Fiscal Multipliers in the 21st Century[☆]

Pedro Brinca[a,b,c,1,*], Hans A. Holter[d], Per Krusell[e], Laurence Malafry[f]

[a] *Nova School of Business and Economics, Universidade Nova de Lisboa*
[b] *Centro de Economia e Finanças, Universidade do Porto*
[c] *Robert Schuman Centre for Advanced Studies, European University Institute*
[d] *University of Oslo*
[e] *IIES, Stockholm University*
[f] *Stockholm University*

Abstract

The recent experience of The Great Recession has brought the effectiveness of fiscal policy back into focus. Fiscal multipliers do, however, vary greatly over time and place. Running VARs for a large number of countries, reveals 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 model is calibrated to match key characteristics of a number of OECD economies, including the distribution of wages and wealth, social security, taxes and debt, etc. and then used to study the effects of changing policies and various forms of inequality on the fiscal multiplier. Model results indicate that the fiscal multiplier is highly sensitive to the fraction of the population who face binding credit constraints and also negatively related to the average wealth level in the economy. This explains the correlation between wealth inequality and fiscal multipliers.

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[*] Corresponding author
Email address: pedro.brinca@novasbe.pt (Pedro Brinca)
[1] Campus de Campolide, 1099-032 Lisboa, Portugal, +351 912 206 887

1. Introduction

After the 2008 financial crisis, the global economy was faced with a substantial economic slowdown. Many countries responded by pursuing expansionary fiscal policies, in some cases financed by austerity measures due to burgeoning debt and lack of credit market access. In this context, it is fundamental to have a measure of the impact of fiscal shocks on macroeconomic aggregates, and the effectiveness of fiscal policy has been brought back into focus for both practitioners and researchers. The literature on fiscal multipliers has, however, brought forth the notion that there is no such thing as *a* fiscal multiplier. These depend on country characteristics, the state of the economy and the type of fiscal instrument, see for instance Ilzetzki, Mendoza, and Vegh (2013).

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 the book by Piketty (2014), "Capital in the 21st Century". Over the past decades many countries have experienced a rapid increase in wealth inequality. There is, however, significant variation across countries. Growing wealth inequality may have implications for economic policy[2].

In this paper we ask the question of whether differences in the distribution of wealth across countries lead to differences in their respective aggregate response to fiscal policy. We choose to focus on a fiscal policy scenario which has been a classic in the literature: a one period unexpected increase in government expenditure, financed by a one period increase in lump-sum taxation (see for instance Baxter and King (1993)). Fiscal multipliers are naturally expected to depend on the fiscal instrument and we leave the response to alternative policies for future research.

We begin by documenting an empirical relationship between the size of fiscal multipliers and wealth inequality by estimating SVARs, using the data and methodology in Ilzetzki et al. (2013) and adding metrics of wealth inequality. Our estimates show that countries with relatively high inequality experience significantly larger responses to increases in government spending.

In order to explain this relation we develop a life-cycle, overlapping generations economy with uninsurable labor market risk. We calibrate the model to match data from a number of OECD countries along dimensions such as the distribution of income and wealth, taxes, social security and

[2] In the words of Krueger, Perri, Pistaferri, and Violante (2010): "Modern macroeconomics has evolved from the study of economic aggregates such as GDP, consumption and wealth to the study of the distribution of these variables across agents in an economy"

debt level. We then study the contributions from each of these country characteristics to creating a correlation between fiscal multipliers and wealth inequality.

We find that the size of fiscal multipliers is highly sensitive to the fraction of liquidity constrained individuals in the economy and also depends negatively on the average wealth level in the economy. Agents who are liquidity constrained have a higher marginal propensity to consume goods and leisure and respond more strongly to fiscal shocks. Larger labor supply responses leads to larger output responses. The marginal propensity to consume is also higher for relatively wealth poor agents who have a precautionary savings motive. Finally, relatively wealth-poor economies have a higher interest rate and the net present value of an otherwise equally large fiscal shock today is larger when the interest rate is higher. We should therefore expect fiscal multipliers to be high in countries with high inequality, low savings rate and/or high debt.

In a multi-country exercise, where we calibrate 15 OECD countries to country specific data, we get that the raw correlations between the fiscal multipliers generated by our model and the country Gini and country capital to output ratio, K/Y, are 0.62 and -0.68 respectively. The regression coefficients when the fiscal multiplier is regressed on the Gini or on K/Y are highly statistically significant. We find that an increase of one standard deviation in the wealth Gini coefficient for the countries in our sample, raises the multiplier by about 17% of the average multiplier value.

Changing the progressivity of the tax system, a mechanism which has received some attention in the literature, has a limited impact on the fiscal multiplier. One reason is that the reduction in the fraction of borrowing constrained individuals comes together with lower average asset holdings and a higher interest rate. The decrease in the multiplier stemming from a reduction in the number of constrained agents is counteracted by the positive effect in the multiplier of lower average asset holdings and higher interest rate. Reducing wage inequality, modeled as variation in permanent ability, also has a limited impact on the multiplier. Idiosyncratic wage risk is, on the other hand, found to be of first order importance[3].

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[4]. However, as mentioned previously, research has progressed towards the notion that there is

[3]Unfortunately we do not have the data to make idiosyncratic risk a part of our cross-country analysis.

[4]For a good survey of the various approaches for modeling and measuring the impacts of fiscal policy, see Caldara

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. For example, Ilzetzki et al. (2013) show that multipliers are: larger in developing countries than developed countries, larger under fixed exchange rates but negligible otherwise and larger in closed economies than in open economies. Auerbach and Gorodnichenko (2011) show that for a large sample of OECD countries the response of output is large in a recession, but insignificant during normal times. 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.

Heathcote (2005) studies the effects of changes in the timing of income taxes and finds that tax cuts have large real effects and that the magnitude of the effect depends crucially on the degree of market incompleteness. McKay and Reis (2013) study the effects of automatic stabilizers on volatility. In line with our findings, they find that simply making taxes progressive has limited effect on volatility. Tax-and-transfer programs aimed at reducing inequality and increasing social insurance can, however, greatly enhance the effectiveness of stabilizers.

Ferriere and Navarro (2014) find that for the U.S., expansionary fiscal shocks occurred only during times when they were financed by a temporary increase in the progressivity of the tax schedule and that the distributional impacts of fiscal shocks are key in terms of aggregate dynamics. This is also in line with our finding that agents at the bottom of the wealth and income distribution respond more strongly to income shocks. A temporary increase in progressivity will lower the marginal tax rate for agents at the bottom of the income distribution and rise it for agents at the top. If agents at the bottom of the distribution change their behavior much more than agents at the top, a progressivity shock will result in an increase in output and consumption.

Our work is also closely related to Carroll, Slacalek, and Tokuoka (2013) who study the impact of the wealth distribution on the marginal propensity to consume. Carroll et al. (2013) measures marginal propensities to consume for a large panel of European countries, calibrating a model for each country using net wealth and liquid wealth. The authors also find the same type of relationship

and Kamps (2008).

as we document for output multipliers below: the higher the proportion of financially constrained agents in an economy, the higher the consumption multiplier.

Kaplan and Violante (2014) propose a model with two types of assets that provides a rationale for relatively wealthy agents' choice of being credit constrained. In a context of portfolio optimization with one high-return illiquid asset and one low-return liquid asset, relatively wealthy individuals may end up as credit constrained. Kaplan, Violante, and Weidner (2014), using micro data from several countries, 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. Antunes and Ercolani (2015) introduce endogenous borrowing constraints and find that the dynamics of borrowing limits explain a significant share of aggregate dynamics. Finally, Krueger, Mitman, and Perri (2015) conducts a case study of the recent U.S. recession in a business-cycle model with infinite horizon. They find that the presence of wealth-poor individuals is important for the response of macroeconomic aggregates to the business-cycle shock.

The remainder of the paper is structured as follows. In Section 2 we document an empirical relationship between wealth inequality and fiscal multipliers. In Section 3 we describe our quantitative OLG economy with heterogeneous agents and define a competitive equilibrium. Section 4 describes the calibration of the model to country-specific data. In Section 5 we isolate the effect of different characteristics, by which countries differ, on the size of the fiscal multiplier. Section 6 presents the results from a multi-country analysis of fiscal multipliers. We conclude in Section 7. The appendix discusses data and some properties of our tax function.

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 et al. (2013) to identify the impact of different factors on fiscal multipliers across countries and time. We use their data, see Section 8.2. 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 above average Ginis 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 et al. (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:

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

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.

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

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 about here.]

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 et al. (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 four 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[5]. This holds even when controlling for output per capita, which suggests that the degree of industrialization is not the driving factor behind the result.

[Table 1 about here.]

Next we plot the point estimates for the fiscal multipliers against the respective country's fiscal multiplier[6] and the regression line from the first model in Table 1.

[5]It should be emphasized that point estimates for the individual fiscal multipliers have very large variance, given the reduced number of observations that are used for many of the countries. Given this, it is even more surprising that we find such strong and robust correlation between these point estimates and the wealth GINIs

[6]Given the large uncertainty around the point estimates we exclude extreme values (the minimum and maximum observations) from the regression in 1 and Figure 2. If instead we run weighted (by the amplitude of the 95% confidence interval) least squares, we still find a positive correlation though only significant at the 10% level.

[Figure 2 about here.]

As expected, given the relatively small number of observations available per country on average, the multipliers vary considerably ant there is large uncertainty around point estimates. The vertical lines show whether the point estimates 95% confidence interval includes the predicted value from the regression line. Estimates that are unrealistically high (low) are associated with higher variance and the confidence interval typically includes the predicted value from the regression line. Regardless, the regression in 1 shows that the Gini coefficients alone, explain about 20% of the variation in our point estimates for fiscal multipliers.[7]

These findings motivate our study of the impact of wealth and income inequality on fiscal multipliers in a structural model, to be explored in the following sections.

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.

3.1. Technology

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

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

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

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

[7] In light of our findings in the modeling section, that the percentage of constrained households is a primary driver of the differences between countries' multipliers. Here we turn to our sample of countries for which we possess survey data and observe that the wealth held by the bottom decile is significantly and negatively correlated with Gini coefficients.

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:

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

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

3.2. 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.[8]. 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 uniformly 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

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

to denote the per-household bequest.

3.3. 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:

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

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.

3.4. 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:

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

3.5. 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 (2015):

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

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.[9]. Heathcote et al. (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.

3.6. Recursive Formulation of the Household Problem

At any given time a household is characterized by (k, β, a, u, j), where k is the household's savings, $\beta \in \beta_1, \beta_2, \beta_3$, is the time discount factor, a is permanent ability, u is the idiosyncratic productivity shock, and j is the age of the household. We can formulate the household's optimization problem

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

over consumption, c, work hours, n, and future asset holdings, k', recursively:

$$
\begin{aligned}
V(k,\beta,a,u,j) &= \max_{c,k',n}\left[U(c,n) + \beta\omega(j)E_{u'}[V(k',\beta,a,u,j+1)]\right] \\
&\text{s.t.:} \\
c(1+\tau_c) + k' &= \begin{cases} (k+\Gamma)(1+r(1-\tau_k)) + g + Y^L, & \text{if } j < 65 \\ (k+\Gamma)(1+r(1-\tau_k)) + g + \Psi, & \text{if } j \geq 65 \end{cases} \\
Y^L &= \frac{nw(j,a,u)}{1+\tilde{\tau}_{ss}}\left(1 - \tau_{ss} - \tau_l\left(\frac{nw(j,a,u)}{1+\tilde{\tau}_{ss}}\right)\right) \\
n \in [0,1], \quad k' \geq -b, &\quad c > 0, \quad n = 0 \text{ if } j \geq 65
\end{aligned} \tag{15}
$$

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.

3.7. Stationary Recursive Competitive Equilibrium

Let $\Phi(k,\beta,a,u,j)$ 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 $V(k,\beta,a,u,j)$ and policy functions, $c(k,\beta,a,u,j)$, $k'(k,\beta,a,u,j)$, and $n(k,\beta,a,u,j)$, solve the consumers' optimization problem given the factor prices and initial conditions.

2. Markets clear:

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

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

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

3. The factor prices satisfy:

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

4. The government budget balances:

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

5. The social security system balances:

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

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

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

3.8. Fiscal Experiment and Transition

The fiscal experiment that we analyze in the next section is 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. In the context of this experiment 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 $V_t(k,\beta,a,u,j)$ and policy functions, $c_t(k,\beta,a,u,j)$, $k'_t(k,\beta,a,u,j)$, and $n_t(k,\beta,a,u,j)$, solve the consumers' optimization problem given factor prices and initial

conditions.

2. Markets clear:

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

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

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

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:

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

5. The social security system balances:

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

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

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

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. The calibration of other countries is conducted in a similar fashion and is described in the Appendix. A number of parameters have direct empirical counterparts and can be calibrated outside of the model.

4.1. 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:

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

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[10]. 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 $\ln(w_i)$.

4.2. Preferences

There is considerable debate about the Frisch elasticity of labor supply, η, in the literature. We set it to 1.0, which is similar to a number of recent studies, see for instance Trabandt and Uhlig (2011) and Guner, Lopez-Daneri, and Ventura (2014). The parameter χ, governing the disutility of working more hours, and the discount factors β_1, β_2, β_3, are calibrated endogenously. The corresponding data moments are average yearly hours, taken from the OECD Economic Outlook, and the ratio of capital to output, K/Y, taken from the Penn World Table 8.0.

4.3. Taxes and Social Security

As described in Section 8.1 we apply the labor income tax function in Equation 12, proposed by Benabou (2002). We use U.S. labor income tax data provided by the OECD to estimate the

[10]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 θ_0 and θ_1 for different family types. To obtain a tax function for the single individual households in our model, we take a weighted average of θ_0 and θ_1, where the weights are each family type's share of the population[11]. Table 9 in the Appendix summarizes our findings for different countries.

We assume that the social security contributions for the employee, τ_{SS}, and the employer, $\tilde{\tau}_{SS}$ are flat taxes, which is close to true. We use the rate from the bracket covering most incomes, 7.65% for both τ_{SS} and $\tilde{\tau}_{SS}$. We follow Trabandt and Uhlig (2011) and set $\tau_k = 36\%$ and $\tau_c = 5\%$.

4.4. Parameters Calibrated Endogenously

We use the simulated method of moments to calibrate the parameters which do not have any direct empirical counterparts. We choose β_1, β_2, β_3, b, χ and σ_a in order to minimize the loss function below:

$$L(\beta_1, \beta_2, \beta_3, b, \chi, \sigma_a) = ||M_m - M_d|| \tag{17}$$

M_m and M_d refer to moments in the data and moments in the model respectively. We have six instruments and, in order to have an exactly identified system, we target six moments in the data: the three wealth quartiles, the variance of log wages, average fraction of hours worked and the capital output ratio. Table 3 summarizes the calibrated parameters and Table 2 displays the moments and their value in the data and the model. We fit all the targeted data moments with less than 2% error margin.

[Table 2 about here.]

[Table 3 about here.]

5. Inspecting the Mechanisms

Our model is a standard dynamic, neoclassical, incomplete markets economy. In this environment, output is supply-determined and most of the short-run effects come from the response of labor supply to the fiscal shock. The rise in government consumption and the corresponding increase in lump-sum taxation will lead to an increase in labor supply. The increase is particularly

[11] We use US family weights for all countries as we do not have detailed demographic data for most of them.

strong for credit constrained agents, and the larger the fraction of such agents in the economy, the stronger the labor supply response will be and also the impact on output.

In terms of consumption and welfare, the increase in lump-sum taxation makes low-income agents more at risk of hitting the constraint after a negative income shock and induces a rise in precautionary savings and a reduction in consumption. The welfare consequences are negative. In our U.S. benchmark economy, the average consumer in a steady state would be willing to pay 0.11% of benchmark GDP every year to avoid the 1-period unexpected increase in lump-sum taxation by an amount equal to 2% of benchmark GDP, which we simulate in our fiscal experiment. The decrease in welfare is larger for wealth-poor individuals. Looking at the welfare of 40-year olds by wealth quartile, quartiles 1-4 would be willing to pay 0.27%, 0.03%, 0.07% and 0.045% of benchmark GDP every period of their life to avoid the fiscal shock. The reason for the non-monotonic relationship among the wealthiest quartiles is the mix of individuals with respect to discount factor, permanent ability and idiosyncratic productivity shock. It is, however, clear that the poorest individuals are willing to pay the most to avoid the shock.

As discussed above, the finding of an empirical relationship between fiscal multipliers and wealth heterogeneity need not imply causation. Countries with low wealth inequality are also characterized by a number of other features such as higher and more progressive taxes, more generous social security systems and lower returns to labor market experience. These features may all contribute to dampen the fiscal multiplier.

We begin this section by presenting the results of our first fiscal experiment for the US and Italy, two countries that are in the opposite end of our wealth Gini ranking, 0.796 (US) vs. 0.59 (Italy), but also have very different fiscal policies and institutions. Indeed we find, as our theory suggests, that the fiscal multiplier is much larger in the US. The rest of the section is devoted to studying the effects of wealth level, binding borrowing constraints, tax level, tax progressivity and the age profile of wages. The latter three also affect wealth accumulation, so it is not possible to completely isolate the effect of each factor. Nonetheless, our results point in the direction of the level and distribution of capital being the most promising driver of fiscal multipliers across countries.

Wealthy economies with little inequality will have fewer credit constrained individuals and fewer individuals with strong precautionary savings motive. This lowers the average marginal propensity to consume, reduces the elasticity of labor supply and reduces the fiscal multiplier. Wealthy economies also have a lower real interest rate (if capital markets are imperfect), which reduces the relative value of a fiscal shock today in the agents' life-time budget constraint, and leads to a lower multiplier. An isolated change to a country's tax policies does not have a large impact on fiscal multipliers. This suggests that other more fundamental factors affecting the wealth distribution, such as technology or impatience, is driving the size of the fiscal multiplier, through their impact on the fraction of the population which is credit constrained, on precautionary saving, and on the real interest rate.

5.1. Example: Fiscal Multipliers in the US vs. Italy

We calibrate our model to match key characteristics of the U.S. (the benchmark) and Italian economies, as described in Section 4 and perform the classical fiscal experiment in the literature: an increase in wasteful government consumption ΔG_1 financed by a reduction in government transfers Δg_1. As can be seen from Figure 3, 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 0.119 vs 0.059, an increase of about 100%. Although our multipliers are somewhat small in absolute size if compared to results from the empirical literature, the relative size difference is large and in line with stylized facts from the real business cycle literature.

[Figure 3 about here.]

Of course Italy 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 profile of wages, the level and progressivity of taxation, average hours worked, the debt-to-GDP ratio and many other aspects. Figure 4 provides a breakdown of the drivers of the difference in the fiscal multiplier between the U.S. and Italy. We change the parameters that differ in the calibration of the two countries one by one. As can be seen from the figure, the main drivers of the difference are the time discount factors which affect wealth accumulation. One may ask whether it is impatience itself, and not wealth, that drives the difference in multipliers. However, we show below that if we only make people wealthier or change other factors affecting savings and the fraction of borrowing constrained individuals, in particular idiosyncratic risk, and keep the discount factors constant, we still see significant changes in the multipliers.

[Figure 4 about here.]

5.2. *The Impact of Capital*

To isolate the impact of wealth and keeping all other parameters constant, we change the starting asset level, k_0, of agents in our economy (in the benchmark economy all agents start with 0 assets). Table 4 displays the results from this experiment. When agents become wealthier, the fiscal multiplier falls. There are, however, three different channels through which increased wealth may affect the fiscal multiplier. i) The fraction of liquidity constrained individuals, who have the highest marginal propensity to consume, falls. ii) The precautionary savings motive of relatively poor non-constrained individuals falls. iii) The real interest rate falls, reducing the value of a fiscal shock today. Below we try to study each of these effects in isolation.

[Table 4 about here.]

5.3. *The Impact of Liquidity Constraints*

We investigate in greater detail the relationship between the percentage of agents constrained in the economy and the size of the government consumption multiplier. During the experiment we keep the K/Y ratio constant.

[Figure 5 about here.]

We start with our benchmark economy, the model calibrated to the U.S., matching the wealth distribution we observe in the data. We then hold the borrowing constraint constant and multiply β_1 and β_2 by a constant ξ. We no longer aim at matching the US wealth distribution but instead make the fraction of the population which is liquidity constrained, λ, a calibration target. We change ξ, β_3, χ and σ_α to maintain our targets on the fraction of hours worked, the capital-output ratio and the variance of log wages in addition to λ. In Figure 5, we plot the fiscal multiplier as a function of the percent of borrowing constrained individuals, λ.

In the context of our calibrated model, the magnitude of the impact multiplier is very sensitive to the proportion of agents constrained. For instance, the benchmark multiplier is 0.11 when 10% of agents are constrained. When 50% are constrained, the multiplier increases to 0.29.

5.4. *The Impact of Wealth Level (K/Y) in General and Partial Equilibrium*

To study the impact of the average level of wealth, we conduct an experiment where we keep the fraction of liquidity constrained individuals in the economy constant at its benchmark level (13.6%) but alter the K/Y ratio. We do this by multiplying the discount factors by a constant and adjust the borrowing limit. Figure 6 displays the results.

[Figure 6 about here.]

As can be seen from the figure, a higher K/Y ratio is associated with a lower fiscal multiplier - holding the fraction of borrowing constrained agents constant. This holds both in partial equilibrium when we keep the interest rate fixed at 4.9% and in general equilibrium. The precautionary savings motive is a natural explanation for why wealth matters. The impact of changing K/Y is, however, significantly larger in general equilibrium, indicating that the interest rate itself may play a role. The life-time value of a transfer, g, is larger when the interest rate is higher.

5.5. *The Impact of Wage Heterogeneity*

To study the impact of the wage distribution on the impact multiplier we shut down the three different types of wage heterogeneity that we have in the model; age profiles, permanent ability types and idiosyncratic shocks, one by one. When we shut down the different types of heterogeneity, we also adjust γ_0 by a constant to keep average productivity unchanged. Table 5 displays the results from this exercise.

The one type of wage heterogeneity which seems to have a potentially large effect on the multiplier and on the fraction of liquidity constrained individuals is the idiosyncratic productivity shocks[12]. Shutting down the shocks eliminates any precautionary savings motive and many individuals with $\beta(1 + r) < 1$ will want a downward sloping consumption profile and borrow until they hit the borrowing limit. In the economy without idiosyncratic shocks 39.6% of agents are liquidity constrained and the impact multiplier is 0.223 or about 87% greater than in the benchmark economy.

[Table 5 about here.]

[12] Unfortunately we do not have cross-country data on idiosyncratic wage shocks and therefore cannot evaluate the importance of this channel for international variation in fiscal multipliers.

Shutting down the variance in permanent abilities greatly reduces wage inequality in our economy, however, the effect on the fraction of liquidity constrained agents is relatively modest, it falls from 13.0% to 10.3%. The impact multiplier actually rises slightly. One reason for this is that we observe a small fall in savings and the impact multiplier tends to be decreasing in K/Y. However, more importantly, when we reduce inequality with a progressive tax system, the average tax rate falls[13] and the steady state lumpsum distribution, g, falls. The relative increase in the lumpsum payment is therefore larger when wage inequality is smaller. This leads to a greater multiplier.

Shutting down the age profile of wages has little effect on the number credit constrained. However there is a drop in the multiplier because average savings increase and the real interest rate falls.

5.6. The Impact of Labor Income Taxation

Our functional form for the labor income tax schedule allows us to easily change the level of taxes without changing tax progressivity and to change tax progressivity while keeping the level of taxes constant. Our measure of progressivity is the below progressivity wedge, where $\tau(y)$ is the average tax rate:

$$PW(y_1, y_2) = 1 - \frac{1 - \tau(y_2)}{1 - \tau(y_1)} \tag{18}$$

This measure always takes a value between 0 and 1 and increases with the increase in the average tax rate, τ, as earnings increases from y_1 to y_2. If there is a flat tax, then the progressivity wedge would be zero for all levels of y_1 and y_2. Analogous progressivity measures are used by Caucutt, Imrohoroglu, and Kumar (2003), Guvenen, Kuruscu, and Ozkan (2013) and Holter (2014) among others. With our tax function, $PW(y_1, y_2)$ is uniquely determined by the parameter θ_1, see Appendix 8.1.

We begin by examining the effect of the average tax level on the impact multiplier, see Table 6. As we increase the average tax rate from 7.5% to 21.1% the impact multiplier increases from 0.117 to 0.121. As the tax level goes up, the economy becomes poorer, the capital to output ratio, K/Y, falls, the real interest rate increases and the wage rate falls. Even if the lumpsum redistribution

[13] With progressive taxes, taxes paid is a convex function of income and by Jensen's inequality the average when we reduce inequality, the average tax rate falls.

from the government increases, more people are borrowing constrained. The overall effect on the impact multiplier is, however, relatively modest for a large tax change and it seems unlikely that labor income tax levels are a key driver of the cross-country variation in fiscal multipliers.

[Table 6 about here.]

In Table 7 we keep the average tax rate at its benchmark value but vary the parameter governing tax progressivity, θ_1. As can be seen from the table, a more progressive tax system reduces the number of credit constrained individuals in the economy. The effect on the impact multiplier is, however, close to 0. More progressive taxes also reduces the average level of wealth and the interest rate increases. This effect counteracts the effect of fewer credit constrained individuals.

[Table 7 about here.]

6. Fiscal Multipliers Across Countries

In Section 2 we documented a cross-country correlation between wealth inequality and fiscal multipliers in the data, and in the previous section we showed that differences in the distribution of wealth could produce different fiscal multipliers in our model. In this section we use the model to conduct a cross-country analysis of the relationship between the distribution of wealth and fiscal multipliers. We calibrated the model to data from 15 OECD countries (naturally selected by data availability). Tables 11 and 12 in the Appendix summarize the country-specific data. Among the calibration targets, as before, we aim to replicate the wealth distribution of each of the countries. We are able to match the wealth data almost perfectly, as the correlation between the Gini coefficients generated by our model and the ones that come from the data is 0.995, see Figure 9.

[Figure 7 about here.]

As can be seen from Figure 7, the variation in country-specific calibration targets, generates substantial variation in fiscal multipliers. The multipliers range from 0.05 for Finland to 0.142 for Switzerland. However, what Figure 7 also shows is that these differences in multipliers are highly correlated with the measure of wealth heterogeneity used in our replication of Ilzetzki et al. (2013), namely the Gini coefficient ($\rho = 0.623$, $p-$val$= 0.012$).

Next, we perform a simple linear regression of the impact multipliers on the Gini coefficients. Our estimates suggest that a one standard deviation increase in the Gini coefficient (0.083) would lead to an increase of 0.015 in the size of the multiplier, which corresponds to about 17% of the average multiplier (0.0871) value we find.

[Table 8 about here.]

To check if the results we found in the previous section, regarding the effect of the capital-output ratio and the proportion of agents at the borrowing constraint on the fiscal multiplier is also reproduced for our sample of countries, we look at the cross-country correlations. The results are shown in Figure 8. Across our calibrated economies, we can observe a strong correlation between the impact multiplier and capital-output ratio ($\rho = -0.684$, $p-$val$= 0.005$) and the proportion of agents at the borrowing constraint ($\rho = 0.667$, $p-$val$= 0.006$).

[Figure 8 about here.]

These results are in line with our previous analysis in Section 5, where we establish that the capital-output ratio and the proportion of agents at the borrowing constraint are two statistics that have a strong impact on fiscal multipliers through their impact on the marginal propensity to consume (both statistics) and on the real interest rate (K/Y).

7. Conclusion

In this paper we develop a neoclassical macro model with heterogeneous agents, which we calibrate to country-specific data. We show that in the model the size of fiscal multipliers is sharply increasing in the fraction of credit constrained agents and also decreasing in the capital to output ratio, K/Y. These findings are consistent with a positive correlation between wealth inequality and fiscal multipliers, which we document both in the data and in a multi-country analysis within our model.

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 will in general differ for different fiscal instruments. In future research it would be interesting to explore the interplay of wealth inequality and fiscal policy in the context of other fiscal shocks, for instance increases in government transfers financed by domestic or foreign borrowing or a fiscal consolidation process. These fiscal instruments have been the subject of analysis in recent work by Oh and Reis (2012) and Erceg and Lindé (2013) respectively.

The question of how the fiscal policy transmission mechanism works is still open and debated, and we do not claim that this paper has the answer. In a New-Keynesian framework, the increase in aggregate demand would also lead to a decrease in markups and increase in productivity, resulting in a stronger response of output. However, as Nekarda and Ramey (2013) point out, empirically an increase in aggregate demand is associated with an increase, rather than a decrease in markups. This raises concerns about how suitable the standard New-Keynesian framework is for studying the effects of fiscal policy. We focus instead on showing how in a standard neoclassical DSGE model, cross-country differences in wealth distributions can have a significant impact on fiscal multipliers, a relationship we also find in the data.

In general the effect of government spending will depend crucially on the size of the wealth effects that we document relative to other demand side effects. As an example, labor supply increases more in response to fiscal shocks in countries with more constrained agents in our setting. However, if government spending leads to an increase (rather than a decrease) in household disposable income the relationship would be reversed: countries with a higher share of financially constrained agents would observe a comparably smaller labor (and consequently output) response to the fiscal shock and the relationship between wealth inequality and fiscal multipliers would, *ceteris paribus*, also be reversed. Nonetheless, our SVAR exercise shows that wealth inequality is associated with higher, rather than lower, fiscal multipliers.

Finally, the multipliers we produce, though in line with standard findings in neoclassical models, are small in comparison to results from empirical exercises. As mentioned before, neoclassical DSGE models struggle to produce multipliers of the size found in empirical exercises. It is not our aim to reconcile these two literatures but rather to focus on the relative size of fiscal responses between countries.

Our findings do suggest that wealth inequality is an important dimension to take into account for fiscal policy as we document a 17% increase in the average output response to a fiscal shock for one standard deviation increase in the wealth GINI coefficient, for the countries in our sample.

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8. Appendix

8.1. *Tax Function*

[14] 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

$$1 - \frac{1 - \tau(y_2)}{1 - \tau(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1} \tag{19}$$

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[15] is uniquely determined

[14]This appendix is borrowed from Holter et al. (2015)

[15]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

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

by the parameter θ_1. Heathcote et al. (2012) estimate the parameter $\theta_1 = 0.18$ for US households. Table 9 displays our estimates for a number of OECD countries.

[Table 9 about here.]

8.2. SVAR Data Description

The data series used in the Stylized Facts section are taken from Ilzetzki et al. (2013). These consist of quarterly observations (not interpolated) on macroeconomic variables for a selection of 44 countries, roughly balanced between developed and developing economies (See Table 6 for the list of included countries).

The data series used in the SVAR analysis includes: real government consumption, GDP, the ratio of current account to GDP and the real effective exchange rate. Nominal series are deflated using a GDP deflator when available (and CPI when not). Consumption, GDP and exchange rate variables are transformed by natural logarithm. These series exhibit strong seasonality and are non-stationary. Thus, they need to be de-seasonalized, and analyzed as deviations from their quadratic trend.

8.3. Wealth and Income Gini Coefficients

Table 10 lists Gini coefficients for wealth, taken from Davies et al. (2007), which uses various estimation techniques to construct wealth distributions for countries which do not report household wealth. The Gini coefficients for income are from the CIA World Factbook and represent various years.

[Table 10 about here.]

8.4. Eurosystem Household Finance and Consumption Survey - Summary Wealth Statistics

Table 11 details the cumulative wealth distributions for those countries in the Eurosystem Household Finance and Consumption Survey. In addition, we include several other countries' wealth distributions, derived from the Luxembourg Wealth Study's compilation of various household wealth surveys.

[Table 11 about here.]

and thus marginal tax rates are higher than average tax rates for all income levels.

[Table 12 about here.]

8.5. Additional Figures and Tables

[Figure 9 about here.]

[Table 13 about here.]

[Table 14 about here.]

List of Tables

α	β_1	β_2
-9.902	0.153	
(4.371)	(0.063)	
-8.766	0.142	-0.000
(4.476)	(0.062)	(0.000)

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

Table 2: Calibration Fit

Data Moment	Description	Source	Data Value	Model Value
K/Y	Capital-output ratio	PWT	3.074	3.075
Var(ln w)	Variance of log wages	LIS	0.509	0.509
$\bar{n}$	Fraction of hours worked	OECD	0.248	0.248
Q_{25}, Q_{50}, Q_{75}	Wealth Quartiles	LWS	-0.014, -0.004, 0.120	-0.011, -0.002, 0.122

Table 3: Parameters Calibrated Endogenously

Parameter	Value	Description
Preferences		
$\beta_1, \beta_2, \beta_3$	0.953, 1.002, 0.961	Discount factors
χ	13.3	Disutility of work
Technology		
b	0.142	Borrowing limit
σ_a	0.667	Variance of ability

Table 4: The Effect of a Wealthier Population

k_0 - *Initial capital*	-0.14	0.00	1.00	2.00	3.00
Impact Multiplier	**0.124**	**0.119**	**0.107**	**0.101**	**0.097**
% Borrowing Constrained	16.24	13.03	11.67	11.42	11.40
K/Y	3.06	3.07	3.18	3.29	3.41
r	4.78%	4.73%	4.38%	4.03%	3.69%

Table 5: The Impact of Wage Heterogeneity on the Impact Multiplier and % Liquidity Constrained Agents

Impact Multiplier	% Liquidity Constrained	K/Y	$\sigma_u > 0$	$\sigma_a > 0$	Wages Increasing in Age
0.119	13.04	3.08	X	X	X
0.223	39.56	3.01		X	X
0.121	10.25	3.07	X		X
0.107	12.92	3.29	X	X	

Table 6: The Impact of Tax Level on the Impact Multiplier and % Liquidity Constrained Agents

$\bar{\tau}(y)$ - *Tax level*	0.214	0.180	0.144	0.110	0.075
Impact Multiplier	**0.121**	**0.120**	**0.119**	**0.118**	**0.117**
% Liquidity Constrained	13.95	13.51	13.06	12.69	12.29
K/Y	3.004	3.039	3.075	3.111	3.148

Table 7: The Impact of Tax Progressivity on the Impact Multiplier and % Liquidity Constrained Agents

θ_2 - *Tax progressivity*	0	0.069	0.137	0.206	0.274	0.343	0.411
Impact Multiplier	**0.1210**	**0.1197**	**0.1191**	**0.1194**	**0.1201**	**0.1208**	**0.1227**
% Liquidity Constrained	13.75	13.45	13.04	12.74	12.39	12.03	11.63
k/y	3.13	3.10	3.08	3.05	3.03	3.01	2.99

α	β_1
-0.034	0.178
(0.024)	(0.048)

Table 8: OLS estimates for $IM_n = \alpha + \beta_1 Gini_n + \varepsilon_n$ (S.E.s in parenthesis)

Table 9: Estimated Tax Functions for Selected Countries

Country	θ_0	θ_1
Austria	0.9387	0.1875
Canada	0.9000	0.1928
Denmark	0.7864	0.2585
Finland	0.8540	0.2371
France	0.9146	0.1416
Germany	0.8807	0.2212
Greece	1.0615	0.2014
Iceland	0.8683	0.2040
Ireland	0.9810	0.2263
Italy	0.8969	0.1804
Japan	0.9476	0.1014
Luxembourg	0.9522	0.1796
Netherlands	0.9380	0.2541
Norway	0.8345	0.1691
Portugal	0.9372	0.1360
Spain	0.9044	0.1478
Sweden	0.7957	0.2232
Switzerland	0.9294	0.1333
UK	0.9200	0.1998
US	0.8879	0.1372

Table 10: Wealth and Income Ginis for 44 Selected Countries

Country	Wealth Gini	Income Gini
Argentina	0.740	0.458
Australia	0.622	0.303
Belgium	0.662	0.280
Botswana	0.751	0.630
Brazil	0.784	0.508
Bulgaria	0.652	0.453
Canada	0.688	0.321
Chile	0.777	0.521
Colombia	0.765	0.585
Croatia	0.654	0.320
Czech Republic	0.626	0.310
Denmark	0.808	0.248
Ecuador	0.760	0.477
El Salvador	0.746	0.469
Estonia	0.675	0.313
Finland	0.615	0.268
France	0.730	0.327
Germany	0.667	0.270
Greece	0.654	0.330
Hungary	0.651	0.247
Iceland	0.664	0.280
Ireland	0.581	0.339
Israel	0.677	0.392
Italy	0.609	0.319
Latvia	0.670	0.352
Lithuania	0.666	0.355
Malaysia	0.733	0.462
Mexico	0.749	0.517
Netherlands	0.650	0.309
Norway	0.633	0.250
Peru	0.738	0.460
Poland	0.657	0.341
Portugal	0.667	0.385
Romania	0.651	0.332
Slovakia	0.629	0.260
Slovenia	0.626	0.238
South Africa	0.763	0.650
Spain	0.570	0.320
Sweden	0.742	0.230
Thailand	0.710	0.536
Turkey	0.718	0.402
United Kingdom	0.697	0.400
United States	0.801	0.450
Uruguay	0.708	0.453
Sample mean	0.689	0.379

Table 11: Cumulative Distribution of Net Wealth

	10%	20%	30%	40%	50%	60%	70%	80%	90%	Gini
HFCS sample[a]										
Austria	-1.3	-1.1	-0.7	0.2	2.2	6.5	13.5	23.9	40.6	0.732
Finland	-1.2	-1.1	-0.7	1.1	5.2	11.9	21.5	35.1	55.0	0.646
France	-0.2	-0.1	0.4	1.8	5.4	11.6	20.4	32.3	49.7	0.655
Germany	-0.6	-0.5	-0.1	0.8	2.7	6.4	12.7	23.5	40.4	0.729
Greece	-0.2	0.3	2.4	6.5	12.5	20.3	30.4	43.6	61.6	0.545
Italy	0.0	0.4	1.7	4.9	10.2	17.4	26.7	38.5	55.2	0.590
Netherlands	-3.0	-2.8	-2.0	0.4	5.0	12.3	23.2	38.4	59.8	0.638
Portugal	-0.2	0.1	1.4	4.1	8.2	13.9	21.4	31.9	47.1	0.644
Spain	-0.3	0.6	3.3	7.3	12.9	19.9	28.7	40.1	56.6	0.562
Other sources										
Canada[b]	-1.8	-2.1	-2.1	-1.5	1.0	6.0	14.2	27.0	46.7	0.725
Japan[b]	-3.3	-3.3	-2.9	-1.1	2.9	9.4	19.1	33.1	53.8	0.685
Sweden[b]	-8.3	-9.8	-10.0	-9.7	-7.8	-3.2	5.2	19.0	41.7	0.866
Switzerland[c]	0.2	0.6	1.2	2.1	3.6	6.0	9.8	16.1	28.5	0.764
UK[b]	-0.8	-0.8	-0.5	1.2	5.4	11.7	21.0	34.0	54.3	0.649
US[b]	-1.2	-1.4	-1.4	-1.0	0.4	3.2	8.1	15.8	29.6	0.796

[a] Cumulative distribution of net wealth (survey variable designation: *DN3001*) for a selection of countries from the ECB's HFCS.
[b] Sourced from Luxembourg Wealth Study's most recent entry for each respective country (survey variable designation: *nw1*).
[c] Sourced from recent edition of wealth distributions calculated as in Davies, Sandström, Shorrocks, and Wolff (2011).

Table 12: Country-specific calibration targets

	Macro ratios		Labour targets			Ta	
	K/Y	B/Y	$\bar{n}$	Var(ln w)	$\gamma_1, \gamma_2, \gamma_3$	θ_1, θ_2	$\tilde{\tau}_{ss}, \tau_s$
Austria	3.359	0.432	0.226	0.199	0.155, -0.004, $3.0 * 10^{-5}$	0.939, 0.187	0.217
Canada	2.435	0.343	0.236	0.272	0.222, -0.005, $3.0 * 10^{-5}$	0.900, 0.193	0.117
Finland	4.402	-0.482	0.222	0.168	0.183, -0.004, $2.8 * 10^{-5}$	0.854, 0.237	0.243
France	3.392	0.559	0.184	0.478	0.384, -0.008, $6.0 * 10^{-5}$	0.915, 0.142	0.434
Germany	3.013	0.489	0.189	0.354	0.176, -0.003, $2.3 * 10^{-5}$	0.881, 0.221	0.206
Greece	3.262	1.038	0.230	0.220	0.120, -0.002, $1.3 * 10^{-5}$	1.062, 0.201	0.280
Italy	3.943	0.893	0.200	0.225	0.114, -0.002, $1.4 * 10^{-5}$	0.897, 0.180	0.329
Japan	4.033	0.799	0.265	0.386	0.039, $-2.0 * 10^{-4}$, $-1.8 * 10^{-6}$	0.948, 0.101	0.128
Netherlands	2.830	0.232	0.200	0.282	0.307, -0.007, $4.9 * 10^{-5}$	0.938, 0.254	0.102
Portugal	3.229	0.557	0.249	0.298	0.172, -0.004, $2.6 * 10^{-5}$	0.937, 0.136	0.238
Spain	3.378	0.368	0.183	0.225	0.144, -0.002, $1.4 * 10^{-5}$	0.904, 0.148	0.305
Sweden	2.155	-0.034	0.233	0.315	-0.021, 0.001, $-1.2 * 10^{-5}$	0.796, 0.223	0.326
Switzerland	2.923	0.395	0.263	0.299	0.248, -0.005, $3.3 * 10^{-5}$	0.929, 0.133	0.062
UK	2.315	0.371	0.231	0.302	0.183, -0.004, $2.2 * 10^{-5}$	0.920, 0.200	0.105
USA	3.074	0.428	0.248	0.509	0.265, -0.005, $3.6 * 10^{-5}$	0.888, 0.137	0.078

[1] Macro ratios: K/Y is derived from Penn World Table 8.0, average from 1990-2011; B/Y is the average of net p (IMF)
[2] Labour targets: $\bar{n}$ is hours worked per capita derived from OECD data, average from 1990-2011; Var(ln w) anc most recent LIS survey available before 2008. Data from Portugal comes from Quadros de Pessoal 2009 database
[3] Taxes: θ_1, θ_2 are as discussed in Section 8.1; $\tilde{\tau}_{ss}, \tau_{ss}$ are the average social security withholdings faced by the a from 2001-7; τ_k and τ_c are either taken from Trabandt and Uhlig (2011) or calculated using their approach, represe tax rates from 95-07.

Table 13: Country-specific Paramater Values
Estimated by SMM[1]

Country	β_1	β_2	β_3	χ	b	σ_α
Austria	1.013	0.986	0.979	15.5	0.196	0.329
Canada	0.982	0.958	0.958	13.1	0.208	0.433
Finland	1.026	1.004	1.000	15.1	0.329	0.281
France	1.023	1.003	1.000	21.7	0.143	0.601
Germany	1.007	0.976	0.974	18.5	0.063	0.538
Greece	1.007	0.991	0.990	17.6	0.082	0.300
Italy	1.030	1.009	1.002	24.0	0.050	0.370
Japan	1.034	1.016	0.994	16.1	0.700	0.423
Netherlands	0.992	0.981	0.974	15.8	0.433	0.388
Portugal	1.001	0.978	0.978	12.7	0.000	0.486
Spain	1.007	0.991	0.991	27.1	0.144	0.370
Sweden	0.975	0.960	0.950	9.6	0.340	0.510
Switzerland	0.992	0.942	0.931	12.4	0.087	0.440
UK	0.975	0.959	0.956	12.9	0.100	0.484
US	1.002	0.961	0.953	13.3	0.142	0.667

Table 14: Parameters held constant across countries

Parameter	Value	Description	Source
Preferences			
η	1	Inverse Frisch Elasticity	Trabandt and Uhlig (2011)
σ	1.2	Risk aversion parameter	Literature
Technology			
α	0.33	Capital share of output	Literature
δ	0.06	Capital depreciation rate	Literature
ρ, σ_ϵ^2	0.335, 0.307	$u' = \rho u + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2)$	PSID 1968-1997

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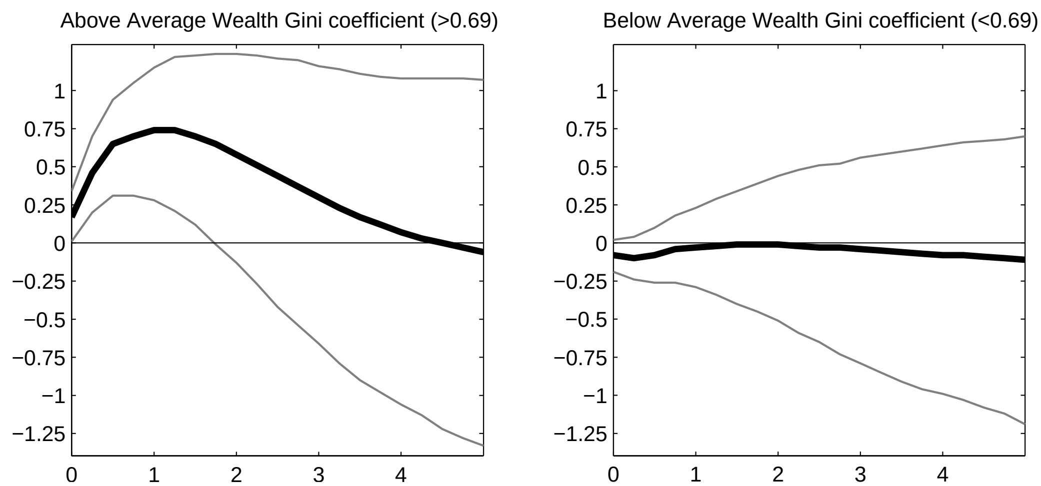


Figure 1: Impulse Responses of Output to a 1% Increase in Government Consumption (95% error bands in gray)

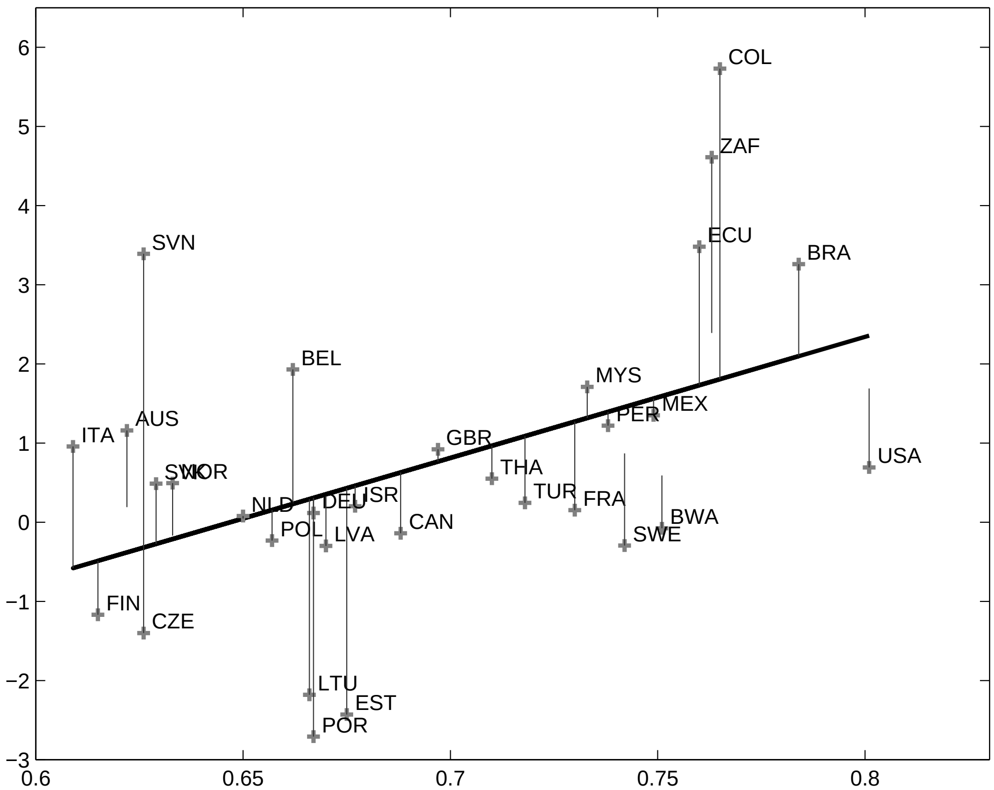
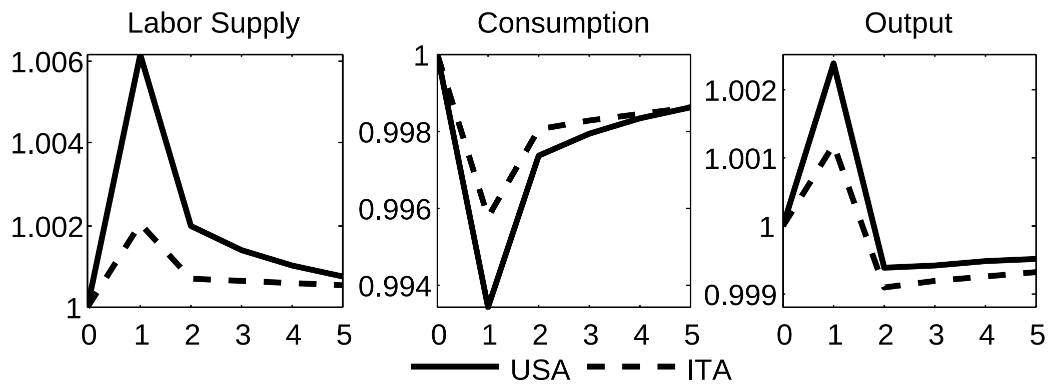


Figure 2: Fiscal multipliers and Wealth Gini's



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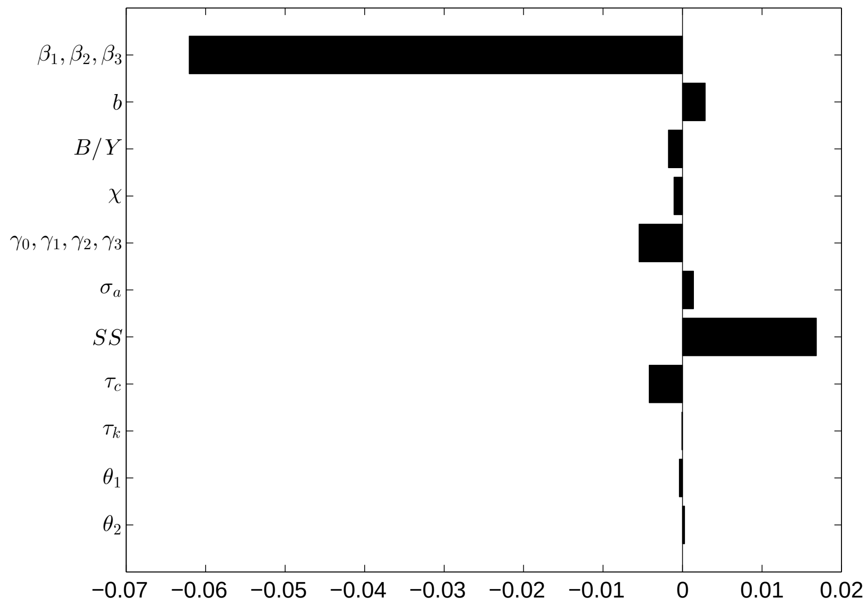

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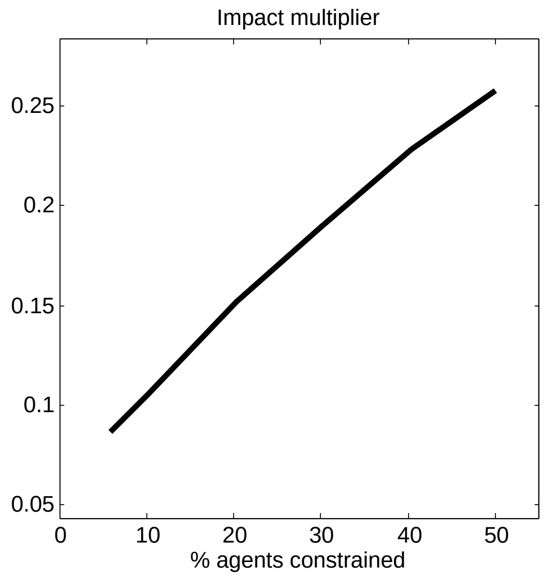

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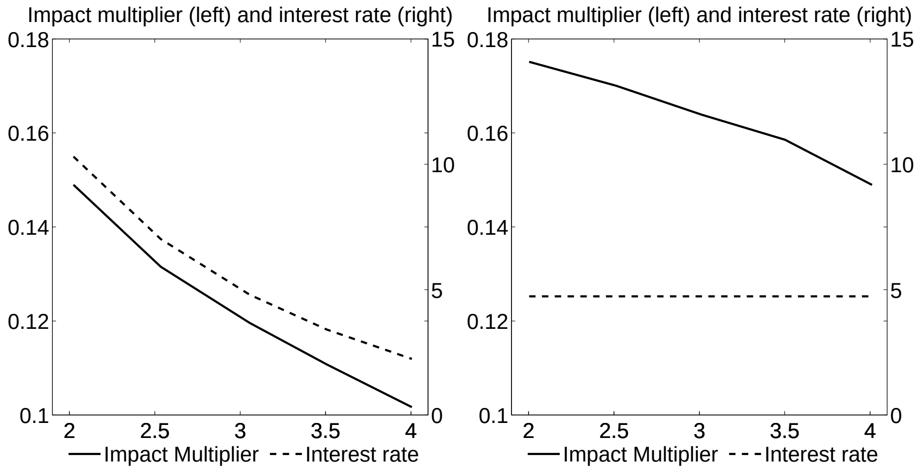

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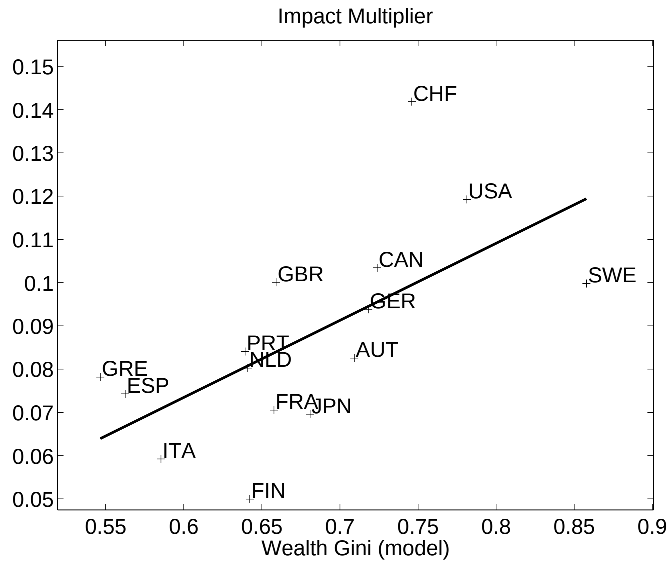

Figure 7: Impact Multipliers vs Gini coefficients (model)

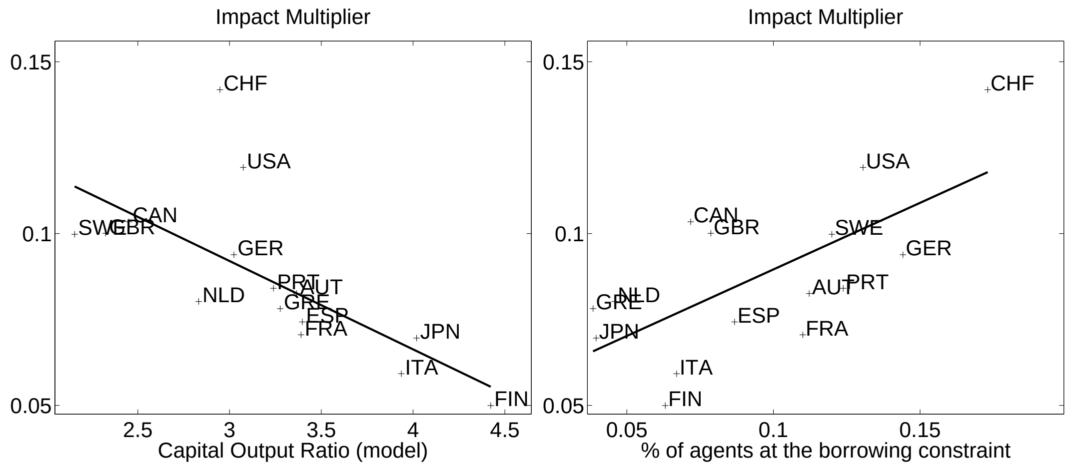

Figure 8: The Impact of K/Y and % of constrained agents in the multiplier

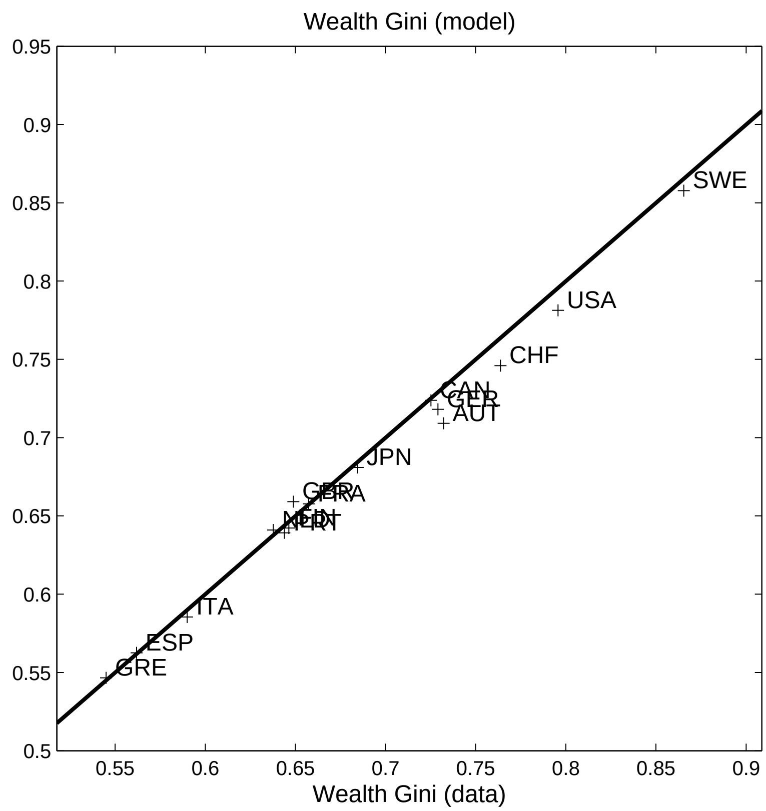

Figure 9: Gini Coefficients in Our Model v.s. the Data: $\rho = 0.995$, $p-$val< 0.01