced with a substantial economic slowdown, exacerbated by sovereign debt concerns. In response, many pursued expansionary policies, particularly in instances where monetary policy was not an option. However, with burgeoning debt, some countries were unable to access credit markets in order to finance fiscal recovery programs, and instead pursued austerity measures.

Along with the renewed interest in fiscal policy, growing wealth inequality has re-entered the public discourse, with particular interest raised by the projections in Thomas Piketty's book, Capital in the 21st Century. In 2007, the top 1% of US households held 34% of the nation's wealth, and this number grew over the course of the Great Recession. Inequality matters now, and with growing inequality, it will matter even more in the future.

Fiscal multipliers measure the effectiveness of fiscal policy in stimulating economic activity. Empirical evidence suggests that government consumption and tax cuts have a positive impact on output. However, the other side of this coin is that fiscal consolidation may tend to slow the economy - especially in the presence of distortionary taxation. Thus anticipating the size of the response is important when planning substantial fiscal intervention. Growth forecasts, and thus expected tax revenues, depend critically on the size of the multiplier.

Empirical studies aiming at measuring fiscal multipliers have taken varying approaches[1]: while these approaches find different results, they all agree that increases in government consumption can lead to persistent positive expansion of output - consistent with both Keynesian and neoclassical theories for fiscal policy[2]. However, the empirical approaches diverge in their prediction for the behaviour of other aggregate variables and prices. For example, the largest point of contention seems to be the response of private consumption, which falls under certain identification strategies (consistent with the neoclassical approach).

While these discrepancies remain a point of contention in the empirical literature and theoretical models have diverged along these discrepancies, a parallel research agenda has begun investigating the relative performance of fiscal policy between economies or the state of the economy. Here, research has progressed towards the notion that there is no such thing as *a* fiscal multiplier, but rather that the effect of a fiscal shock on output is dependent on country characteristics, the state of the economy and the type of fiscal instrument. Our aim is to contribute to this second research agenda, by formulating a modelling approach for examining the relative performance of fiscal policy when economies differ on the degree of income and wealth inequality.

Economies vary widely across several dimensions, which can have substantial implications on aggregate responses to fiscal policy. For example, Ilzetzki, Mendoza, and Vegh (2013) show that multipliers are: larger in developing countries than developed countries, large under fixed exchange rates but negligible otherwise, larger in closed economies than in open economies and negative in high debt countries. Fiscal multipliers are also state-dependent.

[1]For a good survey on the various approaches for modelling the impacts of fiscal policy, as well as, an investigation into both the qualitative and quantitative disagreements, see Caldara and Kamps (2008)

[2]Neoclassical models require the spending increase to be financed by non-distortionary taxes for this result to hold, see Baxter and King (1993)

Auerbach and Gorodnichenko (2011) show, for example, that that for a large sample of OECD countries the response of output is large in a recession, but insignificant during normal times.

In parallel work, Anderson, Inoue, and Rossi (2013) find that in the context of the U.S. economy, individuals respond differently to unanticipated fiscal shocks depending on age, income level and education. The wealthiest agents' behavior is consistent with Ricardian equivalence but poor households show evidence of non-Ricardian behavior. This last observation motivates us to rationalise the behavior of an economy's response to fiscal shocks in the context of heterogeneous agents, focusing on the role that wealth and income heterogeneity may have.

In a special edition of the Review of Economic Dynamics on inequality, Krueger, Perri, Pistaferri, and Violante (2010b) summarize some cross-sectional facts regarding different dimensions of heterogeneity of agents, for a selection of countries. They find that there are large differences between countries in inequality for wages, earnings and consumption. The authors highlight that both the level and trend of wage inequality differ across countries, with the US, Canada and the UK showing increasing wage dispersion, while the sample of continental European countries exhibit stable wage inequality (or even falling as in the case of Sweden and Spain). Inequality in earnings (defined as wages times hours worked) is systematically larger than pure wage dispersion, driven by both the variance in hours worked as well as the increase in the correlation between hours worked and wages. Adding asset income to earnings does not significantly impact inequality when measured by the variance of log income, due to the median asset level being quite small[3]. Predictably, fiscal redistribution has an important role in compressing the level of inequality across all countries, due to the progressive nature of the tax and social insurance systems. Accordingly, the level of inequality in consumption is smaller than that in disposable income, and the gap between inequality in disposable income and inequality in consumption is larger for those in the

[3]Contrary to the GINI measure, which is more sensitive to asset levels in the top of the distribution

bottom of the distribution. This implies that progressive redistribution systems have a significant impact on decreasing the dispersion of household consumption.

2 Stylized Facts

In this section we document an empirical relationship between wealth inequality and fiscal multipliers in the data. The exercise we perform is similar to the one performed by Ilzetzki, Mendoza, and Vegh (2013) to identify the impact of different factors on fiscal multipliers across countries and time. Our metric for wealth inequality is the Gini coefficient, which we take from Davies, Sandström, Shorrocks, and Wolff (2007). First we split the sample into two groups, countries with Gini coefficient above and below the sample mean and run SVARs for the two groups separately. We find that the group of countries with Gini above average have a significantly higher fiscal multiplier. Next we repeat the exercise for individual countries and find a statistically significant positive relationship between a country's estimated fiscal multiplier and its Gini coefficient.

To measure the fiscal multiplier, generally defined as output's response to a change in a fiscal instrument, we follow the approach of Ilzetzki, Mendoza, and Vegh (2013), which in turn adopts the method of Blanchard and Perotti (2002) and model the relationship between the variables as the system of equations in 1:

$$AY_{n,t} = \sum_{k=1}^{K} C_k Y_{n,t-k} + u_{n,t} \tag{1}$$

where $Y_{n,t}$ is a vector of endogenous variables in country n during quarter t: $Y_{n,t} = (g_{n,t}, y_{n,t}, CA_{n,t}, dREER_{n,t})'$, where $g_{n,t}$ is government consumption, $y_{n,t}$ output, $CA_{n,t}$ the ratio of the current account to GDP, and $dREER_{n,t}$ the change in the natural logarithm of the real effective exchange rate. C_k is a matrix of lag specific own- and cross-effects of variables on their current observations. Equation 1 cannot be estimated directly, so we pre-multiply the system by $A^{-}1$ and use a Panel OLS regression with fixed effects to obtain estimates of $P = A^{-1}C_k, k = 1, ..., K$ and $e_{n,t} = A^{-1}u_{n,t}$ for both sub-samples.

$$Y_{n,t} = \sum_{k=1}^{K} A^{-1}C_k Y_{n,t-k} + A^{-1}u_{n,t} \tag{2}$$

In order to be able to compute the impact on output, due to an exogenous change in government consumption $\Delta g_{n,t}$, we need to solve the system $e_{n,t} = A^{-1}u_{n,t}$ to identify the primitive innovations and infer a causal effect. To do so we need further assumptions on A.

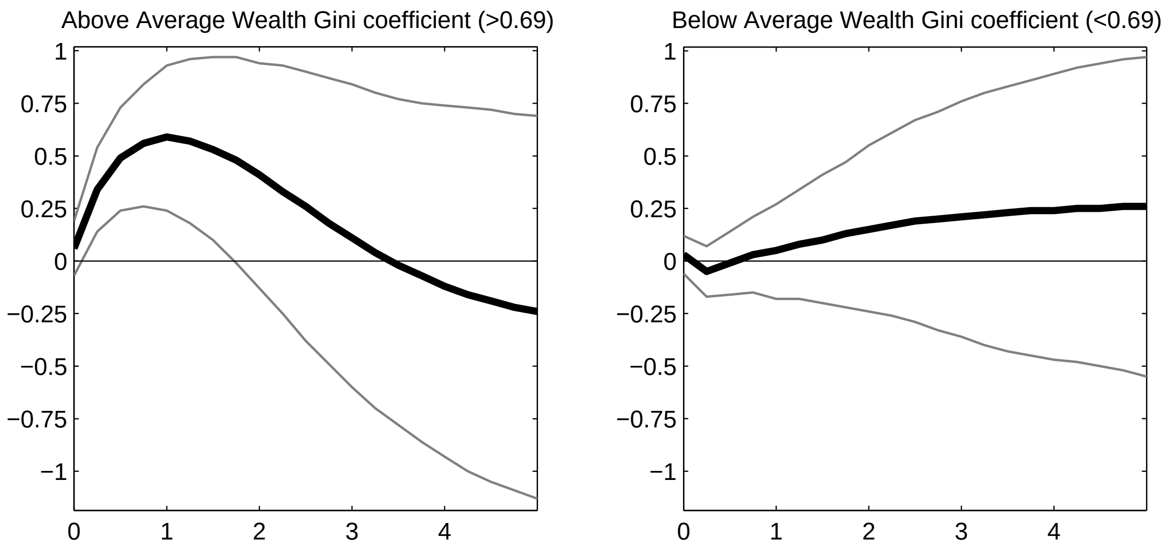

Figure 1: Impulse Responses of Output to a St. Dev. Increase in Goverment Consumption

95% error bands in gray

The assumption that Blanchard and Perotti (2002) use to make a claim upon the identification of a causal effect of government consumption on output is that government consumption is predetermined at the beginning of the year by the annual budget and cannot react to changes in output within the same quarter. This assumption, together with further assumptions on the ordering of the remaining variables (the current account follows output and the exchange rate variable follows the current account), allows us to recover the primitive shocks to the system and compute impulse responses.

We find that, empirically, countries with high and low inequality have very different responses to shocks to government consumption conditional on the level of wealth inequality, as can be observed in Figure 1. The group of economies characterized by high wealth inequality have a significant positive response to an increase in government consumption up to almost two years after the shock, while the group of low inequality countries do not exhibit a significant change.

In the next exercise we estimate the same model as in equation 1 but for a single country at a time. We drop the countries for which there were not enough data points to estimate the system of equations from the sample. The Choleski factorization that Ilzetzki, Mendoza, and Vegh (2013) use to identify the causal effect of government consumption on output implies that for government consumption to have its total effect on output in a year (directly and through the other variables in the system), it takes a total of four quarters. We look at the cumulative multipliers for each country after 4 periods and take that as country estimates of fiscal multipliers. The raw correlation between the estimated Fiscal multipliers and the Gini coefficients is 0.412. We then proceed to estimate the following cross-country model, regressing the estimated fiscal multiplier in country n, FM_n, on the Gini coefficient in country n, $Gini_n$. In a separate regression, we also control for output per capita, $output_n$:

$$FM_n = \alpha + \beta_1 Gini_n + \beta_2 output_n + \varepsilon_n \tag{3}$$

As can be seen in Table 1, the regression coefficient on the Gini index is positive and statistically significant. This holds even when controlling for output per capita, which suggests that the degree of industrialization is not the driving factor behind the result.

α	β_1	β_2
-8.398	0.132	
(13.593)	(0.003)	
-7.189	0.120	-0.023
(17.512)	(0.003)	(0.001)

Table 1: OLS estimates for $FM_n = \alpha + \beta_1 Gini_n + \beta_2 output_n + \varepsilon_n$ (S.E.s in parenthesis)

These findings motivate our study in the next sections of the impact of wealth and income inequality on fiscal multipliers in a structural model.

3 Model

In this section we describe the model we will use to study the response to fiscal stimulus in different countries. Our model is a relatively standard life-cycle economy with heterogeneous agents and incomplete markets.

Technology

There is a representative firm which operates using a Cobb-Douglas production function:

$$Y_t(K_t, L_t) = K_t^{\alpha} \left[L_t\right]^{1-\alpha} \tag{4}$$

where K_t is the capital input and L_t is the labor input measured in terms of efficiency units. The evolution of capital is described by

$$K_{t+1} = (1-\delta)K_t + I_t \tag{5}$$

where I_t is the gross investment, and δ is the capital depreciation rate. Each period, the firm hires labor and capital to maximize its profit:

$$\Pi_t = Y_t - w_t L_t - (r_t + \delta)K_t. \tag{6}$$

In a competitive equilibrium, the factor prices will be equal to their marginal products:

$$w_t = \partial Y_t / \partial L_t = (1-\alpha)\left(\frac{K_t}{L_t}\right)^{\alpha} \tag{7}$$

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

Demographics

The economy is populated by J overlapping generations of finitely lived households. All households start life at age 20 and enter retirement at age 65. Let j denote the household's age. Retired households face an age-dependent probability of dying, $\pi(j)$, and die for certain at age 100.[4]. A model period is 1 year, so there are a total of 40 model periods of active work life. We assume that the size of the population is fixed (there is no population growth). We normalize the size of each new cohort to 1. Using $\omega(j) = 1 - \pi(j)$ to denote the age-dependent survival probability, by the law of large numbers the mass of retired agents of age $j \geq 65$ still alive at any given period is equal to $\Omega_j = \prod_{q=65}^{q=J-1} \omega(q)$.

In addition to age, households are heterogeneous with respect to asset holdings, idiosyncratic productivity shocks and their subjective discount factor $\beta \in \{\beta_1, \beta_2, \beta_3\}$, which takes three different values and is uniformily distributed across agents. Finally, they also differ in terms of ability i.e. a starting level of productivity that is realized at birth. Every period of active work-life they decide how many hours to work, n, how much to consume, c, and how much to save, k. Retired households make no labor supply decisions but receive a social security payment, Ψ_t.

There are no annuity markets, so that a fraction of households leave unintended bequests which are redistributed in a lump-sum manner between the households that are currently alive. We use Γ to denote the per-household bequest.

Labor Income

The wage of an individual depends on the wage per efficiency unit of labor, w, and the number of efficiency units the household is endowed with. The latter depends on the household's age, j, permanent ability, $a \sim N(0, \sigma_a^2)$, and idiosyncratic productivity shock or market luck, u. The idiosyncratic shock follows an AR(1) process:

$$u' = \rho u + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2) \tag{9}$$

[4]This means that $J = 81$.

Thus, the wage of an individual i is given by:

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

$\gamma_{1\iota}$, $\gamma_{2\iota}$ and $\gamma_{3\iota}$ here capture the age profile of wages.

Preferences

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

$$U(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \chi\frac{n^{1+\eta}}{1+\eta} \tag{11}$$

Government

The government runs a balanced social security system where it taxes employees and the employer (the representative firm) at rates τ_{ss} and $\tilde{\tau}_{ss}$ and pays benefits, Ψ_t, to retirees. The government also taxes consumption, labor- and capital income to finance the expenditures on pure public consumption goods, G_t, which enter separable in the utility function, interest payments on the national debt, rB_t, and lump sum redistribution, g_t. We assume that there is some outstanding government debt, and that government debt to output ratio, $B_Y = B_t/Y_t$, does not change over time. Consumption and capital income are taxed at flat rates τ_c, and τ_k. To model the non-linear labor income tax, we use the functional form proposed in Benabou (2002) and recently used in Heathcote, Storesletten, and Violante (2012) and Holter, Krueger, and Stepanchuk (2014):

$$\tau(y) = 1 - \theta_0 y^{-\theta_1} \tag{12}$$

where y denotes pre-tax (labor) income, ya after-tax income, and the parameters θ_0 and θ_1 govern the level and the progressivity of the tax code, respectively.[5]. Heathcote, Storesletten,

[5]A further discussion of the properties of this tax function is provided in the appendix

and Violante (2012) argue that this fits the U.S. data well.

In a steady state, the ratio of government revenues to output will remain constant. G_t, g_t, Ψ_t and must also remain proportional to output. Denoting the government's revenues from labor, capital and consumption taxes by R_t and the government's revenues from social security taxes by R_t^{ss}, the government budget constraints takes the following form:

$$g\left(45+\sum_{j\geq 65}\Omega_j\right)=R-G-rB, \tag{13}$$

$$\Psi\left(\sum_{j\geq 65}\Omega_j\right)=R^{ss}. \tag{14}$$

Where we have suppressed the time subscripts, which are not needed in steady state.

Recursive Formulation of the Household Problem

At any given time a household is characterized by (k, u, ν, j), where k is the household's savings, u is the persistent component of the idiosyncratic productivity shock, ν is the transitory component, and j is the age of the household. We can formulate the household's optimization problem over consumption, c, work hours, n, and future asset holdings, k', recursively:

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

s.t.:

$$c(1+\tau_c)+k'=\begin{cases}(k+\Gamma)\left(1+r(1-\tau_k)\right)+g+Y^L, & \text{if } j<65\\ (k+\Gamma)\left(1+r(1-\tau_k)\right)+g+\Psi^z, & \text{if } j\geq 65\end{cases}$$

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

$$n\in[0,1],\quad k'\geq -b,\quad c>0,\quad n=0 \text{ if } j\geq 65 \tag{15}$$

Y^L is the household's labor income after social security taxes and labor income taxes. τ_{ss} and $\tilde{\tau}_{ss}$ are the social security contributions paid by the employee and by the employer, respectively.

Stationary Recursive Competitive Equilibrium

Let $\Phi(k, u, \nu, j)$ be the measure of households with the corresponding characteristics. We now define such a stationary recursive competitive equilibrium as follows:

Definition:

1. The value function $V(k, u, \nu, j)$ and policy functions, $c(k, u, \nu, j)$, $k'(k, u, \nu, j)$, and $n(k, u, \nu, j)$, solve the consumers' optimization problem given the factor prices and initial conditions.

2. Markets clear:

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

$$L = \int \left(n(k, u, \nu, j)\right) d\Phi$$

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

3. The factor prices satisfy:

$$\begin{aligned} w &= (1-\alpha)\left(\frac{K}{L}\right)^{\alpha} \\ r &= \alpha\left(\frac{K}{L}\right)^{\alpha-1} - \delta \end{aligned}$$

4. The government budget balances:

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

5. The social security system balances:

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

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

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

Fiscal Experiments and Transitions

In our computational experiments we analyze four types of fiscal shocks:

1. The impact of a one time increase in (wasteful) government consumption ΔG, to be financed by non-distortionary taxation Δg. This is the classical experiment which most of the literature on fiscal multipliers relates to.

2. The government increases its lumpsum transfer to households from g_1 to $g_1 + \Delta_g$ for one time period. It finances the increased spending by increasing government debt from B_1 to $B_1 + \Delta_g$. The debt is to be paid down over a 50-year time period through an increase of Δ_τ in every household's labor income tax rate.

3. Identical to 2, with the exception that government debt is to be held by agents outside the economy.

4. The impact of a 50% reduction of the debt-to-GDP ratio over a period of 50 years.

In the context of these experiments a recursive competitive equilibrium is defined as:

Definition: Given the initial capital stock, K_0, and initial distribution, Φ_0, and taxes $\{\tau_l, \tau_c, \tau_k, \tau_{ss}, \tilde{\tau}_{ss}\}_{t=1}^{t=\infty}$ a competitive equilibrium is a sequence of individual functions for the household, $\{V_t, c_t, k'_t, n_t\}_{t=1}^{t=\infty}$, sequences of production plans for the firm, $\{K_t, L_t\}_{t=1}^{t=\infty}$, factor prices, $\{r_t, w_t\}_{t=1}^{t=\infty}$, government transfers $\{g_t, \Psi_t, G_t\}_{t=1}^{t=\infty}$, government debt, $\{B_t\}_{t=1}^{t=\infty}$, inheritance from the dead, $\{\Gamma_t\}_{t=1}^{t=\infty}$, and a sequence of measures $\{\Phi_t\}_{t=1}^{t=\infty}$, such that for all t:

1. The value function $V_t(k,u,\nu,j)$ and policy functions, $c_t(k,u,\nu,j)$, $k'_t(k,u,\nu,j)$, and $n_t(k,u,\nu,j)$, solve the consumers' optimization problem given the factor prices and initial conditions.

2. Markets clear:

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

$$L_t=\int \left(n_t w_t(u,\nu,j)\right) d\Phi_t$$

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

3. The factor prices satisfy:

$$\begin{aligned} w_t &= (1-\alpha)\left(\frac{K_t}{L_t}\right)^{\alpha} \\ r_t &= \alpha\left(\frac{K_t}{L_t}\right)^{\alpha-1}-\delta \end{aligned}$$

4. The government budget balances:

$$g_t\int d\Phi_t+G_t+rB_t=\tau_k r_t K_t+\int\left(\tau_c c_t+\tau_l\left(\frac{n_t w_t(u,\nu,j)}{1+\tilde{\tau}_{ss}}\right)\right)d\Phi_t$$

5. The social security system balances:

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

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

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

7. Aggregate law of motion:

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

4 Calibration

We calibrate our benchmark model to match moments of the U.S. economy over the time period 2000-2007[6]. A number of parameters have direct empirical counterparts and can be calibrated outside of the model. They are listed in Table 2. 6 parameters are calibrated using a simulated method of moments approach. They are listed in Table 3. Below we describe the calibration of each parameter in more detail. The calibration of other countries is conducted in a similar fashion and is described in the Appendix.

Table 2: Parameters Calibrated Exogenously

Parameters	Values	Description	Source
Preferences			
η	1	Inverse Frisch Elasticity	Trabandt and Uhlig (2011)
σ	1.2	Risk aversion parameter	
Technology			
α	0.33	Capital share of output	
δ	0.06	Capital depreciation rate	
$\gamma_1, \gamma_2, \gamma_3$	0.284, -0.006, 0.000	$w = \bar{w}e^{\gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3}$	LIS
ρ, σ_ϵ^2	0.335, 0.307	$u' = \rho u + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2)$	PSID 1968-1993
Taxes			
τ_c	0.05	Consumption Tax	Trabandt and Uhlig (2011)
$\tilde{\tau}_{ss}$	0.0765	S.S. tax on the employer	OECD Tax data
τ_{ss}	0.0765	S.S. tax on the employee	OECD Tax data
τ_k	0.36	Capital gains tax rate	Trabandt and Uhlig (2011)
θ_1, θ_2	0.888, 0.137	Labor income tax	OECD Tax data
B/Y	0.879	Debt to GDP ratio	

Wages

To estimate the life cycle profile of wages (see equation 10), we use data from the Luxembourg Income and Wealth Study and run the below regression for each country:

[6]Relatively recent time but before the financial crisis.

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

where j is the age of individual i. Because we lack panel data from most of our countries we us the PSID to back out the variables governing the idiosyncratic wage shocks and assume that the shocks to wages are the same across countries[7]. We run the wage regression in 16 and obtain the residuals, ε_{it}, which we use to estimate ρ and σ_ϵ. Finally, the variance of permanent ability, σ_a is among the endogenously calibrated parameters. The corresponding data moment is the variance of $\ln(w_i)$.

Preferences

Taxes

Parameters Calibrated Endogeneously

We use the simulated method of moments to calibrate our set of parameters to make the moments in the model match moments of the data. We choose β_1, β_2, β_3, $-b$, χ and σ_a in order to minimize the loss function below:

$$L(\beta_1, \beta_2, \beta_3, \underline{a}, \chi, \sigma_a) = ||Q_m - Q_d|| \quad (17)$$

subject to calibration targets being met with 2% accuracy, namely the fraction of hours worked, k/y and the variance of log wages. Q_m and Q_d are the quantiles of the wealth distribution in the model and in the data, respectively. In Table 3 we reproduce the outcome of our estimation procedure applied to U.S. data.

[7]This is a somewhat strong assumption. However, Keane and Wolpin (1997) find that most of the variation in wages is due to events before an individual enters the labor market. The most important reasons for cross country differences in income inequality will most likely be captured by varying the variance of permanent ability, σ_a.

Parameters	Values	Description	
Preferences			
$\beta_1, \beta_2, \beta_3$	0.958, 1.005, 0.959	Discount factors	
χ	12.8	Disutility of work	
Technology			
$\underline{a}$	0.33	Borrowing limit	
σ_a	0.667	Variance of ability	
Target Moments	Data		Model
K/Y	3.073	Capital-output ratio	3.025
$\text{Var}(\ln w)$	0.516	Variance of log wages	0.515
n	0.252	Fraction of hours worked	0.254
Q_{25}, Q_{50}, Q_{75}	-0.022, -0.030, 0.092	Wealth Quartiles	-0.026, -0.028, 0.092

Table 3: Parameters set inside the model

5 Results

We start by presenting the results of our first fiscal experiment: an increase in wasteful government consumption ΔG_1 financed by a reduction in government transfers ∇g_1. We calibrate two models to match the U.S. (the benchmark) and Finnish economies. We select these two countries for our analysis as they represent two extremes of wealth inequality in our sample of advanced industrialized economies. The US experiences a high degree of wealth and income dispersion (yielding a Gini coefficient for wealth of 0.801), while Finland experiences much less inequality in both measures (Gini coefficient for wealth of 0.621).

As it can be observed in Figure 2, the response of the macroeconomic aggregates is much larger in the case of the model calibrated to the U.S. economy. In terms of the impact output fiscal multiplier, the difference is 0.107 vs 0.052, an increase of about 100%. Though small if compared to standard results from the empirical literature, the multipliers are in line with standard findings in the empirical literature. The fact worth noting is that the fiscal multiplier for the U.S. is twice as large as in the case for Finland. As suggested by our structural VAR estimation, higher inequality is associated with a higher fiscal multiplier.

Of course Finland and the U.S. differ along many dimensions which can make multipliers different. In our model representations of the two economies, they differ along the life cycle

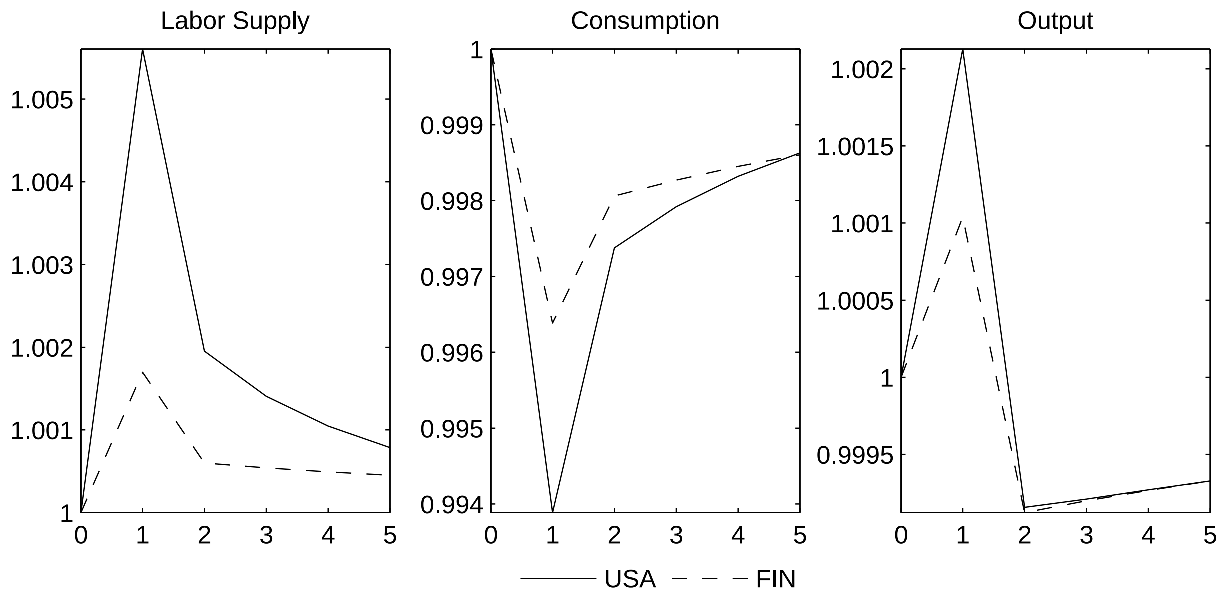

Figure 2: Impact of a $\Delta G_1 = 2\%$ increase in Government Consumption Financed by ∇g_1

profile of wages, the level and progressivity of taxation, average hours worked, the debt-to-GDP ratio and many other aspects. In Figure **??** we produce the impact responses to the same policy experiment. The difference is that now we compare the responses of the same model calibrated to the U.S. economy as shown in Figure 2 to a model also calibrated to the U.S. economy but now shutting down the heterogeneity across abilities and subjective discount factors, while still matching the same capital-output ratio and fraction of hours worked. The resulting wealth distributions differ: in the benchmark case, the Gini coefficient is 0.82 and in the model with no heterogeneity (other than idionsyncratic labor shocks) is just 0.47. But in every other aspect the two models are exactly the same.

We can still observe a larger response of the macroeconomic aggregates to the fiscal shock in the model with higher wealth heterogeneity. The difference between the impact multipliers to output is now smaller - 0.107 vs 0.082 - but still 30% larger.

In this example, there are two factors that explain the difference in the results. First, in order to match the same fraction of hours worked, we need to increase the time-preference parameter, making the agents labor supply less responsive, a key mechanism that is also at play in the U.S. vs Finland case, since the average fraction of hours worked is much lower

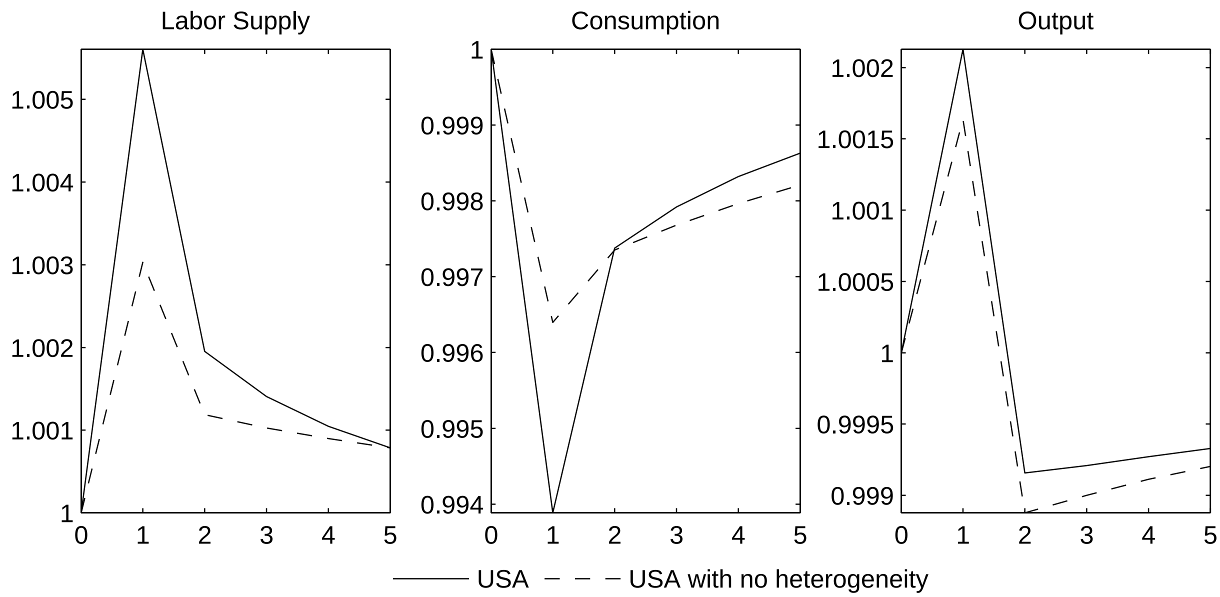

Figure 3: Impact of $\Delta G_1 = 2\%$ in Government Consumption Financed by ∇g_1

in Finland. Given that capital is fixed at the beggining of the period, all of the impact on output from a fiscal policy shock comes from the change in labor supply.

On the other hand, by decreasing wealth heterogeneity we have a smaller share of agents at the borrowing constraint. In the U.S. vs Finland example, the percentage of agents constrained is 10% vs 5% respectively. In the model with no heterogeneity is just 2%. The labor supply elasticity with regard to income of agents at the constraint is much higher due to consumption smoothing motives.

Fiscal multipliers and constrained agents

Next we investigate in greater detail the relationship between the percentage of agents constrained in the economy and the size of the government consumption multiplier. We start with our benchmark economy, the model calibrated to the U.S., matching the wealth distribution we observe in the data at the quartile resolution. We then, holding the borrowing constraint constant and still matching the fraction of hours worked, the capital-output ratio and the variance of log wages, change the subjective discount factors β_1, β_2 and β_3. We then get different models calibrated to the U.S. data with percentages of agents at the borrowing constraint for which we compute the impact multipliers. The results are shown in Figure 4.

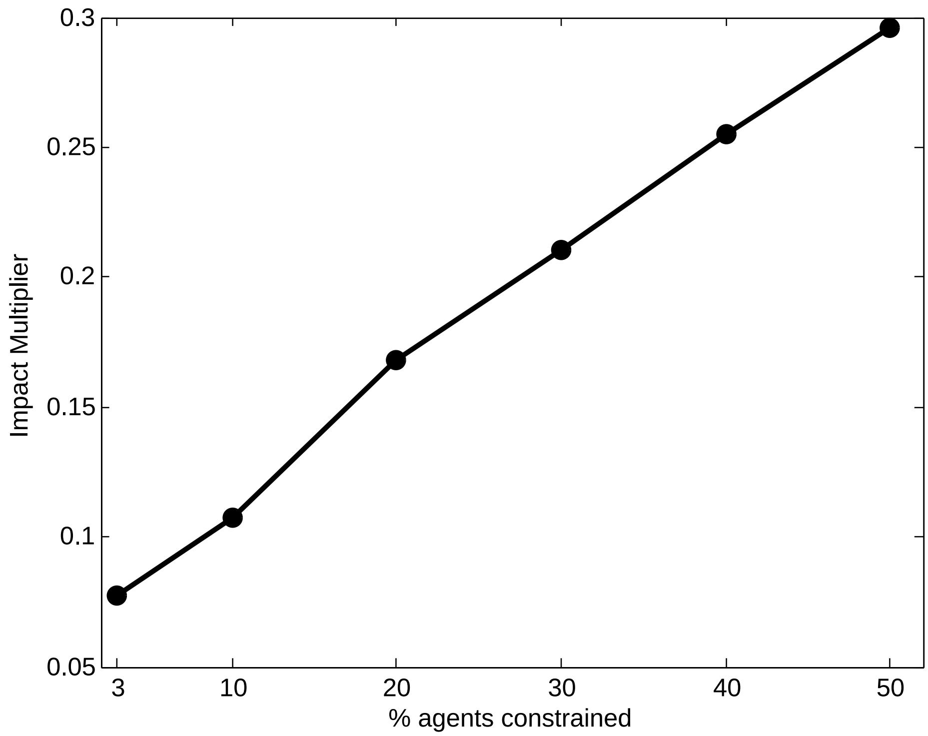

Figure 4: Impact multipliers vs % of agents constrained

In the context of our calibrated models, the magnitude of the impact multiplier is quite sensitive to the proportion of agents constrained. The relevance of the share of financially constrained agents to fiscal policy has been subject to a renewed interest. Kaplan, Violante, and Weidner (2014) argue that the percentage of financially constrained agents can be well above what is typically thought due to large shares of agent's wealth being tied up in illiquid assets. Kaplan and Violante (2011) propose a model with two types of assets that provides a rationale for agents' decisions in a context of asset portfolios with assets that are potentially illiquid. In a similar line of work, Carroll, Slacalek, and Tokuoka (2013) estimate marginal propensities to consume for a large panel of European countries, calibrating models for each country using net wealth and liquid wealth. The authors also find the relationship we show above: the higher the proportion of financially constrained agents in an economy, the higher the multiplier.

6 Conclusion

The results of a simple experiment where we calibrate our model to match the U.S. social security system, tax structure, wealth distribution and key macroeconomic ratios, show that for a change in the distribution of agents with regard to wealth holdings, the impact of the same fiscal stimulus (as a share of GDP) is higher for the economy with higher inequality. Comparing two models calibrated to economies at the opposite ends of wealth inequality in our sample, namely the U.S. and Finland, we still find that the economy with higher inequality, the U.S., experiences a larger response of output to a fiscal policy shock. These results confirm our initial empirical exercise, where we perform a structural VAR analysis similar to Ilzetzki, Mendoza, and Vegh (2013) and find that countries with higher inequality are associated with higher responses to a fiscal stimulus.

One major factor that drives the results in our modeling exercise is the number of agents at the borrowing constraint that rises as the variance of the wealth distribution gets larger and the density of the lower tail of the distribution increases. Our findings are consistent with recent work by Kaplan and Violante (2011), Kaplan, Violante, and Weidner (2014) and Carroll, Slacalek, and Tokuoka (2013).

So far our results focus only on studying the responses of macroeconomic aggregates in the context of a shock to government consumption financed by non-distortionary taxation. However, fiscal multipliers in general, will differ for different fiscal instruments. In future work, we will produce results showing the interplay of wealth inequality and fiscal policy in the context of other fiscal shocks, namely increases in government transfers financed by domestic or foreign borrowing and fiscal consolidation processes.

Our solution method allows us to follow the distribution of agents across all dimensions during the transition path from the initial shock back to the steady state. This enables us to study the redistributive effects of the different fiscal experiments, the impact of the fiscal shocks for savings and labor supply along different income and wealth brackets and so forth. We expect this analysis will provide a deeper insight with regard to the adjustment process economies go through in the event of fiscal interventions.

Finally we plan to address our initial research question regarding whether observable differences in wealth distributions across countries can lead to economically significant differences in fiscal multipliers by producing fiscal multipliers for all countries in our sample, to quantify the relationship between metrics of wealth inequality and the response of macroeconomic aggregates to fiscal policy shocks in the context of different policy experiments.

7 Appendix

7.1 Tax function

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

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

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

$$1 - \frac{1-\tau(y_2)}{1-\tau(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1} \tag{18}$$

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[8] is uniquely determined by the parameter θ_1. Heathcote, Storesletten, and Violante (2012) estimate the parameter $\theta_1 = 0.18$ for US households.

[8]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 income levels.

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