Fiscal Consolidation Programs and Income Inequality*

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Abstract

Following the Great Recession, many European countries implemented fiscal consolidation policies aimed at reducing government debt. Using three independent data sources and three different empirical approaches, we document a strong positive relationship between higher income inequality and stronger recessive impacts of fiscal consolidation programs across time and place. To explain this finding, we develop a life-cycle, overlapping generations economy with uninsurable labor market risk. We calibrate our model to match key characteristics of a number of European economies, including the distribution of wages and wealth, social security, taxes and debt, and study the effects of fiscal consolidation programs. We find that higher income risk induces precautionary savings behavior, which decreases the proportion of credit-constrained agents in the economy. These credit constrained agents have less elastic labor supply responses to increases in taxes or decreases in government expenditures. This explains the relation between income inequality and impact of fiscal consolidation programs. Our model produces a cross-country pattern between inequality and the fiscal consolidation multipliers, which is quite similar to that in the data.

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1 Introduction

The 2008 financial crisis led several European economies to adopt counter-cyclical fiscal policy, often financed by debt. Government deficits exceeded 10% in many countries, and this created an urgency for fiscal consolidation policies as soon as times returned to normal. Many countries designed plans to reduce their debt through austerity, tax increases, or more commonly a combination of the two, Blanchard and Leigh (2013), Alesina et al. (2015a). The process of fiscal consolidation across European countries, however, raised a number of important questions about the effects on the economy. Is debt consolidation ultimately contractionary or expansionary? How large are the effects and do they depend on the state of the economy? How does the impact of consolidation through austerity differ from the impact of consolidation through taxation? In this paper we contribute to this literature, both empirically and theoretically, by presenting evidence on a dimension that can help explain the heterogeneous responses to fiscal consolidation observed across countries: income inequality and in particular *the role of uninsurable labor income risk.*

We begin by documenting a strong positive empirical relationship between higher income inequality and stronger recessive impacts of fiscal consolidation programs across time and place. We do this by using data and methods from three recent, state-of-the-art, empirical papers, which cover different countries and time periods and make use of different empirical approaches: i) Blanchard and Leigh (2013) ii) Alesina et al. (2015a) iii) Ilzetzki et al. (2013)[1].

Next we study the effects of fiscal consolidation programs, financed through both austerity and taxation, in a neoclassical macro model with heterogeneous agents and incomplete markets. We show that such a model is well-suited to explain the relationship between income inequality and the recessive effects of fiscal consolidation programs. The mechanism we propose works through idiosyncratic income risk. In economies with lower risk, there are more credit constrained households and households with low wealth levels, due to less

[1]While the first two papers study fiscal consolidation programs in Europe, Ilzetzki et al. (2013) study government spending multipliers using a greater number of countries. We include this study for completeness.

precautionary saving. Importantly, these credit constrained households have a less elastic labor supply response to increases in taxes and decreases in government expenditures.

Our empirical analysis begins with a replication of the recent studies by Blanchard and Leigh (2013) and Blanchard and Leigh (2014). These studies find that the International Monetary Fund (IMF) underestimated the impacts of fiscal consolidation across European countries, with stronger consolidation causing larger GDP forecast errors. In Blanchard and Leigh (2014), the authors find no other significant explanatory factors, such as pre-crisis debt levels[2] or budget deficits, banking conditions, or a country's external position, among others, can help explain the forecast errors. In Section 3.1 we reproduce the exercise conducted by Blanchard and Leigh (2013), now augmented with different metrics of income inequality. We find that during the 2010 and 2011 consolidation in Europe the forecast errors are larger for countries with higher income inequality, implying that inequality amplified the recessive impacts of fiscal consolidation. A one standard deviation increase in income inequality, measured as P_{90}/P_{10} [3] leads the IMF to underestimate the fiscal multiplier in a country by 66%.

For a second independent analysis, we use the Alesina et al. (2015a) fiscal consolidation episodes dataset with data from 12 European countries over the period 2007-2013. Alesina et al. (2015a) expands the exogenous fiscal consolidation episodes dataset, known as IMF shocks, from Devries et al. (2011) who use Romer and Romer (2010) narrative approach to identify exogenous shifts in fiscal policy. Again we document the same strong amplifying effect of inequality on the recessive impacts of fiscal consolidation. A one standard deviation increase in inequality, measured as P_{75}/P_{25}, increases the fiscal multiplier by 240%.

Our third empirical analysis replicates the paper by Ilzetzki et al. (2013). These authors use time series data from 44 countries (both rich and poor) and a SVAR approach to study the impacts of different country characteristics on fiscal multipliers. We find that countries

[2]In Section 8.1 we show that, in line with our proposed mechanism, household debt matters if an interaction term between debt and the planned fiscal consolidation is included in the regression.

[3]Ratio of top 10% income share over bottom 10% income share.

with higher income inequality experience significantly stronger declines in output following decreases in government consumption.

To explain these empirical findings, we develop an overlapping generations economy with heterogeneous agents, exogenous credit constraints and uninsurable idiosyncratic risk, similar to that in Brinca et al. (2016). We calibrate the model to match data from a number of European countries along dimensions such as the distribution of income and wealth, taxes, social security and debt level. Then we study how these economies respond to gradually reducing government debt, either by cutting government spending or by increasing labor income taxes.

Output falls when debt reduction is financed through either a decrease in government spending or increased labor income taxes. In both cases, this is caused by a fall in labor supply. In the case of reduced government spending, the transmission mechanism works through a future income effect. As government debt is paid down, the capital stock and thus the marginal product of labor (wages) rise, and thus expected lifetime income increases. This will lead agents to enjoy more leisure and decrease their labor supply today, and output to fall in the short-run, despite the long run effects of consolidation on output being positive. Credit constrained agents and agents with low wealth levels do, however, have a lower marginal propensity to consume goods and leisure out of future income (for constrained agents the MPC to future income is 0[4]). Constrained agents do not consider their lifetime budget, only their budget today. Agents with low wealth levels are also less forward looking and less responsive to future income changes because they will be constrained in several future states of the world. High future consumption levels will thus have limited effect on their expected consumption Euler equations today.

In the case of consolidation through increased labor income taxes there will also be a negative income effect on labor supply today, through higher future wages and increased life-time income. For constrained agents, who do not consider their life-time budget but

[4]The fact that constrained agents also slightly change their labor supply in our model simulations is due to general equilibrium effects (price changes) today.

only their budget today, the tax would instead cause a drop in available income in the short-run, leading to a labor supply increase. However, the tax also induces a negative substitution effect on wages today, both for constrained and unconstrained agents. It turns out that all agents decrease their labor supply, but the response is weaker for constrained and low-wealth agents.

When higher income inequality reflects higher uninsurable income risk, there exists a negative relationship between income inequality and the number of credit constrained agents. Greater risk leads to increased precautionary savings behavior, thus decreasing the share of agents with liquidity constraints and low wealth levels. Since unconstrained agents have more elastic labor supply responses to the positive lifetime-income effect from consolidation, labor supply and output will respond more strongly in economies with higher inequality.

Through simulations in a benchmark economy, initially calibrated to Germany, we show that varying the level of idiosyncratic income risk strongly affects the fraction of credit constrained agents in the economy and the fiscal multiplier, both for consolidation through taxation and austerity. If we instead change inequality by changing the variance of permanent ability, there is very little effect on the fraction of credit constrained agents or on the fiscal multiplier.

In a multi-country exercise, we calibrate our model to match a wide range of data and country-specific policies from 13 European economies, and find that our simulations reproduce the anticipated cross-country correlation between income inequality and fiscal multipliers. Moreover, we show that in our model, countries with higher idiosyncratic uninsurable labor income risk have a smaller percentage of constrained agents and have larger multipliers, confirming our analysis and mechanism for the benchmark model calibrated to Germany.

We perform two empirical exercises to test the validity of the mechanism described above. First, in our calibrated model, countries with higher levels of household debt also have a higher number of credit constrained households. This implies that countries with higher levels of debt should have experienced less recessive impacts of fiscal consolidation programs.

We show that such relationship exists in the data, by again performing a similar exercise to Blanchard and Leigh (2013).

Second, the mechanism we propose implies that fiscal consolidations lead to decreases in labor supply, and that these are amplified by income inequality. We follow Alesina et al. (2015a) but now look at the impacts of fiscal consolidation and income inequality on hours worked. We find, precisely in line with our simulations, that fiscal consolidation programs have a negative impact on hours worked and that this impact is amplified by increases in income inequality.

In Section 9, we conduct a final validity test of the mechanism by using our model. In the empirical analysis we make the case that the IMF forecasts did not properly take income inequality into account. In this section we show that using data from our model, obtained by simulating the observed fiscal consolidation shocks in the data, we get similar results to Blanchard and Leigh (2013) when we shut down all labor income risk in our model. The difference between the output drop that our calibrated model predicts both with and in the absence of risk (which is our proxy for the forecast error), is explained by the size of the fiscal shock and its interaction with the same income inequality metrics as in our replication of the Blanchard and Leigh (2013) experiment (found in Section 3.1). The resulting pattern of regression statistics are strikingly similar to Blanchard and Leigh (2013).

The remainder of the paper is organized as follows: We begin by discussing some of the recent relevant literature in section 2. In Section 3 we assess the empirical relation between income inequality and the fiscal multipliers associated with consolidation programs. In Section 4 we describe the overlapping generations model, define the competitive equilibrium and explain the fiscal consolidation experiments. Section 5 describes the calibration of the model. In Section 6 we inspect the transmission mechanism, followed by the cross-country analysis in Section 7. In Section 8 we empirically validate the mechanism and in Section 9 we replicate the Blanchard and Leigh (2014) exercise with model data. Section 10 concludes.

2 Related Literature

In the wake of the response to the European sovereign debt crisis, there has been a surge in the literature regarding the impacts of fiscal contractions. Guajardo et al. (2014) focus on short-term effects of fiscal consolidation on economic activity for a sample of OECD countries, using the narrative approach as in Romer and Romer (2010), finding that a 1% fiscal consolidation causes GDP to to decline 0.62%; Yang et al. (2015) build a sample of fiscal adjustment episodes for OECD countries in the period of 1970 to 2009 and find that somewhat smaller recessive impacts: a 1% increase in fiscal consolidation leads to a fall of 0.3% in output. Alesina et al. (2015b) conclusions support previous findings, emphasizing that tax-based adjustments produce deeper and longer recessions than spending based ones. Pappa et al. (2015) study the impacts of fiscal consolidation in an environment with corruption and tax evasion and find evidence that fiscal consolidation causes large output and welfare losses and that much of the welfare loss is due to increases in taxes that create the incentives to produce in the less productive shadow sector. Dupaigne and Fève (2016) focus on how the persistence of government spending can shape the short-run impacts on output through the response of private investment.

Our paper also relates to the recent literature on the optimal composition of fiscal policy. Romei (2015) addresses the issue of the optimal speed and composition of a fiscal consolidation, evaluating the impact of different speeds of adjustment and of variations in several fiscal instruments on aggregate welfare. Romei (2015) concludes that a fiscal consolidation should be done quickly and by cutting public expenditure. Viegas and Ribeiro (2016), in line with our own findings, find that the welfare impacts of spending-based cuts are smaller than tax-based consolidation.

There is also a growing literature regarding the relevance of wealth and income inequality for fiscal policy. Anderson et al. (2016) provides evidence that consumers respond differently to unexpected fiscal shocks depending on characteristics, such as age, education and income. Specifically, rich households are Ricardian-like consumers, while poor households exhibit non-Ricardian behavior in the face of unexpected government spending shocks. Brinca et al. (2016) provide empirical evidence that higher wealth inequality is associated with stronger impacts of increases in government expenditures and show that a neoclassical overlapping generations model with uninsurable income risk calibrated to match key characteristics of a number of OECD countries, can replicate this empirical pattern. Hagedorn et al. (2016), in a New Keynesian model, present further evidence of the relevance of market incompleteness in determining the size of fiscal multipliers. Ferriere and Navarro (2014) provide empirical evidence that in post-war U.S., fiscal expansions are only expansionary when financed by increases in tax progressivity. As in Brinca et al. (2016), Ferriere and Navarro (2014) are also able to match this empirical result using a similar framework. Winter et al. (2014) suggest that, even though there are long-term welfare benefits of fiscal consolidation in the US, they do not outweigh the welfare costs of the transition to the new steady state. The authors also find evidence that wealth inequality is a major driver of welfare effects.

Krueger et al. (2016) assess how and by how much wealth, income and preference heterogeneity across households amplifies aggregate shocks. Krueger et al. (2016) conclude that, in an economy with the wealth distribution consistent with the data, the drop in aggregate consumption in response to a negative aggregate shock is 0.5 percentage points larger than in a representative household model. This is conditional on the economy featuring a sufficiently large share of agents with low wealth.

3 Empirical Analysis

In this section we report three main empirical findings. First we provide evidence that income inequality is a relevant dimension that the IMF failed to properly take into account when forecasting the impacts of austerity packages in the 2010-2011 period. We do so by following the exercise in Blanchard and Leigh (2013) and showing that income inequality contains robust and statistically significant information regarding output forecast errors made by the IMF. To illustrate that the link between the effects of fiscal consolidation and income inequality is robust to alternative methodologies and periods, we use Alesina et al. (2015a)'s fiscal consolidation episodes dataset. Results indicate that inequality amplifies the recessive impacts of consolidation shocks. We then provide further evidence regarding the link between income inequality and the heterogeneous effects of fiscal policy and use the same methodology as in Ilzetzki et al. (2013), now pooling countries between high and low income inequality groups. Again, we find that countries with higher income inequality experience, on average, stronger recessive effects of contractions in government expenditures.

3.1 Forecast errors and fiscal consolidation forecasts

Blanchard and Leigh (2013) propose a standard rational expectations model specification to investigate the relationship between growth forecast errors and planned fiscal consolidation during the crisis. The approach regresses forecast errors for real GDP growth on forecasts of fiscal consolidation plans made in the beginning of 2010. The specification proposed by Blanchard and Leigh is the following,

$$\Delta Y_{i,t:t+1} - \hat{E}\{\Delta Y_{i,t:t+1}|\Omega_t\} = \alpha + \beta \hat{E}\{F_{i,t:t+1|t}|\Omega_t\} + \epsilon_{i,t:t+1} \tag{1}$$

where α is the constant, $\Delta Y_{i,t:t+1}$ is the cumulative year-on-year GDP growth rate in economy i in periods t and $t+1$ (years 2010 and 2011 respectively), and the forecast error is measured as $\Delta Y_{i,t:t+1} - \hat{E}\{\Delta Y_{i,t:t+1}|\Omega_t\}$, with $\hat{E}$ being the forecast conditioned on the information set Ω at time t. $\hat{E}\{F_{i,t:t+1|t}|\Omega_t\}$ denotes the planned cumulative change in the general government structural fiscal balance in percentage of potential GDP, and is used as a measure of discretionary fiscal policy.

Under the null hypothesis that the IMF forecasts for the impacts of fiscal consolidation were accurate, β should be zero. What Blanchard and Leigh (2013) find is that β is not only statistically different from zero, but also negative and around 1. This means that the IMF severely underestimated the recessive impacts of austerity, where each additional percentage point of fiscal consolidation is associated with a fall in output 1 percent larger than forecasted. [5]

Blanchard and Leigh (2013) then investigate what else could explain the forecast errors. The authors test for initial levels of financial stress, initial levels of external imbalances, trade-weighted forecasts for trading partners' fiscal consolidation plans, the initial level of household debt, vulnerability ratings from the IMF's Early Warning Exercise computed in early 2010, and other variables. The results are robust and no control is significant. Two conclusions are drawn from this. First, none of the variables examined correlate with both the forecast error and planned fiscal consolidation; and thus the under-estimation of the recessive impacts of consolidation are not related to these different dimensions. Second, since they are not statistically significant, none of these dimensions significantly affected the forecast errors of the IMF.

We expand Equation 1 to account for several different metrics of income inequality[6]. Using the European Union Statistics on Income and Living Conditions (EU-SILC) dataset, we construct various measures of income inequality for the same 26 European economies used by Blanchard and Leigh (2013). [7]

Moreover, to test whether inequality helps to explain the impact of fiscal consolidation, we include in the regression an interaction between the planned fiscal consolidation and inequality. To provide better intuition, we re-parametrize the specification and demean the inequality measures in the interaction term. Therefore, we estimate the following equation,

[5] Blanchard and Leigh (2013) also account for the fact that this result could have been driven by the difference between planned and actual fiscal consolidations. The authors show that this was not the case, as planned and actual consolidations have a correlation of almost one-to-one.

[6] The shares of income of top 25%, 20%, 10%, 5% and 1% over the share of the bottom 25%, 20%, 10%, 5% and 1% respectively and the income Gini coefficient

[7] The 26 economies used by Blanchard and Leigh were Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Finland, France, Greece, Hungary, Ireland, Iceland, Italy, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

$$\Delta Y_{i,t:t+1} - \hat{E}\{\Delta Y_{i,t:t+1}|\Omega_t\} = \alpha + \beta \hat{E}\{F_{i,t:t+1|t}|\Omega_t\} + \gamma I_{i,t-1} + \iota((\hat{E}\{F_{i,t:t+1|t}|\Omega_t\})(I_{i,t-1} - \mu_I)) + \epsilon_{i,t:t+1} \quad (2)$$

where $I_{i,t-1}$ is the inequality measure for country i and μ represents the mean of I. We use lagged inequality to guarantee that it is not influenced by the GDP growth rate or by the fiscal consolidation measures. Results are presented in table 1. The β coefficients, with the demeaned inequality measures, have a convenient interpretation for how much the effects of fiscal consolidation were underestimated for a country with inequality equal to the sample mean. The ι coefficients tell us by how much (relative to the β coefficients) the IMF underestimated fiscal consolidation effects for a country with inequality one percentage point above the sample mean.

First, relative to the benchmark case in Blanchard and Leigh (2013), we see that despite the consolidation variable being statistically significant, the coefficient point estimates are now smaller in absolute value. This tells us that controlling for income inequality, as well as its interaction with planned consolidation, reduces the impact of the size of fiscal consolidation by itself.

Second, note that an increase of 1% above the mean of income inequality amplifies the forecast error of the effects of fiscal consolidation by ι. This means that, had forecasters taken into account income inequality, the effects of fiscal consolidation would have been more properly predicted.

The results are not only statistically significant and robust, but are also economically meaningful. For example, an increase of one standard deviation in the ratio of income shares for the top and bottom 10% leads to an underestimation of the fiscal multiplier of 66%, for a country with an average consolidation[8].

[8] Also note that, even though this is a statement specifically about the IMF's forecast errors, when we simply use output as the dependent variable, the result is the same - showing that higher income inequality is associated with a larger impact of fiscal consolidation. See Table 11 in Appendix for details.

VARIABLES	(1) Blanchard-Leigh	(2) inequality 4/1	(3) inequality 5/1	(4) inequality 10/1	(5) inequality 95/1	(6) inequality 100/2	(7) inequality gini
β	-1.095***	-0.841***	-0.806***	-0.697**	-0.759***	-0.750***	-1.267***
	(0.255)	(0.227)	(0.234)	(0.252)	(0.240)	(0.238)	(0.275)
γ		-0.194	-0.144	-0.065	0.008	0.018	0.273**
		(0.385)	(0.291)	(0.120)	(0.036)	(0.032)	(0.121)
ι		-0.251	-0.238	-0.154***	-0.071***	-0.066***	-0.085
		(0.208)	(0.153)	(0.054)	(0.021)	(0.019)	(0.084)
Constant	0.775*	2.150	2.041	1.812	0.805	0.558	-9.344**
	(0.383)	(2.632)	(2.422)	(1.758)	(0.928)	(0.597)	(4.463)
Observations	26	26	26	26	26	26	26
R-squared	0.496	0.545	0.559	0.612	0.600	0.610	0.624

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 1: GDP forecast errors, income inequality and interaction without the means

3.2 IMF shocks

In this section we provide evidence that the link between income inequality and the output response to fiscal consolidations is not exclusive to the years of 2010 and 2011 or the methodology used in Blanchard and Leigh (2013). We base our analysis on the Alesina et al. (2015a) annual dataset of fiscal consolidation episodes who expanded the exogenous fiscal consolidations episodes dataset from Devries et al. (2011), known as IMF shocks, built using Romer and Romer (2010)'s narrative approach to identify fiscal consolidations solely driven by the need to reduce deficits. The use of the narrative approach allows for filtering out all policy actions driven by the economic cycle and guarantees exogeneity of the shocks in fiscal policy.

Alesina et al. (2015a) expand the Devries et al. (2011) dataset, but use the methodological innovation proposed by Alesina et al. (2015b), noting that a fiscal adjustment is not an isolated change in expenditure or taxes, but rather a multi-year plan, in which some policies are known in advance and others are implemented unexpectedly. Ignoring the connection between the unanticipated and announced measures can lead to biased results.

In the Alesina et al. (2015a) dataset, fiscal consolidations are measured as expected revenue effects of changes in the tax code and as deviations of expenditure relative to the expected level of expenditure absent the policy changes. The fiscal consolidation episodes are assumed to be fully credible, and announcements that were not implemented are dropped from the database.

Once again, we use income inequality data from EU-SILC dataset and construct the same measures of income inequality as in section 3.1. This leads us to consider the time period between 2007-2013, for 12 European economies[9].

The equation that we estimate is the following,

$$\Delta Y_{i,t} = \alpha + \beta_1 e^u_{i,t} + \beta_2 e^a_{i,t} + \gamma I_{i,t-1} + \iota_1 e^u_{i,t}(I_{i,t-1} - \mu_I) + \iota_2 e^a_{i,t}(I_{i,t-1} - \mu_I) + \delta_i + \omega_t + \epsilon_{i,t} \quad (3)$$

where $\Delta Y_{i,t}$ is the GDP growth rate in economy i in year t, $e^u_{i,t}$ is the unanticipated consolidation shock while $e^a_{i,t}$ is the announced shock. $I_{i,t-1}$ is the inequality measure in year $t-1$ and μ represents the sample mean of I. We include only the lagged value of inequality in order to guarantee inequality is not affected by current changes in output and current fiscal consolidation. We re-parametrize the interaction terms by demeaning the inequality measures so that β_1 and β_2 have a more convenient interpretation of how much a one percent increase in fiscal consolidation affects output growth, for a country with average inequality. Moreover, ι_1 and ι_2 can be interpreted as how much more fiscal consolidation affects GDP growth rate for a country with inequality 1 percentage point above the sample mean (relative to a country with average inequality). δ_i and ω_t are country and year fixed effects, respectively.

Results are presented in Table 2. Notice that, of the two interaction terms, only the interaction with unanticipated IMF shocks is statistically significant. This tells us that, for an unanticipated fiscal consolidation, an increase in inequality by 1 percentage point is going to amplify the recessive impacts of fiscal consolidation by ι_1.

Once again, not only are the results robust and statistically significant, but also economically meaningful. An increase of one standard deviation of the share of income of the top 25% over the share of the bottom 25% leads to an increase in the multiplier on unanticipated

[9] Austria, Belgium, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Italy, Portugal and Sweden.

shocks of 240%, for a country with an average-sized consolidation.

VARIABLES	(1) Benchmark	(2) inequality 4/1	(3) inequality 5/1	(4) inequality 10/1	(5) inequality 95/1	(6) inequality 100/2	(7) inequality gini
β_1	-0.003	0.006	0.004	-0.004	-0.004	-0.004	0.011
	(0.005)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)
β_2	-0.002	-0.003	-0.002	-0.000	-0.002	0.001	-0.001
	(0.005)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
γ		-2.294**	-1.308*	-0.024	0.036	0.009	-1.100***
		(1.001)	(0.756)	(0.344)	(0.135)	(0.049)	(0.380)
ι_1		-1.363**	-0.882*	0.103	0.069	-0.005	-0.501**
		(0.590)	(0.501)	(0.232)	(0.077)	(0.030)	(0.191)
ι_2		-0.357	-0.213	-0.094	-0.017	0.022	-0.112
		(0.633)	(0.510)	(0.245)	(0.091)	(0.026)	(0.173)
Constant	0.014***	0.171**	0.123*	0.018	0.005	0.012	0.434***
	(0.005)	(0.069)	(0.063)	(0.050)	(0.034)	(0.014)	(0.145)
Observations	84	84	84	84	84	84	84
R-squared	0.008	0.132	0.086	0.012	0.030	0.021	0.179
Number of countries	12	12	12	12	12	12	12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: GDP growth rate, unanticipated and announced fiscal consolidation shocks, income inequality and interaction without the means

In the replication of Blanchard and Leigh (2013)'s exercise in the previous section, we find that for the 2010-2011 anticipated shocks (planned fiscal consolidation) do matter. Motivated by the results in this section we redo the Blanchard and Leigh (2013) exercise now with unplanned consolidation - the difference between planned and actual consolidation - and find that the amplifying effect of inequality regarding the impacts of fiscal consolidation is even stronger. The regression results are included in Table 13 in the Appendix.

3.3 SVAR

In this section we provide further evidence regarding the link between income inequality and the recessive impacts of fiscal contractions. We use the methodology proposed by Ilzetzki et al. (2013), running VARs for two different groups of countries pooled by their position above or below the median of various inequality measures, including the ratio between the income share of the top and bottom 20%, the ratio of the top and bottom 10% and the income Gini coefficient. We find that the results are consistent across the three different metrics of income inequality. Countries with high income inequality experience strong recessive impacts from cuts in government spending, which are statistically different to the effects for the group of countries with low inequality.

The objective is to estimate the following system of equations

$$AY_{nt} = \sum_{k=1}^{K} C_k Y_{n,t-k} + u_{n,t} \tag{4}$$

where Y_{nt} is a vector containing the endogenous variables for country n in quarter t. The variables considered are the same as in Ilzetzki et al. (2013): government consumption, output, current account as a share of GDP and the natural logarithm of the real effective exchange rate. C_k is a matrix of lag own- and cross-effects of variables on their current observations. Given that A is not observable we cannot estimate this regression directly. We need to pre-multiply everything by A^{-1} and, using OLS, we can recover the matrix $P = A^{-1}C_k$ and $e_{n,t} = A^{-1}u_{n,t}$. So we estimate the system

$$Y_{nt} = \sum_{k=1}^{K} A^{-1} C_k Y_{n,t-k} + A^{-1} u_{n,t} \tag{5}$$

To be able to estimate the effects of fiscal consolidation, we need more assumptions on A so that we can identify the innovations by solving $e_{n,t} = A^{-1}u_{n,t}$. We use the same assumption used by Ilzetzki et al. (2013) and first introduced by Blanchard and Perotti (2002), to identify the responses of output to government consumption expenditures: government consumption cannot react to shocks in output within the same quarter. The plausibility of this assumption comes from the fact that the government's budget is typically set on an annual basis and thus can only respond to changes in output with a lag. For the ordering of the remaining variables, we also follow Ilzetzki et al. (2013) and let the current account follow output and the real exchange rate follow the current account. Given this, we can identify the impulse responses to a primitive shock in government spending.

The impulse response functions shown in Figures 1, 2 and 3 suggest that, in countries with higher income inequality, contractions in government spending have a more recessive impact.

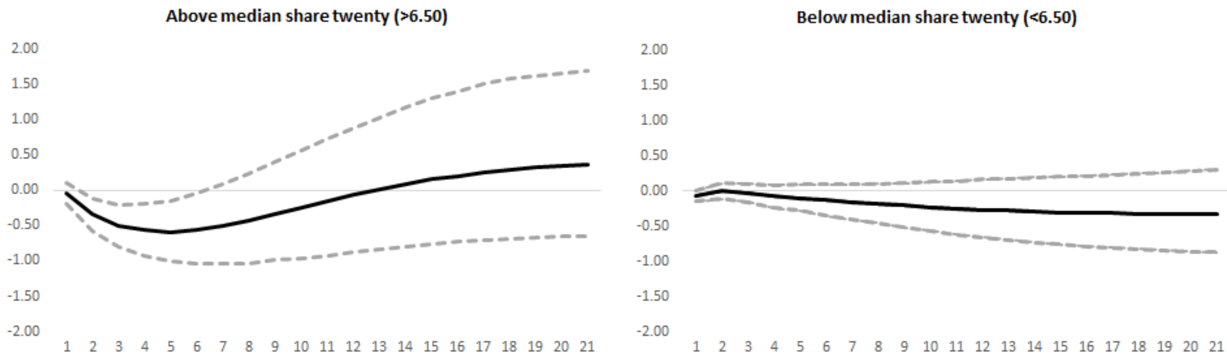

Figure 1: Ratio of the cumulative increase in the net present value of GDP and the cumulative increase in the net present value of government consumption, triggered by 1% decrease in government consumption (90% error bands in gray)

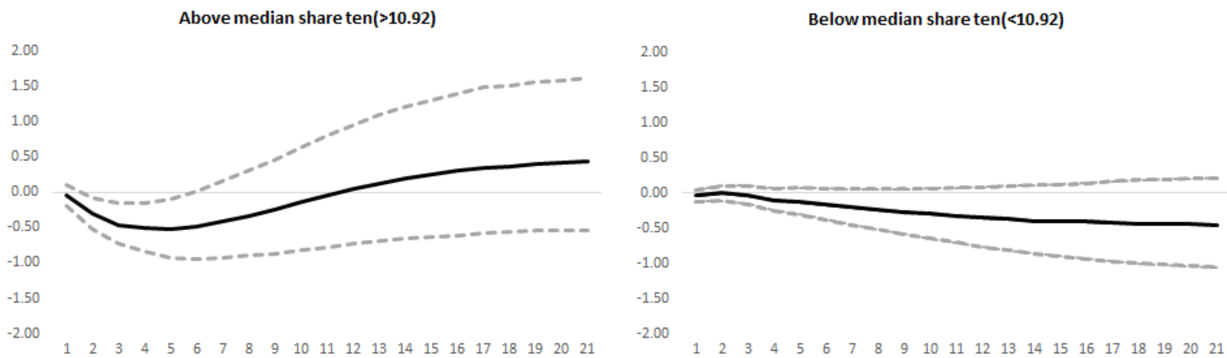

Figure 2: Ratio of the cumulative increase in the net present value of GDP and the cumulative increase in the net present value of government consumption, triggered by 1% decrease in government consumption (90% error bands in gray)

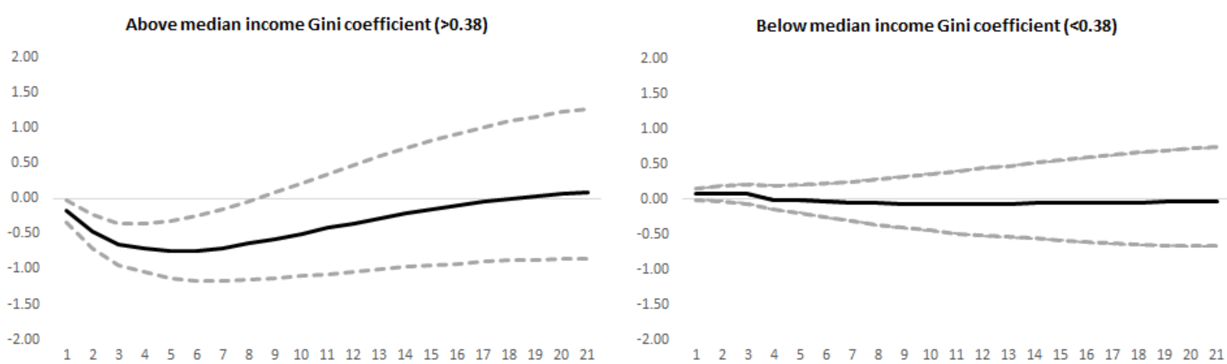

Figure 3: Ratio of the cumulative increase in the net present value of GDP and the cumulative increase in the net present value of government consumption, triggered by 1% decrease in government consumption (90% error bands in gray)

Taken together, these three empirical findings suggest that income inequality is a relevant dimension for studying the effects of fiscal policy. In particular, they suggest that higher inequality amplifies the recessive impacts of fiscal consolidations and decreases in government expenditures. In order to gain insights into the mechanism through which income inequality may play such a role, we build a structural model, introduced in the following section.

4 Model

In this section, we describe the model we will use to study the effects of a fiscal consolidation in different countries. Our model follows closely Brinca et al. (2016).

Technology

There is a representative firm with production function defined by a Cobb-Douglas:

$$Y_t(K_t, L_t) = K_t^{\alpha} [L_t]^{1-\alpha} \tag{6}$$

with K_t being the capital input and L_t the labor input in efficiency units. Capital evolution is given by

$$K_{t+1} = (1-\delta)K_t + I_t \tag{7}$$

with I_t being gross investment, with capital depreciation rate δ. The firm hires labor and capital in each period to maximize profits:

$$\Pi_t = Y_t - w_t L_t - (r_t + \delta)K_t. \tag{8}$$

The factor prices, under a competitive equilibrium, will be equal to their marginal products given by:

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

$$r_t = \partial Y_t / \partial K_t - \delta = \alpha \left(\frac{L_t}{K_t}\right)^{1-\alpha} - \delta \tag{10}$$

Demographics

Our economy is characterized by J overlapping generations households. Recent work by Peterman and Sager (2016) makes the case for the relevance of having a life-cycle dimension for the study of the impacts of government debt. All households are born at age 20 and retire at age 65. Retired households face an age-dependent probability of dying, $\pi(j)$ and die with certainty at age 100. j denotes the household's age and goes from 1 (household's age 20) to 81 (household's age 100). A period in the model corresponds to 1 year, so a household has a total of 45 periods of active work life. We assume there is no population growth. The size of each new cohort is normalized to 1. Denoting the age-dependent survival probability $\omega(j) = 1 - \pi(j)$, at any given period, the mass of living retired agents of age $j \geq 65$ is equal to $\Omega_j = \prod_{q=65}^{q=J-1} \omega(q)$, using the law of large numbers.

Besides age, households are heterogeneous across four other dimensions: idiosyncratic productivity; asset holdings; a subjective discount factor uniformly distributed across agents, with three distinct values $\beta \in \{\beta_1, \beta_2, \beta_3\}$; and in terms of ability, which is the starting level of productivity realized at birth. During active work-life a household must choose the amount of hours he wants to work, n, the amount to consume, c, and how much to save, k. Retired households have no labor supply decision and receive a retirement benefit, Ψ_t.

Since we have stochastic survivability, a percentage of households leave unintended bequests which are uniformly redistributed between the households that remain alive. Per-household bequest is denoted by Γ. Retired households' utility is increasing in the bequest they leave when they die.

Labor Income

The wage of an individual depends on his/her own characteristics: age, j, permanent ability, $a \sim N(0, \sigma_a^2)$, and idiosyncratic productivity shock, u, which follows an AR(1) process:

$$u' = \rho u + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2) \tag{11}$$

These characteristics will dictate the number of efficient units of labor the household is endowed with. Individual wages will also depend on the wage per efficiency unit of labor, w. Thus, individual i's wage is given by:

$$w_i(j,a,u) = we^{\gamma_1 j+\gamma_2 j^2+\gamma_3 j^3+a+u} \tag{12}$$

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

Preferences

The household's utility function, $U(c,n)$, depends on consumption and work hours, $n \in (0,1]$, and is defined by:

$$U(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \chi\frac{n^{1+\eta}}{1+\eta} \tag{13}$$

Retired households gain utility from the bequest they will leave when they die:

$$D(k) = \varphi \log(k) \tag{14}$$

Government

The government is characterized by running a balanced budget social security system. It taxes employees and the representative firm at rates τ_{ss} and $\tilde{\tau}_{ss}$ respectively, and pays retirement benefits, Ψ_t. It also taxes consumption, labor and capital income in order to finance public consumption of goods, G_t, public debt interest expenses, rB_t, and lump sum transfers, g_t.

Tax rates on consumption, τ_c, and on capital income, τ_k, are flat. The labor income tax is non-linear and follows the functional form proposed in Benabou (2002):

$$\tau(y) = 1 - \theta_0 y^{-\theta_1} \tag{15}$$

WRONG DESCRIPTION??? with y being the pre-tax (labor) income, ya the after-tax income, and the level and progressivity of the tax is dictated by the parameters θ_0 and θ_1, respectively.[10].

Given the government's revenues from social security taxes denoted by R_t^{ss}, the government budget constraint is given by

$$g\left(45+\sum_{j\geq 65}\Omega_j\right)=R-G-rB, \tag{16}$$

$$\Psi\left(\sum_{j\geq 65}\Omega_j\right)=R^{ss}. \tag{17}$$

Recursive Formulation of the Household Problem

A household is characterized, in any period, by his asset position, k, the time discount factor, $\beta\in\beta_1,\beta_2,\beta_3$, his permanent ability, a, the idiosyncratic productivity shock, u and his age, j. We can formulate the working-age household's optimization problem over consumption, c, work hours, n, and future asset holdings, k', recursively:

$$\begin{aligned}
V(k,\beta,a,u,j) &= \max_{c,k',n}\left[U\left(c,n\right)+\beta E_{u'}\left[V(k',\beta,a,u,j+1)\right]\right]\\
&\text{s.t.:}\\
c(1+\tau_c)+k' &= \left(k+\Gamma\right)\left(1+r(1-\tau_k)\right)+g+Y^L\\
Y^L &= \frac{nw\left(j,a,u\right)}{1+\tilde{\tau}_{ss}}\left(1-\tau_{ss}-\tau_l\left(\frac{nw\left(j,a,u\right)}{1+\tilde{\tau}_{ss}}\right)\right)\\
n\in[0,1],\quad k' &\geq -b,\quad c>0
\end{aligned} \tag{18}$$

with Y^L being household's labor income post social security taxes paid by the employee, τ_{ss}, and paid by the employer, $\tilde{\tau}_{ss}$, and labor income taxes. The problem of a retired household,

[10]See the appendix for a more detailed discussion of the properties of this tax function

who has a probability, $\pi(j)$, of dying and gains utility, $D(k')$, from leaving a bequest is:

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

s.t.:

$$c(1+\tau_c) + k' = \left(k+\Gamma\right)\left(1+r(1-\tau_k)\right) + g + \Psi,$$

$$k' \geq 0, \quad c > 0 \tag{19}$$

Stationary Recursive Competitive Equilibrium

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

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

2. Markets clear:

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

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

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

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:

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

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:

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

Fiscal Experiment and Transition

The fiscal experiment in our analysis is a decrease in government spending (G) or increase in revenues (R), by increasing the labor tax τ_l, by 0.1% of GDP during 50 periods to pay off debt. After the 50 periods, either the government spending or the labor tax go back to the initial level and we assume the economy takes additional 50 periods to converge to the new steady state equilibrium, with lower debt to GDP ratio. Following the findings in section 3.2, we assume all shocks are unanticipated.

In the context of this experiment, we define a recursive competitive equilibrium along the transition between steady states.

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

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

2. Markets clear:

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

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

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

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:

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

5. The social security system balances:

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

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

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

7. Aggregate law of motion:

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

5 Calibration

Our benchmark model is calibrated to match moments of the German economy. For the other countries, calibration is performed using the same strategy. Certain parameters can be calibrated outside the model using direct empirical counterparts. We choose Germany as our benchmark, as it is the largest economy in the European Union and has the second highest income inequality in our sample, measured by the variance of log wages, just behind France.

Wages

To estimate the wage profile through the life cycle (see Equation 12), we use data from the Luxembourg Income and Wealth Study, and for each country, we run the following regression

$$\ln(w_i) = \ln(w) + \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3 + \varepsilon_i \tag{20}$$

with j being the age of individual i.

The parameter for the variance of ability, σ_a, is equal across countries and set to match the average of σ_a for the European countries in Brinca et al. (2016). Due to the lack of panel data on household income for European economies from which to estimate the persistence of idiosyncratic shock, ρ, we set it equal to the value used in Brinca et al. (2016), who use U.S. data of the Panel Study of Income Dynamics (PSID). The variance of the idiosyncratic risk process, σ_ϵ, is calibrated to match the variance of log wages in the data.

Preferences

The Frisch elasticity of labor supply, η, has created a considerable debate in the literature. Estimates range from 0.5 to 2 or higher. We decide to set it to 1.0, which is the same value as in Brinca et al. (2016). The other parameters φ, χ, β_1, β_2 and β_3, respectively the utility of leaving bequest, disutility of work and the discount factors, are calibrated to match key moments in the data on hours worked and the distribution of wealth.

Taxes and Social Security

As described before, we follow Benabou (2002) and use the same labor income tax function (Equation 15). Using the OECD data on the German labor income tax we estimate θ_0 and θ_1 for different family types. Then, to have a tax function for the single individual household in our model, we calculate the weighted average of both parameters using the weights of each family type on the overall population.[11]. For Germany we estimate θ_0 and θ_1 to be 0.881 and 0.221 respectively. Note that recent research (see McKay and Reis (2013) for example), stress the importance of taking into account transfers when approximating the progressivity of the labor tax schedule, which we do in our estimations. The social security rate on behalf of the employer is set to 0.206 and on behalf of the employee to 0.21, taking average tax rates between 2001 and 2007. Finally, consumption and capital tax rates are set to 0.233 and 0.155 respectively, following Trabandt and Uhlig (2011).

Parameters Calibrated Endogenously

To calibrate the parameters that do not have any direct empirical counterparts, φ, β_1, β_2, β_3, b, χ and σ_ϵ, we use the simulated method of moments so that we minimize the following loss function:

$$L(\varphi, \beta_1, \beta_2, \beta_3, b, \chi, \sigma_\epsilon) = ||M_m - M_d|| \tag{21}$$

with M_m and M_d being the moments in the data and in the model respectively.

Given that we have seven parameters, we need seven data moments to have an exactly identified system. The seven moments we target in the data are: the ratio of the average net asset position of households in the age cohort 75 to 80 year old relative to the average

[11] As we do not have detailed data for the weight of each family on the overall population for European countries, we use U.S. family shares, as in Holter et al. (2015). The same strategy is used to match the wealth of 75-80 cohorts relative to median wealth holdings.

asset holdings in the economy, the three wealth quartiles, the variance of log wages and the capital-to-output ratio. All targeted moments are calibrated to within less than 2% margin of error, as displayed in Table 3. Table 4 presents the calibrated parameters. Figure 15 presents the comparison of the distribution of agents with negative wealth by age decile in the model and in the data for the benchmark economy.

Table 3: Calibration Fit

Data Moment	Description	Source	Data Value	Model Value
75-80/all	Share of wealth owned by households aged 75-80	LWS	1.51	1.51
K/Y	Capital-output ratio	PWT	3.013	3.013
Var($\ln w$)	Variance of log wages	LIS	0.354	0.354
$\bar{n}$	Fraction of hours worked	OECD	0.189	0.189
Q_{25}, Q_{50}, Q_{75}	Wealth Quartiles	LWS	-0.004, 0.027, 0.179	-0.005, 0.026, 0.182

Table 4: Parameters Calibrated Endogenously

Parameter	Value	Description
Preferences		
φ	3.6	Bequest utility
$\beta_1, \beta_2, \beta_3$	0.952, 0.997, 0.952	Discount factors
χ	16.93	Disutility of work
Technology		
b	0.09	Borrowing limit
σ_ϵ	0.439	Variance of risk

6 Results

In the context of our consolidation experiment, the decrease in debt will shift resources to the productive side of the economy, driving the capital-labor ratio up, which will in turn increase the marginal product of labor, generating a permanent income shock and decreasing labor supply. This will generate a recession in the short run. However, given that productive capital increases progressively during the transition to the new steady state, the economy will converge to a higher level of output in the long-run.

In the model, there are three sources of wage inequality: age, income risk and the permanent ability endowment. We abstract from demographic differences across countries in terms of the relative sizes of each cohort. For a study on the effects of the age structure on fiscal multipliers for the U.S. states, see Basso and Rachedi (2017). There is an ongoing debate regarding whether income inequality is mainly due to differences across agents determined before the entry into the labor market or differences in the realization of income shocks during the life-course. Huggett et al. (2011) find that about 60% of the variance in lifetime earnings and wealth in the U.S. is due to initial conditions, a result that suggests that both dimensions are important to generate the observed heterogeneity in the data.

What we show in this section is that, in the context of our model, the link between inequality and fiscal consolidation arises from differences across countries in terms of idiosyncratic uninsurable risk and not from differences in predetermined conditions (ability). To understand this, note that the marginal propensity to work for credit constrained agents is less responsive to positive income shocks. So, an economy with high income inequality arising from idiosyncratic productivity risk, has a smaller percentage of constrained agents due to precautionary savings behavior and a higher aggregate elasticity of labor supply with respect to our fiscal experiment. Therefore, fiscal consolidation will be more recessive on impact in economies with high income inequality. The variance of ability will not affect the precautionary saving behavior of the agents, and changing the variance of ability will have no impact on the number of credit constrained agents.

To illustrate these differences, we first compare the effects of consolidation in Germany and in the Czech Republic. These two countries are on the opposite side of wage inequality scale in our sample, where Germany has the second highest variance of log wages at 0.354 and the Czech Republic has the lowest value at 0.174. These two countries differ along several other dimensions, however the reason we choose Germany and the Czech Republic is due to their differences in wage inequality, idiosyncratic risk and the percentage of constrained agents. In the Czech Republic, the variance of the idiosyncratic risk is 0.145 and the percentage of constrained agents is 8.34%, while Germany has a higher variance of risk - 0.44 - but a lower percentage of agents constrained - 3.41%. We find what our mechanism suggests, that the output multiplier following the shock is larger in Germany than in the Czech Republic.

As can be seen in figures 4 and 5 - labor tax and government spending consolidations respectively - both the labor supply and output multipliers are larger in the German economy, the one with largest wage inequality. The constrained agents cannot anticipate the government shock and fully insure against it, causing their labor supply to be more rigid to the shock. As Germany has a smaller share of constrained agents, the output drop is more pronounced.

Notice as well that the labor tax consolidation causes deeper recessions than the government spending consolidation. This is not surprising, given that agents will have less incentive to work during the consolidation, decreasing even more their labor supply, which produces larger output drops - a common finding in the literature (see for example Alesina et al. (2015a)).

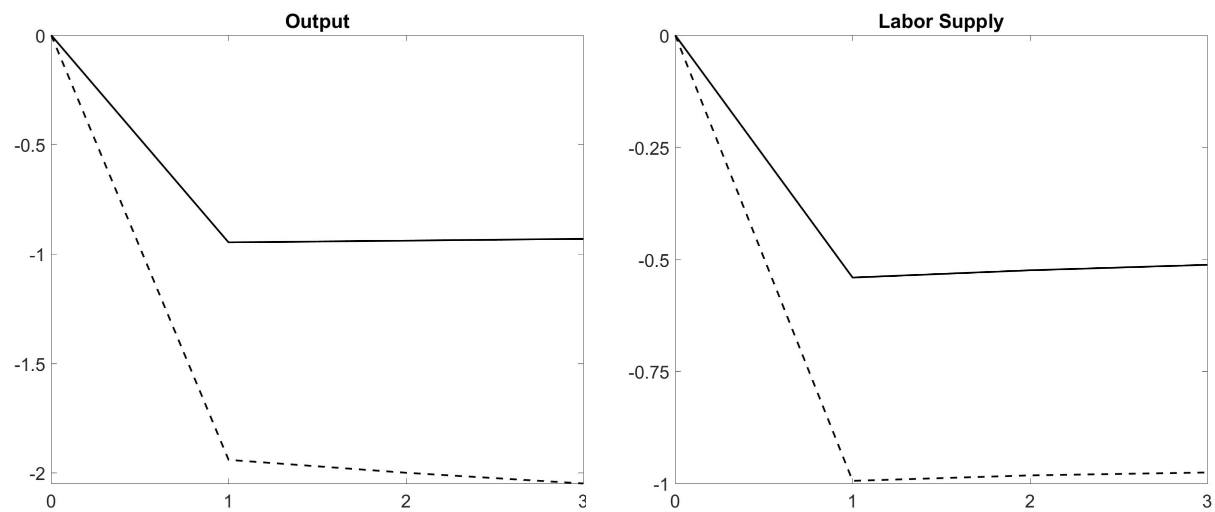

Figure 4: Labor tax consolidation: Output cumulative multiplier (left panel) and Labor Supply cumulative multiplier (right panel) in the first three periods in Germany (dashed line) and Czech Republic (solid line)

Next, we perform a series of experiments that aim to illustrate the mechanism described above.

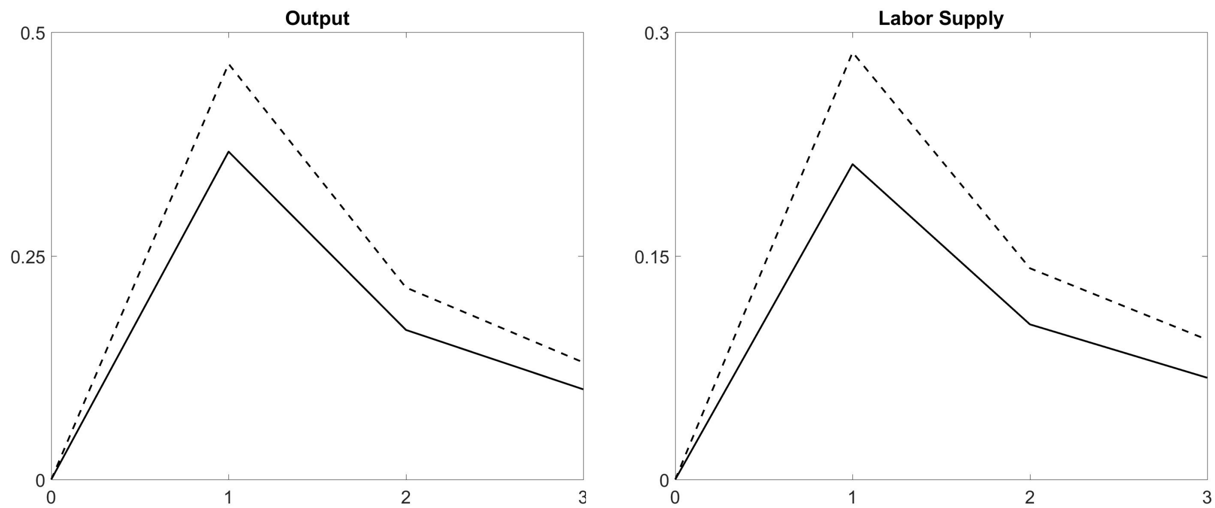

Figure 5: Government spending consolidation: Output cumulative multiplier (left panel) and Labor Supply cumulative multiplier (right panel) in the first three periods in Germany (dashed line) and Czech Republic (solid line)

Variance of ability vs variance of risk

We focus on the two parameters that drive wage inequality in our model to further understand the role that both play in explaining the correlation between income inequality and fiscal multipliers during the consolidation experiment. We show that the correlation between wage inequality and fiscal multipliers captured in the empirical section can only be explained by differences in idiosyncratic risk and not by pre-determined differences in the age profile of wages.

To validate our mechanism we run two different experiments:

- Change the $Var(\ln w)$ in the benchmark model calibrated to Germany, by changing the variance of ability, σ_a;
- Change the $Var(\ln w)$ in the benchmark model by changing the variance of the stochastic income process, σ_ϵ;

We perform these two experiments for both the government spending and the labor tax based consolidations. In both cases we adjust γ_0 by a constant to guarantee that average productivity in the economy stays unchanged.

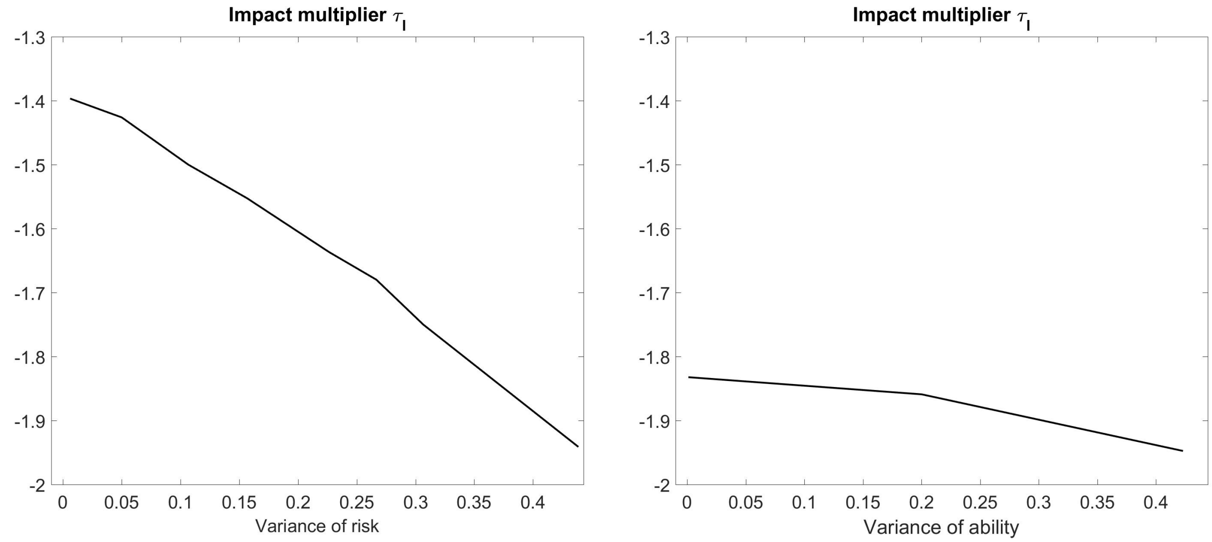

Figure 6: Impact multiplier for the labor tax consolidation in the benchmark model for Germany when changing the variance of risk (left panel) and variance of ability (right panel).

In Figure 6 we can observe the changes induced in the labor tax consolidation multiplier from changes in the variance of ability and risk. In the left panel we show that the fiscal multiplier is very sensitive to changes in income risk, while relatively inelastic w.r.t. changes in ability (right panel). More importantly, there is a positive relationship between income risk and the absolute value of the tax-based consolidation fiscal multiplier, as suggested in our empirical exercise.

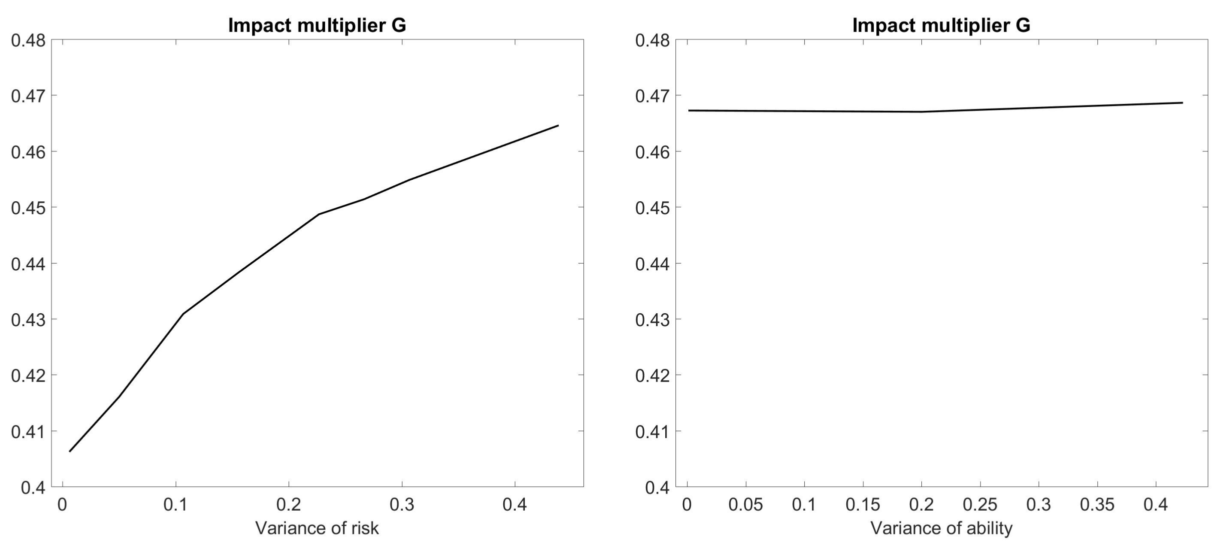

Figure 7: Impact multiplier for the government spending consolidation in the benchmark model for Germany when changing the variance of risk (left panel) and variance of ability (right panel).

The government spending consolidation experiment generates similar results. As can be seen in Figure 7, the changes induced in the multiplier from differences in the variance of risk (left panel) are much larger than the changes induced by changing the variance of ability (right panel). At the same time, only through changes in income risk can we generate a positive relationship between spending-based fiscal consolidation and income inequality.

The analysis of figures 6 and 7 covers changes in risk that go from the highest value in our calibration set of models to zero. In our exercise, the lowest value of the variance of risk we obtain is for Greece at 0.12 and the highest is France at 0.5. Note that the amplitude of change in terms of the multiplier is larger for tax-based than spending-based consolidation. Going from the lowest to the highest level of risk, implies an increase of 30% and 8% respectively, in impact multipliers. The effect for spending-based consolidation is smaller, but it is worth noting that the actual consolidations studied in Section 3.1 include both changes in taxes and spending.

As argued before, the relationship between income risk and the fiscal consolidation multipliers stems from economies with higher income risk having a smaller share of credit constrained agents. In Figure 8 we document a negative strong relationship between the variance of risk and the proportion of credit constrained agents in the economy (left panel). Changing the variance of ability does not affect the share of agents with liquidity constraints, as we anticipated (right panel).

In Figure 9 we show the relationship between the share of agents with liquidity constraints and the impact multiplier, for both spending-based and tax-based fiscal consolidation, stemming from changes in income risk. As it can be observed, there is a strong negative relationship between the share of credit constrained agents and the fiscal consolidation multipliers, in absolute value.

Figure 10 shows household labour supply response by asset position to both tax- and spending-based policies. Labour response drops more dramatically for households with relatively more assets. Labour supply response is also more dramatic for the tax increase, due

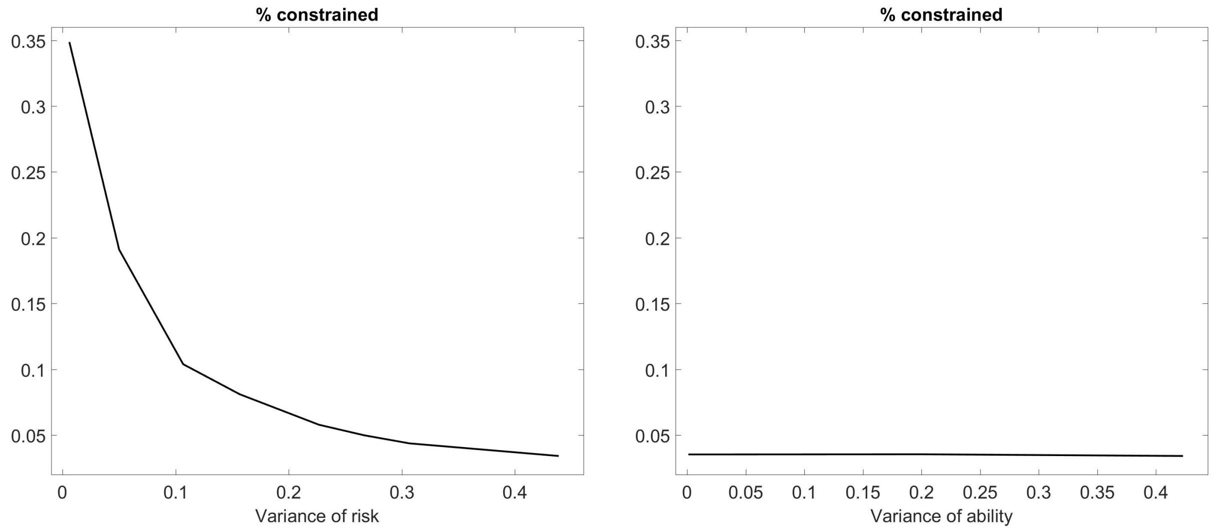

Figure 8: Percentage of agents constrained in the benchmark model for Germany when changing the variance of risk (left panel) and variance of ability (right panel).

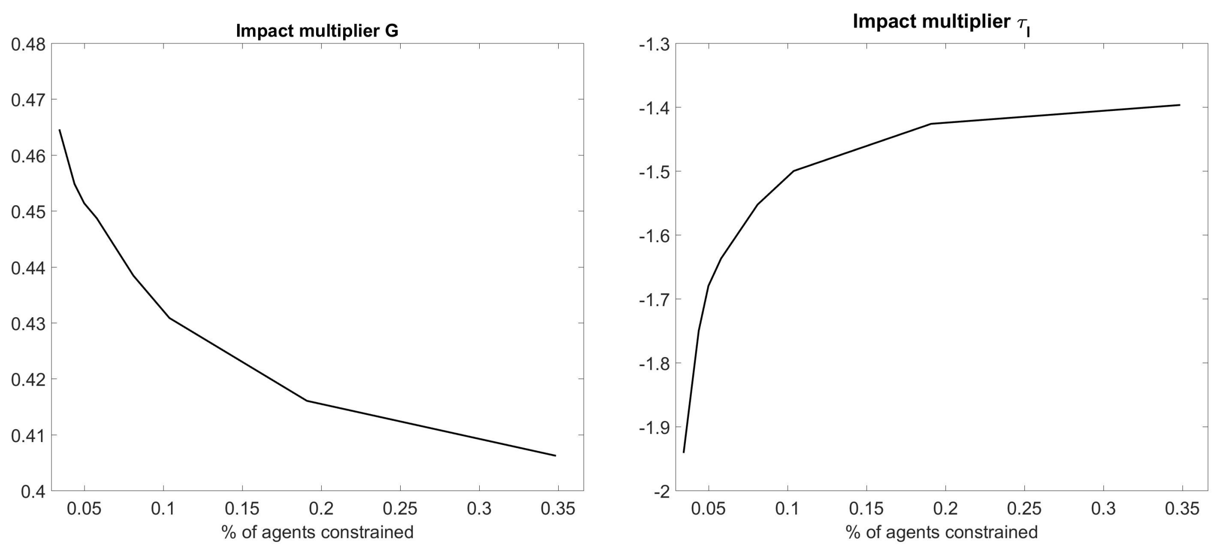

Figure 9: Impact multiplier of the G consolidation (left panel) and of the τ_l consolidation (right panel) and the percentage of agents constrained in the benchmark model for Germany when decreasing the variance of risk.

to the additional distortion on incentive to work.

7 Cross country analysis

In the previous section we show that our model is capable of reproducing the empirical relationship between income inequality and fiscal multipliers. In this section we show that

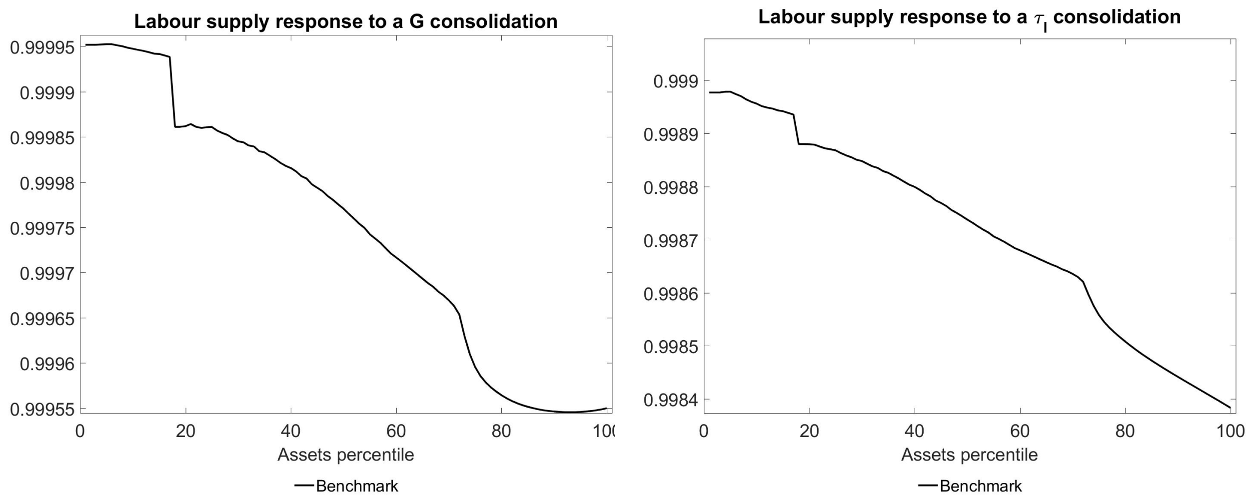

Figure 10: Labour supply response by household asset position for G consolidation (left panel) and τ_l consolidation (right panel).

this mechanism is strong enough such that, when calibrating our model to the different countries in the sample and allow differences along the steepness of income profiles, tax structures, etc., we also reproduce the cross-country relationship between both tax and spending-based fiscal consolidation and income inequality.

We calibrate the model to 13 European countries[12] keeping the variance of the permanent ability fixed and changing the variance of the idiosyncratic shock to match the variance of log wages in the data. Tables 10 and 15 summarize the wealth distribution, the country-specific data that we use to calibrate the model, as well as country specific parameters estimated outside of the model. Table 16 summarizes the country specific parameters estimated through the simulated method of moments, as described in Section 5. Parameters kept constant for all the countries are summarized in Table 17.

In Figure 11 we show that our model is able to reproduce the cross-country empirical relationship between income inequality and the impacts of fiscal consolidation: countries with higher inequality experience larger output drops on impact, for tax- and spending-

[12]For this exercise we used only countries which actually went through fiscal consolidation processes after 2009. In comparison to Blanchard and Leigh (2013), we also exclude Belgium, Cyprus, Denmark, Ireland, Malta, Norway, Poland, Romania and Slovenia due to data limitations. Results in section 3.1 are robust to considering only these 13 countries. See Table 12 in Appendix.

based consolidation. These effects are large and economically meaningful. The spending-based multiplier increases about 30% between the country with the lowest income inequality (Czech Republic) and the highest (France). For tax-based consolidation, the difference is even higher: the multiplier increases by 60% in absolute value.

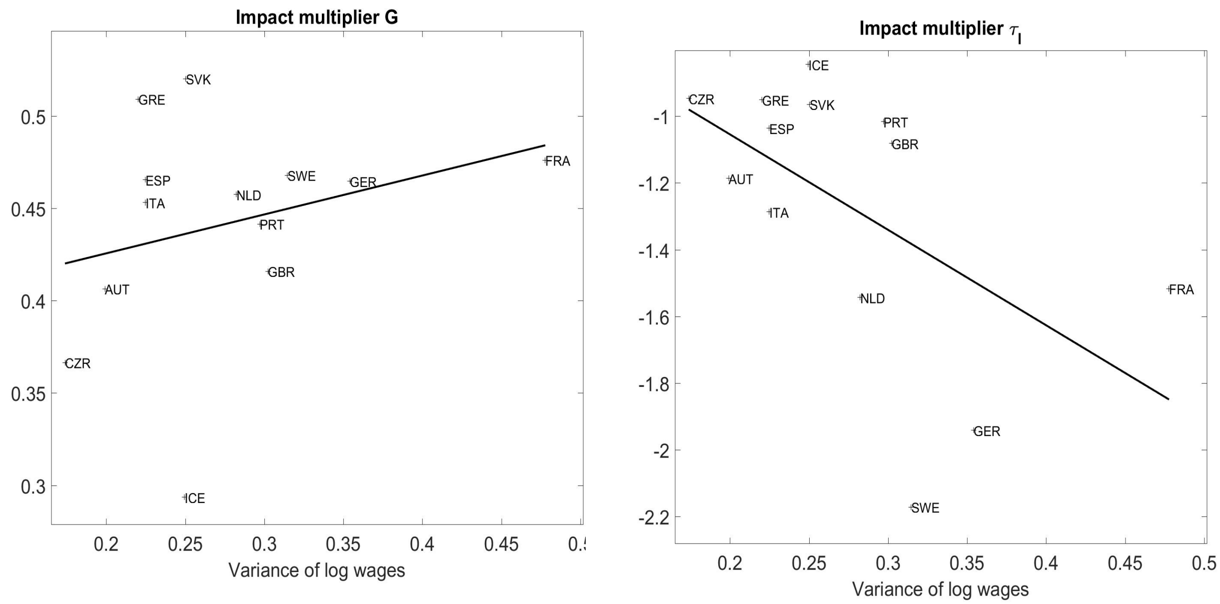

Figure 11: Impact multiplier and Var(ln(w)). On the left panel we have the cross-country data for a consolidation done by decreasing G (correlation coefficient 0.35 , p-val 0.25), while on the right panel we have the cross-country data for a consolidation done by increasing the labor tax (correlation coefficient -0.60 , p-val 0.03).

In the previous section we argued that the mechanism through which higher income risk translates into larger multipliers was through changes in the share of credit-constrained agents. In Figure 12 this relation is documented for the 13 economies for which we calibrate the model: confirming that countries with higher variance of the income risk have a smaller share of agents constrained.

As argued before, labor supply of constrained agents is less elastic with regards to the fiscal shock and, the larger is the percentage of agents constrained, the smaller is the multiplier. In Figure 13 this relationship is documented for the cross-country analysis, with countries with a larger share of agents with liquidity constraints experiencing a smaller output drop for both spending and tax based consolidation. Moreover, note that tax-based consolidations produce deeper recessions across countries. This is not surprising, given the distortionary

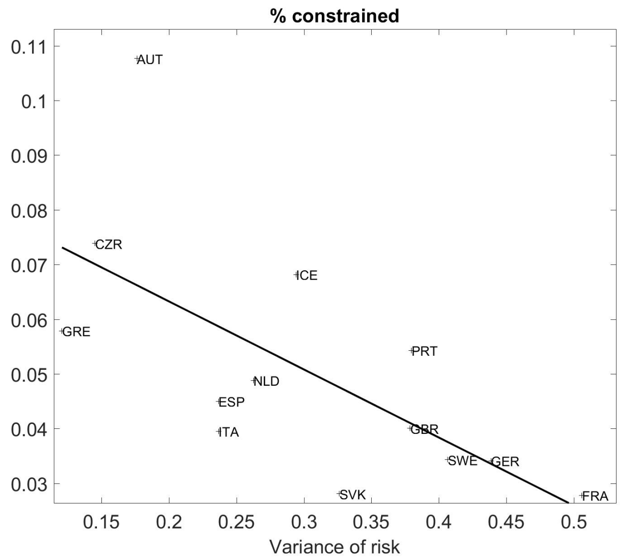

Figure 12: Percentage of agents constrained in the y-axis and variance of idiosyncratic risk on the x axis. Correlation coefficient of -0.73 and p-value of 0.00

effects of the labor tax, generating larger drops in labor supply.

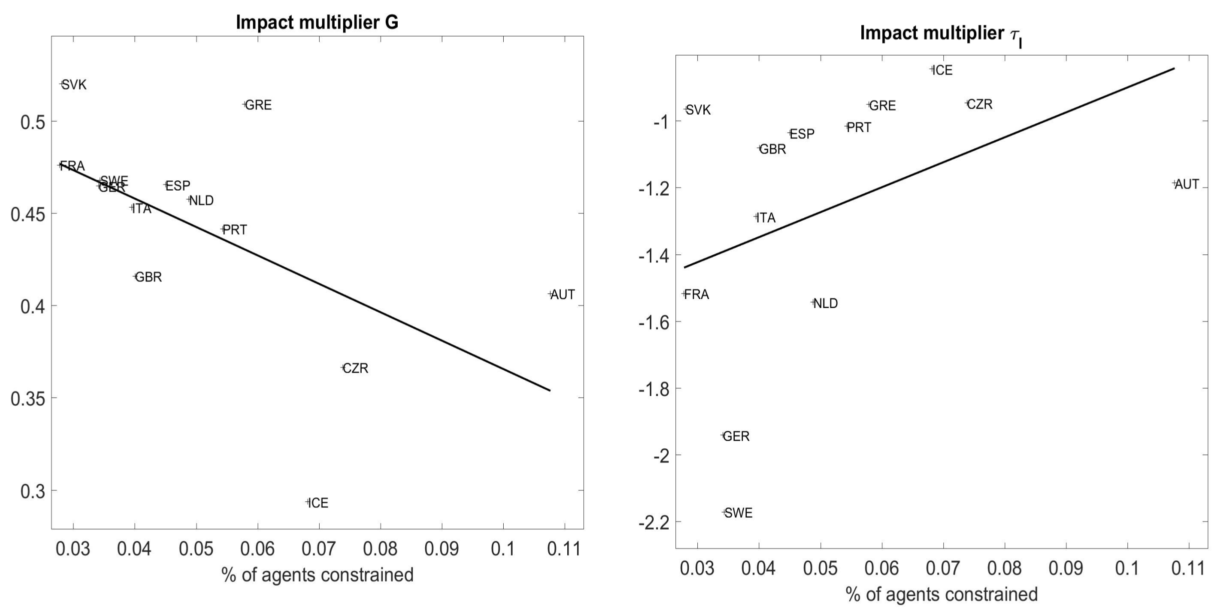

Figure 13: Impact multiplier and percentage of agents constrained. On the left panel we have the cross-country data for a consolidation done by decreasing G (correlation coefficient -0.68 , p-val 0.01), while on the right panel we have the cross-country data for a consolidation done by increasing the labor tax (correlation coefficient 0.55 , p-val 0.06)

8 Validating the mechanism

In section 3 we establish that income inequality amplifies the recessive effects of fiscal consolidations. In Section 6 we unfold the mechanism that leads to this amplification effect: labor supply is more responsive in countries with higher income inequality arising from differences in income risk, leading to larger output drops.

In this section we present two pieces of evidence that validate our mechanism. First, we use the fact that household debt is increasing in the share of constrained agents in our benchmark economy. So, if our mechanism is correct, countries with higher household debt have more constrained agents and the output drop will be smaller. We expand Blanchard and Leigh (2014) regression with an interaction term between household debt and consolidation and we find exactly this: household debt diminishes the recessive effects of fiscal consolidation and the larger the household debt the smaller the forecast error. Then, to test how the link between fiscal consolidation and income inequality affects the labor supply response, we use the Alesina et al. (2015a) dataset but instead of considering GDP growth rates as our dependent variable we use annual hours worked per capita. We find that, for countries with larger income inequality, hours worked are more responsive to a fiscal consolidation, just as our mechanism suggests.

8.1 Household debt

Blanchard and Leigh (2014) test if pre-crisis household debt was one of the dimensions the IMF did not properly account for into consideration when forecasting the GDP growth rates. As with all the other variables they test, they find no explanatory power on the forecast error. However, our mechanism suggests that it should have affected the recessive impacts of fiscal consolidation. Decreasing risk induces less precautionary savings, which results in larger household debt and, consequently, in a higher share of constrained agents, as can be seen in Figure 14. Higher initial household debt should translate into smaller multipliers.

To test whether household debt helps to explain the impacts of fiscal consolidation, in

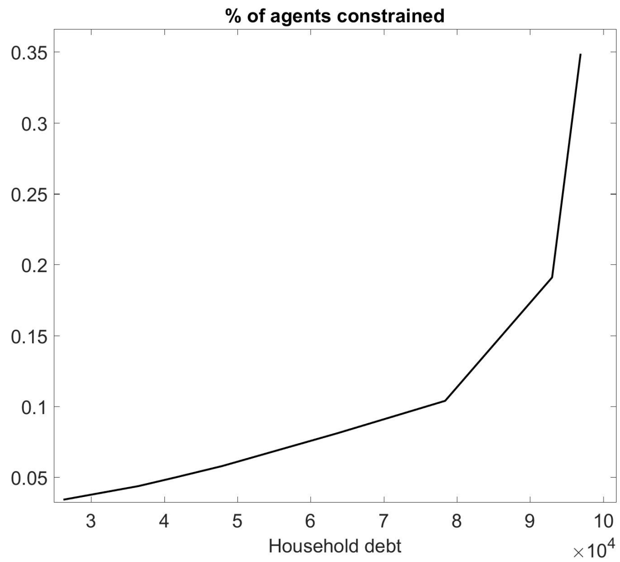

Figure 14: Percentage of agents constrained in the x-axis and household debt in the y-axis, when changing the variance of idiosyncratic risk in the benchmark economy Germany.

addition to extending Equation 1 with pre-crisis household debt, as Blanchard and Leigh (2014) do, we also consider an interaction term between planned fiscal consolidation and pre-crisis household debt. The equation that we estimate is

$$\Delta Y_{i,t:t+1} - \hat{E}\{\Delta Y_{i,t:t+1}|\Omega_t\} = \alpha + \beta \hat{E}\{F_{i,t:t+1|t}|\Omega_t\} + \gamma HD_{i,t-1} + \iota((\hat{E}\{F_{i,t:t+1|t}|\Omega_t\})(HD_{i,t-1} - \mu_{HD})) + \epsilon_{i,t:t+1} \quad (22)$$

with $HD_{i,t-1}$ being the pre-crisis household debt in country i. We use pre-crisis household debt so that it is exogenous to the fiscal shocks and to the output variation. Once again, we reparametrize the interaction term.

Results in Table 5 are in accordance with our mechanism, as the interaction term is positive and statistically significant. Moreover, the R^2 is substantially higher than in the specification without the interaction, and the coefficient associated with the planned consolidation is more negative and statistically different from the specification without the interaction. This suggests that, during the consolidations in the European countries in 2010 and 2011, higher pre-crisis household debt contributed to diminishing the recessive effects of fiscal consolidation, just as our mechanism suggests. Increasing pre-crisis household debt by one standard deviation decreases the recessive impacts of fiscal consolidation by 52%.[13]

VARIABLES	(1) Blanchard-Leigh	(2) Blanchard-Leigh Pre-crisis household debt	(3) Pre-crisis household debt
Consolidation	-1.095***	-1.086***	-1.389***
	(0.255)	(0.262)	(0.117)
Household Debt		-0.001	-0.004
		(0.006)	(0.003)
Interaction			0.010***
			(0.001)
Constant	0.775*	0.887	1.422***
	(0.383)	(0.699)	(0.420)
Observations	26	25	25
R-squared	0.496	0.489	0.690

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

Table 5: GDP forecast errors and pre-crisis household debt and interaction without pre-crisis household debt mean.

8.2 Labor supply response

In the previous section we provide empirical evidence that the recessive impact of fiscal consolidation is decreasing in the percentage of constrained agents, just as our mechanism implies. The remaining aspect of our mechanism requiring validation is how the labor supply response depends on income inequality. Remember that in our model, countries with larger income inequality have a more elastic labor supply and so the multiplier is larger.

To see how hours worked depends on income inequality in the data, we use the Alesina et al. (2015a) dataset augmented with hours worked per employee, total employment and population from OECD Economic Outlook, from 2007 until 2012.[14] We estimate the following equation

$$H_{i,t} = \alpha + \beta_1 e^u_{i,t} + \beta_2 e^a_{i,t} + \gamma I_{i,t-1} + \iota_1 e^u_{i,t}(I_{i,t-1} - \mu_I) + \iota_2 e^a_{i,t}(I_{i,t-1} - \mu_I) + \delta_i + \omega_t + \epsilon_{i,t} \quad (23)$$

where $H_{i,t}$ is hours worked in country i in year t. The right hand side of the equation is the same as in Equation 3.

[13] As in Section 3.1, we perform the experiment for a specification with just output, and find the result is analogous (see table 14 in Appendix).

[14] Hours worked is normalized as the fraction of hours worked per day, per capita.

Results are presented in Table 6 and establish that labor supply is more responsive to fiscal consolidations in countries with higher inequality, just as our mechanism suggests. Notice that, as the results in Section 3.2, it is the interaction with the unanticipated fiscal consolidations that is statistically significant. So, for a country with income inequality 1 percentage point above the sample mean, the drop in hours worked is larger by the amount, ι_1. Increasing the share of income in the top 10% over the share in the bottom 10% by one standard deviation causes hours worked to drop by more 124% for a country with an average-sized consolidation.

VARIABLES	(1) Benchmark	(2) inequality 4/1	(3) inequality 5/1	(4) inequality 10/1	(5) inequality 95/1	(6) inequality 100/2	(7) inequality gini
β_1	-0.004***	-0.003**	-0.003*	-0.003**	-0.003***	-0.007***	-0.004**
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
β_2	-0.004***	-0.001	-0.002	-0.006***	-0.006***	-0.004**	0.000
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)
γ		0.319	0.191	0.100	0.026	0.023**	0.068
		(0.232)	(0.167)	(0.068)	(0.027)	(0.010)	(0.093)
ι_1		-0.116	-0.155	-0.134***	-0.045***	-0.014**	-0.029
		(0.123)	(0.103)	(0.045)	(0.015)	(0.006)	(0.040)
ι_2		-0.266	-0.161	0.091	0.044**	0.005	-0.114
		(0.206)	(0.171)	(0.070)	(0.020)	(0.006)	(0.068)
Constant	0.211***	0.188***	0.194***	0.196***	0.204***	0.204***	0.184***
	(0.001)	(0.016)	(0.014)	(0.010)	(0.007)	(0.003)	(0.036)
Observations	55	55	55	55	55	55	55
R-squared	0.502	0.582	0.577	0.601	0.618	0.563	0.567
Number of countries	11	11	11	11	11	11	11

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Annual hours worker per capita, unanticipated and announced fiscal consolidation shocks, income inequality and interaction without the means

9 Replication of the empirical exercise

We present evidence in Section 3.1 that income inequality was a relevant dimension that the IMF failed to take into account when anticipating the impacts of fiscal consolidation in Europe, namely cross-country differences in uninsurable labor income risk. In Section 4 we present a model that could explain the relationship between income inequality, uninsurable labor income risk and the impacts of fiscal consolidation we also documented in Section 3.2.

Now we shut down the uninsurable labor income risk component of the income process in our simulations and then perform the exact some exercise as in Blanchard and Leigh (2013). That is, we regress the difference between the change in simulated output with and without uninsurable labor income risk on the same set of variables plus the same inequality metrics and interaction terms.

For each of the 13 economies considered here, we calibrate the consolidation accordingly, matching them with data used in Section 3.1. The data is reported in Table 15 in the Appendix.

Results of estimating Equation 2 for spending- and tax-based consolidation, using data from model simulations, are presented in Tables 7 and 8 respectively.[15]

The pattern of correlations and statistical significance of the terms are remarkably similar to Blanchard and Leigh (2013): the consolidation variables are negative and statistically significant, meaning that the model underestimates the impact of fiscal consolidation; including income inequality metrics significantly improves the fit of the regressions; and the interaction between income inequality metrics and the consolidation variables are negative and statistically significant, showing that higher income inequality leads to a larger forecast error.

VARIABLES	(1) Blanchard-Leigh	(2) inequality 4/1	(3) inequality 5/1	(4) inequality 10/1	(5) inequality 95/1	(6) inequality 100/2	(7) inequality gini
G consolidation	-0.610***	-0.634***	-0.654***	-0.747***	-0.879***	-0.844***	-0.623***
	(0.154)	(0.097)	(0.095)	(0.099)	(0.113)	(0.129)	(0.123)
Inequality		-0.064	-0.028	0.010	0.021	0.013	-0.097
		(0.155)	(0.110)	(0.049)	(0.027)	(0.019)	(0.081)
Interaction		-0.073	-0.072*	-0.068***	-0.063***	-0.040***	0.002
		(0.053)	(0.038)	(0.019)	(0.017)	(0.011)	(0.027)
Constant	-0.652*	-0.321	-0.447	-0.640	-0.772	-0.723	2.283
	(0.348)	(0.803)	(0.744)	(0.647)	(0.613)	(0.576)	(2.208)
Observations	13	13	13	13	13	13	13
R-squared	0.370	0.444	0.444	0.450	0.456	0.442	0.510

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

Table 7: GDP forecast errors for the G consolidation and total income inequality

[15] Both spending- and tax-based consolidations are presented in absolute values, so an increase in both variables translates into a stronger consolidation.

Just as in the empirical exercise, the implications of abstracting from inequality are economically meaningful. A one standard deviation increase in income inequality leads to an underestimation of the multiplier by 35% and 52%, for spending- and tax-based consolidation respectively.

VARIABLES	(1) Blanchard-Leigh	(2) inequality 4/1	(3) inequality 5/1	(4) inequality 10/1	(5) inequality 95/1	(6) inequality 100/2	(7) inequality gini
τ_l consolidation	-2.578	-2.321***	-2.662***	-4.134***	-5.987***	-5.603***	-2.475***
	(2.143)	(0.656)	(0.657)	(0.691)	(0.825)	(1.134)	(0.656)
Inequality		-2.144***	-1.500***	-0.549**	-0.189	-0.143	-0.880***
		(0.524)	(0.377)	(0.187)	(0.117)	(0.089)	(0.187)
Interaction		-0.006	-0.219	-0.563***	-0.635***	-0.407***	0.148
		(0.341)	(0.243)	(0.117)	(0.099)	(0.092)	(0.117)
Constant	-4.263**	5.694*	4.208	1.389	-0.422	-0.554	22.246***
	(1.508)	(2.621)	(2.443)	(2.173)	(2.065)	(1.989)	(5.478)
Observations	13	13	13	13	13	13	13
R-squared	0.129	0.657	0.649	0.646	0.634	0.599	0.784

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

Table 8: GDP forecast errors for the τ_l consolidation and total income inequality

10 Conclusion

In this paper we provide empirical evidence that income inequality is an important factor for studying the impacts of fiscal consolidation and that it was a relevant dimension that the IMF did not properly account for, leading to large and unanticipated recessive impacts of fiscal consolidation efforts in European economies, in the aftermath of the Great Recession. Equally, we provide evidence that the link between income inequality and fiscal consolidation is not exclusive to the period of the crisis. We also show that for countries with high income inequality, the recessive impacts of reducing government expenditures are larger than if compared to countries with low income inequality.

To explain this finding, we develop a life-cycle, overlapping generations economy with uninsurable labor income risk. The relationship between income inequality and the impacts of consolidation arises because, in countries with higher income inequality due to higher income risk, agents will have higher savings due to precautionary motives and thus there will be a smaller share of credit constrained agents. A decrease in government debt raises the amount of productive capital in the economy and the marginal product of labor and leads to a permanent positive income shock causing labor supply to fall. Since credit constrained agents have a less elastic response to the shock, output will fall more in countries with a smaller share of these agents. For consolidations financed by an increase in the labor tax schedule, the fall in output is amplified by the disincentive to work. We illustrate this mechanism for a benchmark model calibrated to Germany and show that differences in uninsurable labor income risk generate large differences in fiscal multipliers, providing a rationale for the observed empirical relationship between income inequality and the impacts of fiscal consolidation programs.

Countries differ along many more dimensions than just income inequality. To assess the robustness of the relationship between income inequality with regard to other factors, we calibrate our model to match several moments from 13 European economies and find that, even in the presence of such heterogeneity, our simulations show a clear relationship between income inequality and fiscal consolidation multipliers, arising from the relationship between income risk and the share of credit constrained agents.

The mechanism in our model exercises have two implications that we validate empirically. First, the level of household debt is positively correlated with the share of constrained agents in our model exercises and, consequently, our model predicts that countries with higher household debt experienced a smaller output drop during a fiscal consolidation. Second, the fall in hours worked is steeper in countries with high income inequality.

Finally, in the context of our model, we show that omitting income risk creates a pattern in our consolidation forecast errors that produces a similar pattern (in both coefficients and significance) to the Blanchard and Leigh (2013) exercise.

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11 Appendix

11.1 Tax Function

The tax function is given by

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

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

$$1 - \frac{1 - \tau(y_2)}{1 - \tau(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1} \tag{24}$$

and so it is independent of the scaling parameter θ_0. So, by construction, by lowering θ_0 one can raise average taxes withou changing the progressivity of the tax code, since (as long as tax progressivity is defined by the tax wedges) the parameter θ_1 uniquely determines the progressivity of the tax code.[16]

11.2 Data description

The data series used in section 3.1 for the inequality measures are from the European Union Statistics on Income and Living Conditions (EU-SILC). The EU-SILC is a survey aiming at collecting cross-sectional and longitudinal microdata on income, poverty, social exclusion and living-conditions. Data collected is based on a nationally representative probability sample of the population residing in private households within the country. Cross-sectional data series used is gross income - total monetary and non-monetary income received by the household before deduction of taxes.

The growth forecast error and planned fiscal consolidation series are taken from Blanchard and Leigh (2014), who use data from the IMF's WEO database. The forecasts used were made for the European Economies in early 2010. The growth forecast error consist on the difference between actual cumulative growth in 2010-11 and the IMF forecast prepared for the April 2010 WEO. The planned fiscal consolidation is the IMF forecast of the cumulative changes of structural fiscal balance as percent of potential GDP, also prepared for the April 2010 WEO. Household debt variable used in section 6 also comes from Blanchard and Leigh (2014), who take it from the dataset of the April 2012 WEO chapter on household debt. Household debt consists on total financial liabilities in percent of household disposable income.

The data series used in section 3.3 are taken from Ilzetzki et al. (2013). The data series consist of quarterly observations (not interpolated) on real government consumption, GDP, the ratio of current account to GDP, and the real effective exchange rate for 44 countries, roughly balanced between developed and developing economies (see table 9 for the list of

[16] Note that

$$1 - \tau(y) = \frac{1 - T'(y)}{1 - \theta_1} > 1 - T'(y)$$

and so, as long as $\theta_1 \in (0, 1)$ we have

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

and consequently, for all income levels, average tax rates are lower than marginal tax rates.

included countries). Nominal series are deflated using a GDP deflator when available (and CPI when not). Consumption, GDP, and exchange rate variables are transformed by taking natural logarithms. These series are de-seasonalized and analyzed as deviations from their quadratic trend given they exhibit strong seasonality and are non-stationary. The income inequality measures reported in Table 9 are from the World Bank's World Development Indicators dataset. The wealth inequality measures are from Credit Suisse Global Wealth Databook.

Table 9: Wealth and Income Ginis for 44 Selected Countries

Country	Wealth Gini	Income Gini	Income share top20/bottom20	Income share top10/bottom10
Argentina	0.740	0.458	9.833	19.125
Australia	0.622	0.303	5.944	10.192
Belgium	0.662	0.280	4.233	6.667
Botswana	0.751	0.630	23.124	45.091
Brazil	0.784	0.508	17.394	41.800
Bulgaria	0.652	0.453	6.887	13.700
Canada	0.688	0.321	5.775	9.519
Chile	0.777	0.521	12.326	24.412
Colombia	0.765	0.585	17.059	38.091
Croatia	0.654	0.320	5.725	9.560
Czech Republic	0.626	0.310	3.760	5.692
Denmark	0.808	0.248	4.447	8.393
Ecuador	0.760	0.477	11.457	22.813
El Salvador	0.746	0.469	9.055	16.381
Estonia	0.675	0.313	5.667	10.120
Finland	0.615	0.268	3.904	5.718
France	0.730	0.327	5.282	8.645
Germany	0.667	0.270	4.595	6.971
Greece	0.654	0.330	7.554	15.706
Hungary	0.651	0.247	4.949	7.967
Iceland	0.664	0.280	3.957	5.973
Ireland	0.581	0.339	5.273	8.258
Israel	0.677	0.392	10.304	18.412
Italy	0.609	0.319	6.726	13.842
Latvia	0.670	0.352	6.730	12.091
Lithuania	0.666	0.355	6.462	11.652
Malaysia	0.733	0.462	11.174	19.222
Mexico	0.749	0.517	11.041	20.474
Netherlands	0.650	0.309	4.169	6.647
Norway	0.633	0.250	3.796	5.806
Peru	0.738	0.460	11.295	22.267
Poland	0.657	0.341	5.152	7.758
Portugal	0.667	0.385	6.646	12.636
Romania	0.651	0.332	4.090	6.000
Slovakia	0.629	0.260	4.058	6.613
Slovenia	0.626	0.238	3.745	5.703
South Africa	0.763	0.650	27.560	57.000
Spain	0.570	0.320	7.207	15.235
Sweden	0.742	0.230	4.161	6.719
Thailand	0.710	0.536	6.536	10.069
Turkey	0.718	0.402	8.034	13.909
United Kingdom	0.697	0.400	5.347	8.517
United States	0.801	0.450	9.098	17.765
Uruguay	0.708	0.453	9.314	16.316
Sample mean	0.689	0.379	7.976	14.896

11.3 *Eurosystem Household Finance and Consumption Survey - Summary Wealth Statistics*

Table 10 presents the cumulative wealth distributions for the countries in the Eurosystem Household Finance and Consumption Survey. We include four additional countries' wealth distributions, from the Luxembourg Wealth Study's compilation of various household wealth surveys.

Table 10: 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
Czech Republic	-0.2	0.1	0.9	2.9	6.1	10.5	17.4	26.5	39.9	0.691
France	-0.2	-0.1	0.4	1.8	5.4	11.6	20.4	32.3	49.7	0.657
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[b]										
Iceland	-0.2	0.2	1.2	3.7	7.7	13.2	22.0	33.1	48.0	0.642
Slovakia	0.4	3.3	7.9	13.7	20.7	29.0	39.0	51.3	67.3	0.435
Sweden	-8.3	-9.8	-10.0	-9.7	-7.8	-3.2	5.2	19.0	41.7	0.865
UK	-0.8	-0.8	-0.5	1.2	5.4	11.7	21.0	34.0	54.3	0.649

[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*).

VARIABLES	Blanchard-Leigh	inequality 4/1	inequality 5/1	inequality 10/1	inequality 95/1	inequality 100/2	inequality gini
β	-1.556***	-1.116**	-1.078**	-0.901**	-0.901**	-1.026***	-1.696***
	(0.467)	(0.441)	(0.436)	(0.379)	(0.339)	(0.339)	(0.406)
γ		-0.402	-0.302	-0.170	-0.039	0.019	0.286
		(0.578)	(0.444)	(0.191)	(0.053)	(0.050)	(0.169)
ι		-0.405	-0.365	-0.229*	-0.116***	-0.098**	-0.000
		(0.388)	(0.304)	(0.113)	(0.036)	(0.035)	(0.115)
Constant	3.763***	6.545*	6.335*	6.264**	4.938***	3.612***	-6.990
	(0.576)	(3.760)	(3.493)	(2.578)	(1.302)	(1.057)	(6.402)
Observations	26	26	26	26	26	26	26
R-squared	0.465	0.533	0.544	0.607	0.634	0.587	0.542

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

Table 11: GDP growth, income inequality and interaction without the inequality sample mean

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Blanchard-Leigh	inequality 4/1	inequality 5/1	inequality 10/1	inequality 95/1	inequality 100/2	inequality gini
β	-1.430***	-1.161***	-1.170***	-1.204***	-1.286***	-1.259***	-1.378***
	(0.182)	(0.131)	(0.134)	(0.172)	(0.164)	(0.176)	(0.204)
γ		-0.490	-0.303	-0.033	0.031	0.048	0.365**
		(0.750)	(0.534)	(0.165)	(0.034)	(0.046)	(0.120)
ι		-0.122	-0.119	-0.073	-0.039*	-0.040**	-0.053
		(0.187)	(0.134)	(0.047)	(0.017)	(0.017)	(0.063)
Constant	1.207*	4.304	3.553	1.712	0.616	0.228	-12.831**
	(0.567)	(5.167)	(4.552)	(2.709)	(1.233)	(0.840)	(4.458)
Observations	13	13	13	13	13	13	13
R-squared	0.715	0.755	0.750	0.736	0.736	0.748	0.919

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

Table 12: GDP forecast errors, total income inequality and interaction without the inequality sample mean for the 13 countries for which we calibrate the model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Blanchard-Leigh	inequality 4/1	inequality 5/1	inequality 10/1	inequality 95/1	inequality 100/2	inequality gini
β	-0.526	0.152	0.132	0.198	0.118	0.144	-0.626*
	(0.559)	(0.331)	(0.337)	(0.350)	(0.320)	(0.305)	(0.353)
γ		0.323	0.210	-0.033	-0.010	-0.016	-0.120
		(0.385)	(0.295)	(0.129)	(0.062)	(0.037)	(0.143)
ι		-1.103***	-0.844***	-0.325***	-0.127***	-0.112***	0.215**
		(0.234)	(0.183)	(0.071)	(0.026)	(0.021)	(0.100)
Constant	0.690	-1.503	-1.014	1.023	0.815	0.836	5.455
	(0.492)	(2.561)	(2.413)	(1.890)	(1.430)	(0.896)	(5.406)
Observations	26	26	26	26	26	26	26
R-squared	0.078	0.606	0.606	0.594	0.525	0.505	0.245

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

Table 13: GDP forecast errors, unanticipated shocks, total income inequality and interaction without the inequality sample mean.

	(1)	(2)	(3)
VARIABLES	Blanchard-Leigh	Blanchard-Leigh Pre-crisis household debt	Pre-crisis household debt
x	-1.556***	-1.680***	-1.952***
	(0.467)	(0.491)	(0.430)
z		-0.014**	-0.016***
		(0.006)	(0.006)
inter			0.009**
			(0.004)
Constant	3.763***	5.578***	6.058***
	(0.576)	(0.981)	(1.013)
Observations	26	25	25
R-squared	0.465	0.527	0.599

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

Table 14: GDP growth and pre-crisis household debt and interaction without pre-crisis household debt mean.

Table 15: Country-specific calibration targets

	Macro ratios		Labor targets			Taxes			
	K/Y	B/Y	$\bar{n}$	Var($\ln w$)	$\gamma_1, \gamma_2, \gamma_3$	θ_1, θ_2	$\tilde{\tau}_{ss}, \tau_{ss}$	τ_c	τ_k
Austria	3.359	0.432	0.226	0.199	0.155, -0.004, 3.0E-05	0.939, 0.187	0.217, 0.181	0.196	0.240
Czech Republic	6.203	0.206	0.236	0.174	0.174, -0.004, 3.0E-05	0.988, 0.143	0.350, 0.125	0.182	0.220
France	3.392	0.559	0.184	0.478	0.384, -0.008, 6.0E-05	0.915, 0.142	0.434, 0.135	0.183	0.355
Germany	3.013	0.489	0.189	0.354	0.176, -0.003, 2.3E-05	0.881, 0.221	0.206, 0.210	0.155	0.233
Greece	3.262	1.038	0.230	0.220	0.120, -0.002, 1.3E-05	1.062, 0.201	0.280, 0.160	0.154	0.160
Iceland	4.334	0.213	0.308	0.249	0.161, -0.003, 1.9E-05	0.868, 0.204	0.055, 0.000	0.253	0.200
Italy	3.943	0.893	0.200	0.225	0.114, -0.002, 1.4E-05	0.897, 0.180	0.329, 0.092	0.145	0.340
Netherlands	2.830	0.232	0.200	0.282	0.307, -0.007, 4.9E-05	0.938, 0.254	0.102, 0.200	0.194	0.293
Portugal	3.229	0.557	0.249	0.298	0.172, -0.004, 2.6E-05	0.937, 0.136	0.238, 0.110	0.208	0.234
Spain	3.378	0.368	0.183	0.225	0.114, -0.002, 1.4E-05	0.904, 0.148	0.305, 0.064	0.144	0.296
Slovakia	3.799	0.317	0.204	0.250	0.096, -0.002, 1.7E-05	0.974, 0.105	0.326, 0.131	0.181	0.151
Sweden	2.155	-0.034	0.233	0.315	-0.021, 0.001, -1.2E-05	0.796, 0.223	0.326, 0.070	0.255	0.409
UK	2.315	0.371	0.231	0.302	0.183, -0.004, 2.2E-05	0.920, 0.200	0.105, 0.090	0.163	0.456

[1] Macro ratios: K/Y is derived from Penn World Table 8.0, average from 1990-2011; B/Y is the average of net public debt from 2001-8 (IMF)
[2] Labor targets: $\bar{n}$ is hours worked per capita derived from OECD data, average from 1990-2011; Var($\ln w$) and $\gamma_1, \gamma_2, \gamma_3$ are from the 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 11.1; $\tilde{\tau}_{ss}, \tau_{ss}$ are the average social security withholdings faced by the average earner (OECD) from 2001-7; τ_k and τ_c are either taken from Trabandt and Uhlig (2011) or calculated using their approach, representing average effective tax rates from 95-07. τ_k for Iceland comes from the Iceland Ministry of Industries and Innovation.

Table 16: Country-specific Paramater Values
Estimated by SMM

Country	β_1	β_2	β_3	χ	b	σ_u	φ
Austria	0.959	1.003	0.964	14.40	0.00	0.176	4.30
Czech Republic	0.999	1.041	0.996	21.00	0.00	0.145	11.70
France	0.957	1.013	0.990	18.03	0.25	0.506	3.24
Germany	0.952	0.997	0.952	16.93	0.09	0.439	3.60
Greece	0.989	0.997	0.969	16.50	0.00	0.121	3.70
Iceland	0.962	0.996	0.962	7.53	0.08	0.294	9.60
Italy	0.992	1.016	0.984	20.30	0.00	0.237	6.00
Netherlands	0.942	0.986	0.973	14.75	0.15	0.263	2.98
Portugal	0.960	0.991	0.960	11.50	0.00	0.380	5.20
Spain	0.970	0.997	0.983	24.47	0.00	0.237	5.00
Slovakia	0.984	0.993	0.984	20.40	0.00	0.326	7.20
Sweden	0.917	0.971	0.944	9.40	0.33	0.407	2.20
UK	0.939	0.968	0.939	12.40	0.10	0.379	4.90

Table 17: 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	0.335	$u' = \rho u + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2)$	PSID 1968-1997
σ_a	0.423	Variance of ability	European economies average from Brinca et al (2016)

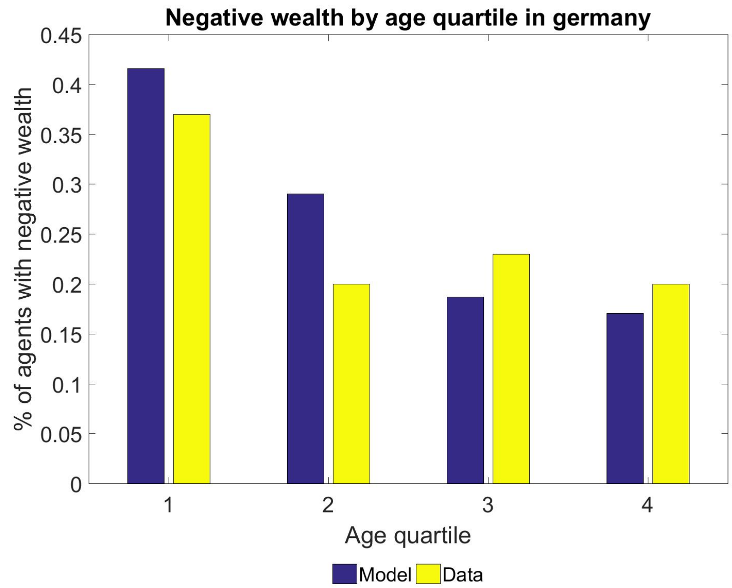

Figure 15: % of agents with negative wealth by age quartile in the model (blue bars) vs empirical observations (yellow bars), in the benchmark economy Germany. Data from ECB HFCS, net wealth of working age households (20-64).

Table 18: Actual consolidation for selected countries. Positive values represent a consolidation. All values are in percentage of GDP.

Country	Actual Consolidation
Austria	1.0
Czech Republic	2.1
France	1.2
Germany	0.3
Greece	10.3
Iceland	4.0
Italy	0.2
Netherlands	0.1
Portugal	2.7
Spain	1.5
Slovakia	2.0
Sweden	0.9
UK	3.0